Re searching Scientific Careers

Edited by
Katarina Prpić
Inge van der Weijden
Nadia Asheulova

(Re)searching Scientific Careers

Edited by
Katarina Prpić,
Inge van der Weijden,
and
Nadia Asheulova

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Contents

List of figures . . . vi
List of tables . . . vii

Foreword . . . 1

Katarina Prpić
Prolegomenon: widening scientific career studies . . . 3
1. Scientific career studies and science and technology studies (STS) . . . 3
2. The concept and composition of the book . . . 6
3. What can be tentatively concluded about academic/scientific careers? . . . 10

Part I. Academic career development

Pleun van Arensbergen, Inge van der Weijden and Peter van den Besselaar
Academic talent selection in grant review panels . . . 25
1. Introduction . . . 25
2. Theoretical background . . . 26
2.1. Peer review . . . 27
2.2. Past performance . . . 28
3. Data, research questions and methods . . . 30
3.1. The case . . . 30
3.2. Research questions . . . 33
3.3. Methods . . . 34
4. Results . . . 34
4.1. The evidence of talent . . . 34
4.2. Effects of the procedure . . . 39
4.3. The dimensions of talent . . . 43
4.4. Predictors for talent selection . . . 46
4.5. Is talent gendered? . . . 47
5. Conclusions and discussion . . . 49

Laura Cruz-Castro and Luis Sanz-Menéndez
(with the collaboration of Kenedy Alva)

The dynamics of academic promotion in Spanish universities ... 55
1. Introduction ... 55
2. How long does it take to receive tenure and why? ... 58
3. Methodology ... 61
4. Time-to-tenure in Spanish universities ... 65
5. Conclusion ... 80

Felizitas Sagebiel

Academic women leaders' career and their potential as gendered organizational change agents ... 85
1. Introduction ... 85
2. Some selected theoretical and research references ... 88
3. Qualitative methodology ... 90
4. Results ... 92
4.1. Leadership style and gender stereotypes ... 92
4.2. Output orientation, commitment and availability ... 96
4.3. The role of networking and networks ... 99
4.4. Understanding technology ... 105
5. Summary of results and conclusions ... 107

Part II. Research career context and preconditions

Teresa Carvalho, Sónia Cardoso and Sofia Branco Sousa

Changes in the institutional context and academic profession — a case from Portugal ... 117
1. Introduction ... 117
2. Current challenges to the academic profession ... 118
3. The Portuguese context ... 120
4. Method ... 124
5. Findings ... 126
5.1. Contract duration ... 126
5.2. Time regime ... 134
6. Conclusions ... 140

Izabela Wagner
Work and career aspects of 'ghetto laboratories' 145
1. Introduction 145
1.1. Mobility of scientists — internationalization in the world of research activity 145
1.2. Literature on multicultural laboratories — an ignored issue? 147
1.3. Concepts (theory and field) — objective and subjective perceptions 148
2. Methodology 149
2.1. Ethnography and research questions 149
2.2. The world of laboratories: between multi-culture teams and the ghetto laboratory 150
3. Data analysis 151
3.1. Language: beyond pidgin laboratory English 151
3.2. Culture: between tolerance and stereotypes 156
4. Conclusions: the ghetto lab — a miracle solution 163

Nadia Asheulova and Svetlana Dushina
Research career development in Russia: the role of international mobility 171
1. Introduction 171
2. Academic careers in Russia: institutional context 172
3. Mobility of Russian scholars in the past 178
4. Empirical study of Russian scientists' international mobility 182
4.1. Research methodology and respondents profile 182
4.2. Results 183
5. Mobility as a measure for boosting academic careers: the experience of China 190
6. Conclusion 193

Blanka Groboljšek, Franc Mali, Anuška Ferligoj and Luka Kronegger
Career aspects of Slovenian researchers' collaboration practices 197
1. Introduction 197
2. The importance of scientific collaboration to ensure more successful professional careers for scientists 199
3. Some advantages and disadvantages of scientific collaboration 204
4. The case of Slovenia 208

4.1. Methods ... 210
4.2. Results ... 212
5. Discussion and conclusion ... 219

Marija Brajdić Vuković
The mentoring of young researchers in the natural and social sciences in Croatia ... 225
1. Introduction ... 225
2. Research questions ... 230
3. Methods ... 230
3.1. In-depth interview ... 230
3.2. Sample ... 231
3.3. Ethics ... 232
3.4. Procedures and analysis ... 232
4. Results ... 232
4.1. Socialization outcomes and the responsibility of formal supervisors ... 233
4.2. High-quality mentoring practices ... 235
4.3. Challenges and obstacles to achieving high-quality mentorship ... 240
5. Discussion and conclusions ... 243

List of contributors ... 251
Subject index ... 256
Name index ... 261

List of figures

- The general grant allocation procedure
- Standardized external referee scores for the complete set of applications
- Average panel scores before and after interview in panel which clearly identified a top talent in both review rounds
- Average panel scores before and after interview in panel which identified top talents only after the interview
- Average panel scores before and after interview in panel which identified no top talents
- The 1st panel review by external referee score
- The 2nd panel review by 1st panel review
- Gender bias by number of female panel members
- Gender bias by number of female applicants
- Survival function from PhD to tenure: general
- Survival function from PhD to tenure: early publications
- Survival function from PhD to tenure: age at PhD
- Survival function from PhD to tenure: PhD abroad
- Survival function from PhD to tenure: postdoctoral international mobility
- Survival function from PhD to tenure: mobility outside academia
- Survival function from PhD to tenure: mobility across research groups
- Survival function from PhD to tenure: tenure in a centre different from PhD
- Survival function from PhD to tenure: involvement in research groups
- Survival function from PhD to tenure: collaboration with PhD supervisor
- Survival function from PhD to tenure: sex
- Survival function from PhD to tenure: research field
- Academics' distribution by educational attainment (degree) and type of institution
- The Dynamics of young colleagues in Institutions of the St. Petersburg Centre of the Russian Academy of Sciences (by year and age group)
- Proportion of laboratory leaders in research institutions of the St. Petersburg scientific centres by age
- Recruitment of graduates of research institutes at the St. Petersburg scientific centres (2000–10) (in numbers)
- What is it that most distracts you from scientific work?
- Do you consider the possibility of working abroad with the goal of a professional career in science and higher education?
- Number of Postgraduates and Students Studying Abroad
- The dynamics of single-authored and co-authored publications
- Scientific collaboration in mathematics and sociology over time
- Scientific collaboration in physics and biotechnology over time

List of tables

- Number of applications per scientific domain and funding programme across the selection procedure
- Disagreement in evaluations by external referees per domain and funding program
- Number of panels (n = 27) which identified top talents before and after the interview, and which identified the same top talents in both selection phases
- Use of evaluation scale
- Changing use of the scores by changing context (n = 26)
- Correlations between the standardized panel review scores for the three criteria per domain
- Used weights for the three criteria
- Simulations: average correlations between rank orders based on five weights for each funding programme and field
- Scenario 5 (Impact with heavy weight) versus scenario 2 (Reality (until 2012)): Number of different grantees
- Logistic regression of the selection of interview candidates
- Logistic regression analysis to predict grant allocation decisions
- Institutional features of the public university system in Spain: snapshots
- Description of the variables
- Descriptive statistics of the variables
- Independent variables and time-to-tenure
- Survival function of Kaplan-Meier
- Log-logistic survival model and expected length of time-to-tenure (general and by research field)
- Log-logistic survival model and expected length of time-to-tenure by type of post-doctoral international mobility
- Academics' distribution by HE subsector and type of HEI
- Academics' distribution by tenured and non-tenured positions in public universities and polytechnics
- Academics' distribution by academic rank and educational attainment in universities
- Academics' distribution by academic rank and educational attainment in polytechnics
- Academics' distribution by time regime in HEIs
- Academics' distribution by time regime and academic rank in universities
- Academics' distribution by time regime and academic rank in polytechnics
- Postgraduate courses in Russia
- Which problems of domestic science you consider the most important?
- What does the most hold you in the position at the scientific institute?
- What preferences do you have for the country of your scientific career?
- What kinds of international cooperation have you participated in during the past five years?
- How did the international cooperation increase your career possibilities?
- Some general network properties by scientific disciplines

Foreword

The Sociology of Science and Technology Network (SSTNET), which is another name for the European Sociological Association's (ESA) Research Network 24 (RN24), was founded in 1999. Its aim has been to offer *a European platform for sociologists to meet, exchange ideas and strengthen their specific profile for the purpose of interdisciplinary collaboration* (see the RN24 webpage on the ESA website). The network's *raison d'être* and activities include the organization of bi-annual scientific meetings — mostly workshops — in order to promote the development and exchange of current sociological and interdisciplinary approaches and research results among the STS (science and technology studies) community.

In collaboration with the Institute for the History of Science and Technology (IHST) of the Russian Academy of Sciences (RAS), RN24/SSTNET convened its latest workshop whose title, proposed by a board member — Inge van der Weijden — was *Career Development in Academia*. The workshop took place on 5 and 6 July 2012 in St. Petersburg. It was attended by a total of 43 participants from 13 countries, mostly European: Austria, Azerbaijan, Belgium, Croatia, Finland, Germany, Mexico, Poland, Portugal, Russia, Slovenia, Spain and the Netherlands. The Workshop Selection and Organizing Committee included the following SSTNET board members: Nadia Asheulova (Committee Chair) Katarina Prpić (SSTNET Chair), Harald Rohracher (SSNET Co-chair) and Aaro Tupasela. The two-day workshop covered several themes crucial for a better understanding of academic careers, presented recent science career studies and highlighted the need to develop further research and collaboration between researchers in this field.

Given the relevance of the workshop topic and the quality of the presentations, it was decided that a selection (a book) of the most interesting papers should be published. Therefore, contributions were invited from the workshop presenters. The details of the book's concept and the selection criteria are explained in the introduction. The production of this book, as the second one co-published by SSTNET (*Women in science and technology* being the first), fulfils one of the main goals of the network — furthering and facilitating the publication of current sociological research as well as related and interdisciplinary research in the STS field.

We are most grateful to the European Sociological Association for workshop funding and, especially, to the Institute for the History of Science and Technology of the Russian Academy of Sciences as a workshop co-financier and (local) co-organizer. More importantly, we are indebted to the Russian Science Foundation for the Humanities and the Centre for Science and Technology Studies (CWTS) of Leiden University for funding this book. Our special thanks should go to the workshop participants, including the keynote speaker Prof. Dr. Paul Wouters and, above all, to the authors of the chapters in this volume for their collaboration and cooperativeness.

Katarina Prpić
Inge van der Weijden
Nadia Asheulova

Prolegomenon: widening scientific career studies

Katarina Prpić

1. Scientific career studies and science and technology studies (STS)

The rationale for preparing a scientific meeting and subsequent book on academic careers rests not only on the cognitive and policy relevance of this research theme but also on its neglect and underrepresentation in STS. At the same time, it is usually studied in the related scientific fields, (sub) disciplines, and specialities. This disciplinary fragmentation results in quite an impressive total number of studies of academic careers, but they mostly lack a broader techno-scientific context, theoretical approach and interdisciplinary perspective.

Academic career studies have been most frequently conducted within the field of (higher) education, especially within the sociology of higher education (HE), the sociology of academic work (Musselin, 2008), educational psychology and the (social) psychology of HE. There have also been many investigations of academic careers in other scientific fields, especially various medical specialities, not to mention numerous (higher) education policy studies and studies of career guidance and counselling. Taking all those educational fields and subfields which deal with the research topic into account, it is not surprising that over 3,000 papers on academic career topics published from 2000 to 2013 in scholarly journals can be found in the EBSCO aggregating database.[1]

Contrary to HE studies, in the field of STS far fewer investigations and publications have been produced regarding academic career issues. In his inspiring keynote talk at the SSTNET workshop *Academic career development* held in St. Petersburg in 2012, Paul Wouters observed that scientific career studies were a relatively small field compared to other branches of the sociology and history of science.[2]

[1] An EBSCO database search was conducted on 21 May 2013, using the syntagma *academic career* as operator, and yielded 3,186 papers in scholarly journals prevalently from the (higher) education field. The search was restricted exclusively to the full texts of papers published in reviewed scientific/academic journals.

[2] This is not a quotation, but a statement based on an audio-video record of the keynote and is a rather accurate reproduction of the keynote speaker's wording.

This statement applies to contemporary scientific career studies as well as to earlier STS. However, the theme of academic careers was of special interest for the Mertonian sociology of science, though it was investigated primarily with the aim of studying the reward systems and social stratification in science. The interest was reflected in many studies sharing this approach, but only a few of them explicitly dealt with scientists' careers (Clemente, 1973; Long, 1978; Long et al., 1979). Due to its research priorities, the entire discipline was (almost pejoratively) called the 'sociology of scientists'. On the other hand, the main STS streams later showed no particular interest in scientific careers due to their primary research preoccupations with knowledge in the making, scientific practice, technology and policy issues, and science and society relations.

As comprehensive meta-studies of STS indicate, the big divide between quantitative and qualitative research and further thematic, theoretical and methodological fragmentation and differentiation have been the main features of the field's development from the end of the 1970s onward (Edge, 1995; Van den Besselaar, 2001; Martin et al., 2012). Yet scientific careers have not been a major research theme of either qualitative or quantitative studies of science and technology, as indicated by the contents of handbooks on STS (Van Raan, 1988; Jasanoff et al., 1995; Moed et al., 2005, Hackett et al., 2008).

The cognitive and social structure of STS shows only one thematic intersection between two STS sub-fields — namely, between quantitative and policy studies — while qualitative studies seem to be an isolated sub-field (Van den Besselaar, 2001). The thematic intersection dealing with scientific performance and evaluation connects a large part of scientometrics and a small section of S&T policy studies (Van den Besselaar, 2001). This finding implies that academic career studies, thematically related but necessarily narrower than research into evaluation — which has been recently understood as a new intra-sociological discipline (Lamont, 2012) — are an even weaker link between the two STS sub-fields.

Crossover tendencies in the STS field could also encourage basing the development of scientific career studies on more complex theoretical and methodological perspectives instead of the opposite critical-technocratic, qualitative-quantitative, reflexive-non/reflexive approaches. A creative reconciliation announced by David Edge (1995) seems possible, at least in smaller segments of STS. It becomes a more desirable and urgent mission in order to broaden both the HE and STS approaches to research evaluation and careers.

One of the main objections to most studies of academics, regardless of their theoretical orientation, claims that they are *research-centred* (Musselin, 2008: 48). Preoccupied with academics' scientific work, these studies ignore teaching activities instead of focusing on the link between the two core aspects of academic work. This criticism obviously comes from the HE field. An opposed point of view expresses criticism of …*a characteristic limitation of higher education studies, whose focus on organisations and governance excludes the primary social context in which scientific knowledge is produced, namely the scientific community* (Gläser, 2007: 246). Neglecting these communities inevitably leads to neglecting knowledge production and the social structures behind it. This broader view is accordant with the primary interest of STS and the sociology of science for scientific knowledge production.

Could career studies avoid the pitfalls of both perspectives and, if so, then for what reasons? The focus on academic careers is a reduction which neglects the careers of scientists in research settings other than universities (or academia), which is understandable for the HE field but not for STS. Other important research organizations of contemporary S&T are within the governmental and especially the business sectors. Moreover, corporate and industrial science, generally under-investigated in STS (Penders et al., 2009), employs the majority of all researchers in the techno-scientifically developed countries and economies. Those researchers' careers demonstrate considerable specificities compared to academic careers and should be better studied and understood (Dietz & Bozeman, 2005; Murray, 2004; Shapin, 2004).

On the other hand, a reason for broadening the focus of scientific career studies lies in the changes in the mode of knowledge production (Gibbons et al., 1997; Whitley, 2000), science governance changes (Whitley, 2007) and, consequently, establishing research evaluation systems (RESs) (Gläser, 2007). These developments also heavily influence the prevailing academic values and norms (Verbree et al., 2013). The career implications of systemic changes in public and corporate science have yet to be studied. They include the evaluation of researchers' other professional activities besides scientific performance, extra-scientific evaluation criteria and additional, non-academic evaluators (Hemlin & Rasmussen, 2006).

Such a broad approach to research in career studies is programmatic. It could and should be a long-term research agenda for career studies in STS, not the (unrealistic and overambitious) aim of any particular scientific meeting or publication. However, it has influenced the concept of this book, its scientific goals and its criteria. Moreover, the book has not been thematically reduced to academic career studies, since some investigations also included researchers from governmental settings (institutes and laboratories).

2. The concept and composition of the book

At the beginning of this section, a short discussion and explanation of the title of the book is necessary, because of its unconventional wording and specifically its use of brackets around 're' in the word 'research'. This graphical solution '(re)searching' is meant to symbolize the two meanings of the title by the use of two verbs in one word: searching scientific careers and researching scientific careers. The twofold meaning denotes the two aims of the book. The first one is to present some relevant findings on searching for a scientific career, which has an additional connotation of a personal activity in career development. The second goal was to simultaneously present some interesting approaches and methods for researching scientific careers. In a word, both the social phenomenon and the modes of its study are the subjects of this book.

The selection and organization of the book chapters are based on several specific scientific goals and criteria. The first of them was to present the relevant but under-investigated research problems of scientific (academic) career studies in STS. The second selection criterion aimed at a broader theoretical background of the research which is prevalently, but not exclusively, sociological, preferably using psychological, historical or philosophical considerations and thus exhibiting some interdisciplinary thinking. No less importance was attributed to methodological diversity, especially to both qualitative and the quantitative research. A further criterion was to concurrently achieve the thematic diversity and complementarity of the individual chapters on scientific careers. The same applies to selecting the contributing texts, which will demonstrate national and wider regional differences, and the specificities of career development related to the techno-scientific, socio-economic and socio-cultural diversity of various European and other societies. Finally, the societal and policy relevance, social implications and potential applicability of the research were also important criteria for chapter selection and presentation.

All the book chapters are empirical but theoretically well-informed and well-founded research. The qualitative studies are based on interviews, and one of them also applied participatory observation. The quantitative studies mostly use questionnaire surveys or national databases, sometimes combining them with bibliometric analyses. There are also combinations of both quantitative and qualitative methods, which have become a desirable methodological option for research into more complex social phenomena. Such methodological variety indicates that career studies might have promising reconciliatory potential, to encourage bridging the gap between the two traditional streams of STS, the hiatus between qualitative and quantitative methodologies, and their alleged critical or positivistic theoretical correlates.

The composition of the book is based on its topic, concept and text-selection. The book consists of the introduction and two thematic parts/units. The first, *Academic career development* encompasses three chapters dealing with the key mechanisms and outcomes of career advancement in academia: grant allocation, promotion and top-career positions. The second part, entitled *Research career context and preconditions*, indicates a broader thematic framework for career studies. The very title of this part indicates that careers in HE are not the only focus of STS. The (five) chapters included studies of the social, institutional and cultural context of a (non)academic or research career, as well as career-formative processes and determinants, such as the researcher's professional socialization, international mobility and scientific collaboration.

The first part begins with the chapter *Academic talent selection in grant review panels*, by Pleun van Arensbergen, Inge van der Weijden and Peter van den Besselaar. The authors study the selection process of talent, which is a both a scientifically (cognitively) and socially relevant yet under-investigated issue, since previous studies have focused on the relation between past performance and success. Using a dataset of the scores of 897 career grant applications, the empirical analyses have been designed to show how talent is identified, distinguished and selected, and whether talent is gender-sensitive. The main findings show that the evaluation of talent is contextual and depends on the selection procedure. Talent is found to have different (low correlated) dimensions. The role of interviewing is important for selection outcomes, which are barely influenced by external peer reviews. No gender bias was found in those decisions.

The authors of the second chapter, entitled *The dynamics of academic promotion in Spanish universities*, are Laura Cruz-Castro and Luis Sanz-Menéndez in collaboration with Kenedy Alva. The chapter is based on a mail (questionnaire) survey of 1,257 natural, biomedical and engineering scientists from public universities in Spain. The aim of this study is to examine time-to-tenure as well as the relationship between promotion speed and theoretically relevant factors — academic productivity, social embedding and mobility. Using event history analysis, the study found that: a) the role of productivity in promotion is contradictory; b) the social side of academic life is important for faster advancement; c) mobility significantly prolongs the non-tenure period; d) promotion speed varies across disciplines. Key elements in speeding tenure are seniority, loyalty, early productivity and the quality of the PhD granting university.

Felizitas Sagebiel has written the next chapter, *Academic women leaders' careers and their potential as gendered organizational change agents*. The chapter's empirical background comprises case studies done at universities and governmental research institutions in science and engineering. Qualitative methods (56 interviews, four focus discussion groups and website analysis) were used in studying female and male leaders' views of technology, leadership styles, commitment, outcome orientation and the role of networks. The main findings show that women professors: a) have a different leadership style and change the organizational structure and culture; b) develop a different understanding of technology; c) have to struggle for acceptance as leaders; d) experience discrimination in various ways and amounts during their professional careers; e) have less powerful networks in a male domain.

The chapter *Changes in the institutional context and academic profession — a case from Portugal*, at the beginning of the second part of the book, is authored by Teresa Carvalho, Sónia Cardoso and Sofia Branco Sousa. It presents an analysis of the main characteristics of working conditions — the duration of academics' employment contracts and the time regime — in Portuguese academic institutions. The hypothetical framework is based on the studies of contemporary changes in the societal position and role of academic professions and the specificities of Portuguese academic personnel development and career regulations. A quantitative analysis of a national database with 34,986 academics shows that only a small academic elite has secure employment, contrary to the majority of academics. Academics' working conditions are better at public universities than at other types of HE institutions.

Izabela Wagner is the author of the second chapter, *Work and career aspects of 'ghetto laboratories'*. This study deals with a new phenomenon in the social organization of science in the USA — ghetto laboratories with one ethnic minority overrepresented among the scientific personnel, as part of the broader problem of the impact of scientists' cultural origins on their academic careers. It is based on qualitative ethnographical studies conducted in life science laboratories in France, Poland and the USA (400 semi-open interviews and participant observation). According to the main findings, such uni-ethnical research teams are a spontaneous adjustment to participation in the process of the internationalization of scientific work. Bringing together people from similar cultures makes their research work and careers easier and more successful in an immigrant (scientific) culture. The implications of these adjustments are also analysed.

Nadia Asheulova and Svetlana Dushina are the authors of the next chapter, *Research career development in Russia: the role of international mobility.* The text presents an analysis of the changes in the Russian scientific system/context and an empirical study of scientists' international mobility. The analysis of the national institutional context and its career implications in the (post)socialist period(s) is based on Bourdieu's concept of scientific fields, Bauman's concept of interregnum and Schütz's concept of relevance. According to a sociological survey of scientists' international mobility, the major motives of (53) respondents in working abroad are an interesting and creative environment, opportunities for self-realization, abundant science funding and the strong reputation of the host institution. Most of them perceive international mobility as an important factor for career development in research.

The fourth chapter, entitled *Career aspects of Slovenian researchers' collaboration practices*, is authored by Blanka Groboljšek, Franc Mali, Anuška Ferligoj and Luka Kronegger. The theoretical concepts and global trends of collaboration in science are outlined. The empirical analyses deal with: a) the collaboration practices of 1,215 Slovenian mathematicians, physicists, biotechnologists and sociologists in the period from 1986 to 2010; b) the opinions about collaboration of 15 of the scientists interviewed. Bibliographic analysis shows differences in publication patterns among the observed scientific fields. The interviewees' responses mostly suggest pragmatic reasons for collaboration — access to skills, techniques and equipment — but their own initiatives for collaboration and personal compatibility are also relevant. As one of the key factors of publication productivity, collaboration is crucial for scientific careers.

Finally, the last chapter of the book, entitled *Mentoring of young natural and social scientists in Croatia*, has been written by Marija Brajdić Vuković. The hypothetical framework of this empirical study relies on the theories of scientists' professional socialization and mentoring, and on the theories of scientific fields and disciplinary cultures. The main thesis postulates that high-quality mentoring is most important for young researchers' professional socialization and their career prospects. The qualitative research (in-depth interviews) was carried out on a sample of 40 respondents, Croatian research novices from the two scientific domains. The analysis of natural and social science mentoring practices shows characteristic differences between these domains related to their mode of knowledge production. It also demonstrates some similarities between the domains and the impact of the Croatian scientific and social context.

3. What can be tentatively concluded about academic/scientific careers?

Despite differences in the approach, methods, scope and socio-cultural as well as techno-scientific background of the presented studies, their findings still allow some broader but hypothetical or tentative interpretations of academic career development at a more general level. Tentative conclusions may also point to the theoretical, methodological and policy implications of research findings and desirable future research. An attempt to discern the similarities and differences between the findings of the individual studies, and to observe them as a whole within a broad picture of science (career) studies, is worthwhile, even if it cannot result in strong conclusions. Changing the tentative character of the conclusions would imply basing them on the whole corpus of scientific career studies in STS and the much larger HE field instead of just the presented research. This tentativeness also emphasizes the temporary nature of generalizations in the context of the desirable, more complex STS approach to scientific careers, which could be built in future.

At a very general level of abstraction, one common conclusion could be drawn, as pointed out by a referee: *The book shows that the development of careers is mainly shaped by a variety of institutional, social, national, and economic contexts. There is no such thing as a universal model for the development of scientific careers. Now, one could claim that no serious person claims that such a thing would exist. Nevertheless, many spokespersons for scientific organizations often pretend that science is a universal affair and thereby often implicitly suggest that there is such a thing as a universal model for a scientific career*.

At the same time, if the level of abstraction is somewhat lower, several more specific and — consequently — more informative, tentative conclusions about contextual career determinants may be inferred. They might specify a few particularly relevant career contexts and formative mechanisms that have been investigated in the contributing studies, and may be observed in the wider perspective of STS and career studies. Four of them can be clearly identified from the presented empirical material on scientific careers: research(er) evaluation and promotion, the institutional and socio-cultural context, disciplinary frameworks and gender differentiation.

The key importance of scientific performance evaluation for academic career development, and the fact that two book chapters deal with different aspects of evaluation and the (resulting) career promotion, lead to the first tentative conclusion. It questions merit-based research assessment, since the influence of non-merit criteria on performance evaluation and subsequent career advancement has been established again. It is well-known that, long ago, the evaluation of scientists' work was found not to be as universalistic (based on cognitive merit) as claimed by Merton and contradicted by the constructivists who insisted on the constructed nature of assessment (Knorr-Cetina, 1981). Even the Mertonians had to admit that a certain degree of particularism or else the impact of extra-scientific criteria were inherent to research evaluation (Cole & Cole, 1983; Cole, 1992).

More recent research reveals that the cognitive and non-cognitive (social, interactional, emotional) aspects of performance evaluation cannot be separated (Lamont, 2009). The customary rules which are constructed and followed by referees and/or panellists, who believe that their funding decisions are fair and guided by meritocracy, give legitimacy to collective outcomes of peer evaluations (Mallard et al., 2009; Lamont & Huutoniemi, 2011). In a broader sociological approach, the evaluation context is theoretically shaped by the RES type and the public science system, especially research funding (Whitley, 2007).

Two studies based on new insights into the evaluation process and the determinants of the speed of academic promotion arrived at a very similar final conclusion, indicating the impact of non-cognitive rather than merit-based assessment criteria. The Van Arensbergen et al. study clearly shows that the evaluation of talent for grant allocations depends on its context — that is, the way it is organized — and the selection procedure, which allows some personality traits (self-confidence) and interpersonal (communication) skills to strongly influence the assessment outcome and funding decisions. According to Gläser (2007), the Dutch RES seems to be at a transitional stage on route to a strong competitive system at the level of research organizations. At the individual level, researchers apply for competitive grants and the evaluation procedure described in the chapter indicates that the key role in decision-making allocated to the panellists allows them to ignore external review outcomes.

Cruz-Castro and Sanz-Menéndez found that factors more relevant to faster promotion are related rather to researchers' stable integration into the academic social environment than to their scientific performance. *The negative effects of mobility on time-to-tenure do not only provide negative incentives for researchers to change jobs, organizations or countries, they are also a clear expression of the absence of open academic job markets, and of the existence of mechanisms of accessing the profession that could be shaped by particularistic dynamics* (Cruz-Castro and Sanz-Menéndez: 80). The authors explicitly conclude that career advancement in the Spanish university system is not strictly merit-based but also connected with the researchers' permanence and integration into their academic milieu.

Despite the differences between the Dutch and Spanish techno-economic, socio-cultural and science systems, both studies confirm that the evaluation of researchers for grant allocation and promotion is not based primarily on their scientific merits or performances, though it is a declarative, normative assumption of various RESs. Furthermore, the implications of Sagabiel's study of (German) academic women leaders, are almost identical. They reveal that, besides women's qualifications and performances, networks and networking also played an important role in their selection as professors. Though the manifestations of non-merit criteria vary and are influenced by the national science system, their very impact on researchers' evaluations seems to be a common (universal) trait of various career models.

The non-merit phenomena registered could be understood as implicit extra-scientific criteria that stress the importance of scientists' social skills and talents, communication and networking, as well as organizational stability/loyalty. Implicit societal expectations in research evaluation seem to be related to the already mentioned systemic changes in science described in the STS literature. The dominant portrait of an eminent (natural) scientist as a brilliant introvert revealed by most psychological studies (see Feist, 1998) seems to correspond to the (past) academic system of knowledge production and social organization of science, with its less developed division of labour, specialization and cooperation, and much weaker governance.

This historical widening of evaluation subjects and criteria makes it desirable to investigate the implicit (extra-scientific) criteria actually used in the evaluation process, not just what is normatively prescribed. Future research of the hidden criteria of evaluation in science is necessary, not only to understand the nature and mechanisms of evaluation and its relation to knowledge production, but also to develop a policy balance between conflicting interests in S&T: global and local/national, scientific and societal, as well as career and knowledge production interests (Chan & Davey, 2010). Finally, inconsistent findings in the studies of peer review might also *reflect the theoretical fragmentation in sociology of science (and vice versa)*, as shown by one meta-analysis (Bormann, 2008: 33). This implies articulating and using more complex theoretical frameworks which are able to link partial and/or reductionist approaches to research into scientific evaluation and its career effects.

The second tentative conclusion drawn from the contributing studies concerns the social context of scientific work and career opportunities. Despite some common features of different national science systems in contemporary societies, comparative (theoretical and empirical) studies point to national peculiarities which may also form several types of science organization, governance and funding subsystems, as well as performance assessment subsystems (Whitley, 2000, 2007, 2010). As all kinds, levels and aspects of career contexts could not be investigated here, this tentative conclusion is more specific and focuses on the striking, unique and/or contradictory impact of national research and socio-cultural systems on scientific career development.

As such, the study by Carvalho et al. finds the deterioration of Portuguese academics' working conditions in line with the general finding of unfavourable changes in academic professions (Huisman, 2002; Musselin, 2005; Kogan & Teichler, 2007; Enders & Musselin, 2008). Nonetheless, significant differences between academics from different types of HE institutions cannot be ascribed only to the global changes in the social framework of the academic profession. The finding that public polytechnics have worse working conditions than public and private universities (and private polytechnics) seems less striking if perceived as an effect of the Portuguese dual system of HE institutions. That system has created two different career types: university careers and polytechnic careers, with distinctive pathways. This case fits with the general implication of organizational theories of science, which claim that national systems with different shares and roles of public, governmental and private sectors, and with various kinds of institutions, form different organizational settings for scientific work and career development (Whitley, 1984; Fuchs, 1992).

In Wagner's study of ghetto laboratories composed of uni-ethnical teams, this relatively new phenomenon in American S&T is interpreted as a spontaneous organizational response by immigrant scientists in their adaptation to a different working milieu and different career perspectives. The phenomenon has not been observed in European multi-ethnic laboratories, where the 'native' scientists comprise the majority while foreigners represent a minority. The latter, according to Wagner's *en passant* remark, may experience other kinds of problems in an immigrant milieu, such as isolation and sometimes even discrimination. Therefore, ghetto laboratories are a unique kind of research organization that is specific to the social organization of science in the USA.

The contradictory impacts of national research systems on scientific career development can be detected in the inverse effects of the mobility of Spanish and Russian researchers on their careers. Spanish academics' mobility — international, inter-sectoral and within academia — has a negative impact on their promotion. This impact is interpreted by Cruz-Castro and Sanz-Menéndez as a specificity of the national university system, which includes a retention strategy developed by departments based on granting an early permanent job, which rewards the integration of scientists into their local academic milieu rather than performance. On the other hand, a positive influence of international mobility on the career perspectives of Russian scientists was found in the study by Asheulova and Dushina. Mobility provides researchers with opportunities to acquire knowledge, experiences and skills, as well as to use sophisticated equipment not (so) available under the funding of a post-socialist science system.

The opposite career effects of the mobility of Spanish and Russian scientists have no simple explanations. Though the two studies are not fully comparable due to their different methodologies and definitions of mobility, the inverse career effects of researchers' mobility may also be ascribed to the different science systems. Previous contradictory findings about the effects of mobility on career development have already been discussed by Cruz-Castro and Sanz-Menéndez, so it would be useful to observe the problem of mobility within a broader comparative framework. Relevant studies and analyses indicate that scientific mobility is not expected or promoted in Europe as it is in the USA, despite the EU pro-mobility strategy. The same overview analysis finds that whether or not mobility is rewarded in scientific career progression in the EU is country-specific (Morano-Foadi, 2005). Thus, national science systems in the EU (de)stimulate researchers' mobility in various ways and degrees. Rewarding academics' organizational stability, the Spanish university/science system also indirectly rewards their non-mobility.

Russia constitutes quite the opposite example. Like some other post-socialist countries, it has been radically changing its national science system since the 1990s and has seen a massive downsizing of its research personnel, both in the form of brain waste and brain drain. The dimensions of these mobility phenomena are difficult to estimate (Mirskaya & Rabkin, 2004). Nevertheless, Russian science policy strives to raise the level and quality of (young) researchers' mobility in order to intensify the country's inclusion in international scientific cooperation (Erokhina, 2009). The changes in scientists' motivation for international mobility and preference for its shorter variants reported by Asheulova and Dushina may help in the further development of such a policy.

The three seemingly perplexing findings also suggest that various under-investigated effects of national science systems on scientific career development deserve more numerous and more complex cross-national investigations. Empirical comparisons might result in a deeper insight into the similar, different and ambivalent career effects of various social and techno-scientific contexts, but they might also offer a wider typology of these effects.

The third tentative conclusion stresses that scientific communities or disciplinary frameworks are crucial cognitive and social contexts for scientific careers. Mentioning this generalization seems almost redundant because it is such a well-known and accepted cognitive claim, both on the theoretical and empirical levels (Whitley, 1984; Fuchs, 1992; Becher & Trowler, 2001). The disciplinary contexts of scientific career development can be studied only by using a comparative research design, or at least by treating scientific fields/domains as a variable. What is even more important, comparative studies of scientific domains may show field-specific epistemic conditions, which are theoretically recognized but rarely applied to RESs and science policies (Whitley & Gläser, 2007; Gläser et al., 2010). For that reason, it seems important to pay attention to the interplay between the disciplinary and systemic/national determinants of scientific careers.

Two chapters of the volume (those by Brajdić Vuković and by Groboljšek et al.) are based on such disciplinary comparisons of two important career development preconditions — the scientific socialization of young researchers and scientific collaboration — as key dimensions of knowledge production. Taken together, their findings allow a presumption (the third tentative conclusion) about the varying impact of (national) techno-scientific systems on the disciplinary context of scientific careers and vice versa.

Thus, the intriguing issue in those studies is not that they find disciplinary patterns of mentoring or collaboration, but that they exhibit the (dis)agreement of their findings with previous investigations. Brajdić Vuković has found mentorship differences between the natural and social sciences, but mentorship patterns in both domains diverge from the results of previous research. Groboljšek et al. have established considerable disciplinary differences between physics, mathematics, biotechnology and sociology in collaborative and publication cultures. The differences are in accordance with the findings of other studies.

Though both studies confirm the impact of disciplinary cultures on scientific careers, the difference in their accordance with other findings may also indicate different effects of the two national science systems. Despite the well-founded criticism of the Slovenian science system (Mali, 2010), its post-socialist transformation has been radical and rapid enough to result in the large-scale growth of collaboration and considerable changes to knowledge production patterns, similar to the general trends. The Croatian science system has not yet created efficient mechanisms for encouraging scientific achievement and a selective evaluation subsystem (Prpić, 2007), which may generate aberrations in mentoring practices from the observed general trends. A complementary explanation regarding the broader relations between disciplinary and systemic influences on career development will be elaborated later.

Another two chapters treat the discipline/domain context as scientific evaluation or promotion variable(s). The career implications of disciplinary and systemic influences were found by Cruz-Castro and Sanz-Menéndez, since the time-to-tenure is much shorter in the engineering and technological sciences than in the natural fields, and especially in the biosciences and medical sciences. Whether this finding is science system-specific presumes methodologically correct comparisons, but the results of an analysis of the disciplinary context of academic promotion in a different national science system might be indicative. Croatian scientists from the main scientific domains (the natural sciences, engineering, medicine, bio-technological sciences and SSH) showed no significant differences in (average) age when promoted to the highest academic rank (Golub & Šuljok, 2005). Such discrepant results could indicate that disciplinary differences in promotion speed might be empowered or attenuated by (some) national science systems.

At the same time, the disciplinary differences in talent evaluation found by Van Arensbergen et al. are 'classical', usually manifesting a greater disagreement among external referees in the SSH fields than in other fields/domains. The opposite result of a meta-analysis of 48 studies of journal peer reviewing did not show any lower reliability for peer reviews in the social sciences. Moreover, no discipline-specific effect was found (Bornmann et al., 2010). In studying and interpreting various — even contradictory — outcomes of the interplay between epistemic entities (scientific fields and domains) and national science systems, the sociological approach proposed by Gläser et al. (2010) might be fruitful.

The authors distinguish between proximate and remote field-specific (epistemic) factors. The distinction is based on the possibility of them being shaped by authoritative agencies on governmental and/or lower levels (university or organization). The proximate factors are '*authority sensitive' properties of research processes* (Gläser et al., 2010: 311), such as resource dependency, diversity of individual research portfolios, correspondence to societal problems, competitiveness and dependence on uninterrupted research time. Remote epistemic factors are generated by the field's relatively stable practices of knowledge production, such as the role of the scientist's personal interpretation, knowledge codification, division of labour, and the use of empirical evidence (Gläser et al., 2010: 316). Authoritative agencies cannot influence these factors.

According to this distinction, the findings of the individual chapters that deal with or tackle disciplinary differences in the scientific career context may be interpreted as being related either to proximate field-specific factors, which may be shaped by the national science system, or remote factors closely connected with field-specific knowledge production. Therefore, the disciplinary contexts of talent evaluation, career promotion and mentoring can be, to a greater degree, affected by governmental, university or faculty regulations, policies and decisions. On the other hand, collaborative processes and (co)authorship are rooted in field-specific knowledge production and are thus less affected by local, national policies.

It can hardly be claimed that these remote epistemic factors cannot be influenced by authoritative agencies. Science policies which usually impose natural science criteria on their evaluation systems — thus shaping the preconditions of career development — also seem to affect (at least partially) remote collaborative and other research practices. This was predicted 30 years ago by Whitley (1984: 302–303): *The more co-ordination and central planning there is, the more similar and comparable scientific fields will become in their dominant pattern of work organization and in their intellectual goals*.

The fourth tentative conclusion is related to gender differentiation in science and technology, investigated in three chapters. The findings are contradictory, depending on the observed academic achievement level, which is typical for gender studies in S&T. No significant gender differences were found in talent selection between grant applicants (study by Van Arensbergen et al.) or in the speed of academic promotion (study by Cruz-Castro and Sanz-Menéndez). Contrary to those results, the study by Sagebiel indicates that female academic leaders encountered greater barriers than male academics on their way to the top, especially in networking. Moreover, these women — as academic leaders — exhibit different organizational behaviour and have a different view of technology and research than their male counterparts.

These findings reflect and corroborate the dual nature of the general (historical) trend of increasing female participation in S&T, based on decreasing gender differences at the lower levels of academic career achievement, yet accompanied by the stronger persistence of gender differentiation at the top levels of the academic hierarchy (Prpić, 2002).

The dual character of the general trend is usually described by two metaphors, popular both in studies of gender in S&T and in statistical and policy publications and documents: *the leaking pipeline* and the *glass ceiling*. The former, introduced by Barryman (1983) and used in many publications (Etzkowitz et al., 2000; Blickenstaff, 2005; Bennett, 2011), indicates that at each educational and career stage more women than men are lost, which leads to the decreasing representation of women at each stage of career advancement. Despite its popularity, the metaphor has been criticized as being misleading, since it implies a linear career path (EC, 2012).

The *glass ceiling* effect, possessing several meanings (Cotter et al., 2001) and coined by a magazine editor back in the early 1980s, denotes invisible yet solid barriers to women's career advancement in S&T. It is not just used in scientific studies (Rosser, 2004), and it also inspired the construction of the Glass Ceiling Index (GCI), a statistical measure of the relative chances for women, in comparison with men, to reach a top position in S&T (EC, 2013). The limitation of this presumption is that it does not clearly show the pyramidal character of women's participation at all levels of the scientific profession.

However picturesque and attractive these metaphors may be, they do not fully reveal the different courses of gender differentiation at the lower and upper levels of scientific careers, whose main result may be quintessentially formulated as: the higher the level, the bigger the gender gap. Empirical evidence corroborates this generalization, especially comparative cross-national studies, in spite of the national techno-economic, political and socio-cultural peculiarities and the different degrees of women's participation in science and technology.

An empirical comparison of women scientists in three different countries from three continents (USA, Germany and India) has found *male dominance in numbers and vertical segregation* (Gupta et al., 2004: 45). In other words, the findings indicate both a general overrepresentation of men and their increasing predominance in the higher scientific positions across three countries. In their comparison of 17 (mostly European) countries, Etzkowitz et al. (2008) found the increasing participation and continued segregation of women, indicated by their decreasing share at the higher levels of the academic ladder, particularly among full professors, in all scientific domains. A West-East comparison of 12 European countries, based on research within the PROMETEA project shows a few common problems, among them the underrepresentation of women in the sciences (which is even higher in the engineering and technological domains) and a large gender discrepancy at the highest academic and scientific management levels (Šidlauskienė, 2009). Finally, according to a meta-analysis of studies of gender in S&T (EC, 2012: 46), vertical segregation or gendered career advancement *is a common trend in all EU countries and scientific disciplines, although variation is considerable in terms of both scientific disciplines and national contexts*. The analysis shows an even greater gender gap regarding women's participation in scientific decision-making boards and leadership positions in their institutions.

Due to this general feature of gender differentiation in research career development, but also because of some contradictory findings about its specific dimensions (see Van Arensbergen et al.), scientific career studies — focused on gender issues or not — should pay special attention to gender discrimination or vertical segregation (which is a politically popular but mitigating phrasing). For theoretical and policy reasons, subtle forms of gender differentiation are more interesting and relevant to study than its open manifestations, which are usually — but not necessarily — illegal.

In conclusion, we hope that this book might help in widening interest in the theoretical and methodological approaches and policy aspects of scientific career studies in STS. Our aim has not been to build a consistent research agenda for these studies, but rather to offer recent research and methodological diversity in the field, to provoke many new, interesting and relevant questions and to motivate more complex investigations of scientific careers. Whether this book has fulfilled these aims and to what extent it contributes to the research of careers in contemporary science and technology, will be judged by our STS colleagues and the broader scientific public.

References

Becher, T. & Trowler, P.R. (2001). *Academic tribes and territories: Intellectual enquiry and the culture of disciplines*. Buckingham — Philadelphia: The Society for Research into Higher Education & Open University Press.

Bennet, C. (2011). Beyond the leaky pipeline: Consolidating understanding and incorporating new research about women's science careers in the UK, *Brussels Economic Review — Cahiers Economiques de Bruxelles*, 54 (2/3), 149–176.

Berryman, S. (1983). *Who will do science? Minority and female attainment of science and mathematics degrees: Trends and causes*. New York, NY: Rockefeller Foundation.

Blickenstaff, J.C. (2005). Women and science careers: leaky pipeline or gender filter? *Gender and Education*, 17 (4), 369–386.

Bornmann, L. (2008). Scientific peer review: An analysis of the peer review process from the perspective of sociology of science theories. *Human Architecture: Journal of the Sociology of Self-Knowledge*, 6 (2), 23–38.

Bornmann, L., Mutz, R. & Daniel, H-D. (2010). A reliability-generalization study of journal peer reviews: A multilevel meta-analysis of inter-rater reliability and its determinants, *PLoS ONE*, 5 (12), 1–10.

Chan, K.B. & Davey, G. (2010). When worlds collide: Scientists doing science in the social world. *Asian Journal of Social Science,* 38, 611–635.

Clemente, F. (1973). Early career determinants of research productivity. *American Journal of Sociology*, 79 (2), 409–419.

Cole, J.R. & Cole, S. (1981). *Social stratification in science.* Chicago, IL — London, UK: The University of Chicago Press.

Cole, S. (1992). *Making science: Between nature and society*. Cambridge, MA — London, UK: Harvard University Press.

Cotter, D.A., Hermsen, J.M., Ovadia, S. & Vanneman, R. (2001). The glass ceiling effect. *Social Forces*, 89 (2), 655–682.

Dietz, J.S. & Bozeman, B. (2005). Academic careers, patents, and productivity: industry experience as scientific and technical human capital. *Research Policy*, 34, 349–367.

EC (2012). *Meta-analysis of gender and science research: Synthesis report* / Caprile, M. et al., (Eds.). Brussels: European Commission.

EC (2013). *She figures 2012: Gender in research and innovation*. Brussels: European Commission.

Edge, D. (1995). Reinventing the wheel. In: S. Jasanoff, G.E. Marle, J.C. Peterson & T. Pinch (Eds.), *Handbook of science and technology studies* (pp. 3–23). Thousand Oaks — London — New Delhi: Sage Publications.

Enders, J. & Musselin, C. (2008). Back to the future? The academic professions in the 21st century. In: *Higher education to 2030. Volume 1: Demography* (pp. 125–150). Paris: OECD.

Erokhina, K.S. (2009). Scientists' social mobility and problems of its regulation by the state. *Russian Education and Society*, 51 (12), 9–23.

Etzkowitz, H., Kemelgor, C., Uzzi, B., with Michael Neuschatz, M., Seymour, E., Mulkay, L. & Alonzo, J. (2000): *Athena unbound: The advancement of women in science and technology*. Cambridge, UK: Cambridge University Press.

Etzkowitz, H., Fuchs, S., Gupta, N., Kemelgor, C. & Ranga, R. (2008). The coming gender revolution in science. In: E.J. Hackett, O. Amsterdamska, M. Lynch & J. Wajcman (Eds.) *The handbook of science and technology studies* (pp. 403–428). Cambridge, MA — London, UK: MIT Press.

Feist, G.J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality & Social Psychology Review*, 2 (4), 290–309.

Fuchs, S. (1992). *The professional quest for truth: A social theory of science and knowledge*. Albany: State University of New York Press.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. & Trow, M. (1997). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London, UK: Thousand Sage.

Gläser, J. (2007). The social orders of research evaluation systems. In: R. Whitley & J. Gläser (Eds.), *The changing governance of the sciences. The advent of research evaluation systems* (pp. 245–265). Dordrecht: Springer Science — Business Media B.V.

Gläser, J., Lange, S., Laudel, G. & Schimank, U. (2010). The limits of universality. How field-specific epistemic conditions affect authority relations and their consequences. In: R. Whitley, J. Gläser & L. Engwall (Eds.), *Reconfiguring knowledge production: Changing authority relationships and their consequences for intellectual innovation* (pp. 291–324). New York, Oxford University Press.

Golub, B. & Šuljok, A. (2005). Socijalni profil znanstvenika i njegove mijene (1990–2004.). In: K. Prpić (Ed.), *Elite znanja u društvu (ne)znanja* (pp. 123–183). Zagreb: Institut za društvena istraživanja.

Gupta, N., Kemelgor, C., Fuchs, S. & Etzkowitz, H. (2004). The 'triple burden': A cross-cultural analysis of the consequences of discrimination for women in science. In, *Gender and excellence in the making* (pp. 41–50). Brussels: EC.

Hackett, E.J, Amsterdamska, O., Lynch, M. & Wajcman, J. (Eds.) (2008). *The handbook of science and technology studies*. Cambridge, MA — London, UK: MIT Press.

Hemlin, S. & Rasmussen, S.B. (2006). The shift in academic quality control. *Science, Technology & Human Values*, 31 (2), 173–198.

Huisman, J., de Weert, E. & Bartelse, J. (2002). Academic careers from a European perspective: The declining desirability of the faculty position. *The Journal of Higher Education*, 73 (1), 141–160.

Jasanoff, S., Marle, G.E., Peterson, J.C. & Pinch, T. (1995) (Eds.). *Handbook of science and technology studies*. Thousand Oaks — London — New Delhi: Sage Publications.

Knorr-Cetina, K. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford, UK: Pergamon Press.

Kogan, M. & Teichler, U. (Eds.) (2007). *Key challenges to the academic profession*. Paris — Kassel: UNESCO — INCHER-Kassel.

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*. DOI: 10.1146/annurev-soc-070308–120022.

Lamont, M. & Huutoniememi, K. (2011). Comparing customary rules of fairness: Evidence of evaluative practices in peer review panels. In: C. Camic, N. Gross & M. Lamont (Eds.). *Social knowledge in the making* (pp. 209–232). Chicago, IL: University of Chicago Press.

Long, S.J. (1978). Productivity and academic position in the scientific career. *American Sociological Review*, 43 (6), 889–908.

Long, S.J., Allison, P.D. & McGinnis, R. (1979). Entrance into the academic career. *American Sociological Review*, 44 (5), 816–830.

Mali, F. (2010). Policy issues of the international productivity and visibility of the social sciences in Central and Eastern European countries. *Sociologija i prostor*, 48 (3), 415–235.

Mallard, G., Lamont, M. & Guetzkow, J. (2009) Fairness as appropriateness: Negotiating epistemological differences in peer review. *Science, Technology & Human Values*, 34 (5), 573–606.

Martin, B.R., Nightingale, P. & Yegros-Yegros, A. (2012). Science and technology studies: Exploring the knowledge base. *Research Policy*, 41, 1182–1204.

Merton, R.K. (1973). *The sociology of science: Theoretical and empirical investigations*. Chicago, IL — London, UK: The University of Chicago Press.

Moed, H.F., Glänzel, W. & Schmoch, U. (Eds.) (2005). *Handbook of quantitative science and technology research: The use of publication and patent statistics in studies of S&T systems*. New York — Boston — Dordrecht — London — Moscow: Kluwer Academic Publishers.

Morano-Foadi, S. (2005). Scientific mobility, career progression, and excellence in the European Research Area. *International Migration*, 43 (5), 133–162.

Murray, F. (2004). The role of academic inventors in entrepreneurial firms: sharing the laboratory life. *Research Policy*, 33, 643–659.

Musselin, C. (2005). European academic labor markets in transition. *Higher Education*, 49, 135–154.

Musselin, C. (2008). Towards a sociology of academic work. In: A. Amaral, I. Bleklie & C. Musselin (Eds.), *From governance to identity. A festschrift for Mary Henkel* (pp. 47–56). Springer Science + Business Media B. V.: Dordrecht.

Penders, B., John M.A. Verbakel, J.M.A. & Nelis, A. (2009). The social study of corporate science: A research manifesto. *Bulletin of Science Technology & Society*, 29 (6), 439–446.

Prpić, K. (2002). Gender and productivity differentials in science. *Scientometrics*, 55 (1), 27–58.

Prpić, K. (2007). Changes of scientific knowledge production and research productivity in a transitional society. *Scientometrics,* 72 (3), 487–511.

Rosser, S. (2004). *The science glass ceiling: Academic women scientists and the struggle to succeed*. New York, NY: Routledge.

Shapin, S. (2004). Who is the industrial scientist? Commentary from academic sociology and from the shop-floor in the United States, ca. 1900-ca. 1970. In: K. Grandin, N. Wormbs & S. Widmalm (Eds.) *The Science–Industry Nexus: History, Policy, Implications: Nobel Symposium 123*, (pp. 337–363). Sagamore Beach, MA: Science History Publications.

Spiegel-Rösing, I. & De Solla Price, D. (Eds.) (1977). *Science, technology and society: A cross-disciplinary perspective*. London — Beverly Hills: SAGE Publications.

Šidlauskienė, V. (2009). *Gendered career paths in engineering and technology in cross-national and West-East perspective*, (pp. 4–29). From: http://etalpykla.lituanistikadb.lt/fedora/objects/LT-LDB-0001:J.04~2009~1367169917113/datastreams/DS.002.1.01.ARTIC/content. Retrieved 15/11, 2013.

Van den Besselaar, P. (2001). The cognitive and the social structure of STS. *Scientometrics*, 51 (2), 441–460.

Van Raan, A.F.J. (Ed.) (1988). *Handbook of quantitative studies of science and technology*. Amsterdam: North-Holland.

Verbree, M., van der Weijden, I. & van den Besselaar, P. (2013). Generation and life cycle effects on academic leadership. In: S. Hemlin, C.M. Allwood, B. Martin & M.D. Mumford (Eds.), *Creativity and leadership in science, technology and innovation.* Oxford, UK: Routledge.

Whitley, R. (1984). *The intellectual and social organization of the sciences*. Oxford, UK: Clarendon Press.

Whitley, R. (2000). Introduction: Science transformed? The changing nature of knowledge production at the end of twentieth century. In R. Whitley, *The intellectual and social organization of the sciences* (Second Edition) (pp. xi-xliv). New York, NY: Oxford University Press.

Whitley, R. (2007). Changing governance of the public sciences: The consequences of establishing research evaluation systems for knowledge production in different countries and scientific fields. In: R. Whitley & J. Gläser (Eds.), *The changing governance of the sciences. The advent of research evaluation systems* (pp. 3–27). Dordrecht: Springer Science — Business Media B.V.

Whitley, R. (2010). Reconfiguring public sciences: The impact of governance changes on authority and innovation in public science systems. In: R. Whitley, J. Gläser & L. Engwall (Eds.), *Reconfiguring knowledge production: Changing authority relationships and their consequences for intellectual innovation* (pp. 3–47). New York, Oxford University Press.

Part I

Academic career development

Academic talent selection in grant review panels[1]

Pleun van Arensbergen, Inge van der Weijden and Peter van den Besselaar

Career grants are an important instrument in selecting and stimulating the next generation of researchers. Earlier research has mainly focused on the relation between past performance and success. In this study, we investigate the evidence of talent and how the selection process takes place. More specifically, we investigate which quality dimensions dominate, and how changes in weighing these criteria affect the talent selection. We also study which phases in the process are dominant. Finally, we look at the effect of the gender composition of the panel on the selection outcomes. Using a dataset of the scores of 897 career grant applications, we found no clear 'boundaries of excellence' and only a few granted talents are identified as top talents based on outstanding reviews compared to the other applicants. Quite often, the scores that applicants receive change after the interview, indicating the important role of that phase. The evaluation of talent can be considered to be contextual, as the rankings of applicants changed considerably during the procedure and reviewers used the evaluation scale in a relative manner. Furthermore, talent was found to have different (low correlated) dimensions. We also found that external peer reviews barely influence the decision-making. Finally, we found no gender bias in the decisions.

1. Introduction

Attracting and maintaining well-qualified staff is essential for organizations that want to improve their status and reputation. Therefore, universities and research councils aim to select the most talented young researchers, using explicit and also often implicit criteria (Van den Besselaar & Leydesdorff, 2009). As academic career opportunities are by far outnumbered by young researchers who hope to establish an academic career (Huisman et al., 2002; Van Balen, 2010), there is strong competition among researchers (De Grande

[1] This paper is based on earlier publications. It integrates the finding reported in Van Arensbergen and Van den Besselaar (2012), and Van den Besselaar and Van Arensbergen (2013), except for Section 4.3 and Section 4.5, which are based on new research. For more detail, we refer to the two mentioned papers.

et al., 2010). Securing a personal career grant seems increasingly crucial for a successful academic career. Besides the necessary resources to conduct research, it provides recognition of one's talent by the scientific community. As both the quality of the research system and the careers of individual researchers depend on these selection processes, it is important to understand how they function.

Most research on grant allocation focuses on the outcomes, searching for predictors for success. The internal selection mechanism has barely been studied and we therefore do not know what happens during the selection process (Bornmann et al., 2010). Only a few studies have been conducted into the individual steps of the selection process (e.g., Hodgson, 1995; Bornmann et al., 2008). Bornmann et al. (2008) applied a latent Markov model to grant peer reviews of doctoral and postdoctoral fellowships. Their model shows that the first stage of the selection procedure — external review — is of great importance for the final selection decisions. External reviews had to be positive for fellowship applicants to have a chance of being approved. However, Van den Besselaar and Leydesdorff (2009), using a different method, could not confirm this.

In this paper, we study the process of selecting scientific talent through career grants. We will show how the selection proceeds through various phases, how consistent these phases are with each other, and which phases and criteria are decisive for the final selection. We will also look at the differences between disciplinary domains and between the three grant schemes under study.

2. Theoretical background

Although 'scientific excellence' and 'talent' are commonly used (Addis & Brouns, 2004), the meaning of these concepts is contested (Hemlin, 1993). Much debated is, e.g., whether talent is innate or acquired. Talent has been explained by innate factors (e.g., Gross, 1993; Baron-Cohen, 1998), but this research is often criticized as being mainly anecdotal and retrospective (Ericsson et al., 2007). Talent is also conceived in terms of personality (and its genetic components) effecting scientific performance (e.g., Busse & Mansfield, 1984; Feist, 1998; Feist & Barron, 2003). However, others claim that people are not born to be a genius (Howe et al., 1998), as excellence is mainly determined by environmental factors, including early experiences, training, preferences and opportunities. If that is the case, talent should not be considered as a quality in itself but more as innate *potential*. Talent is a process that enhances training and, with that, performance. It involves domain-specific expertise (Simonton, 2008). Consequently, it is difficult to decide who is a talented researcher and who is not.

2.1. Peer review

Selection panel members review and discuss grant proposals or job applications and jointly identify the best ones — often using peer review reports. This decision-making process entails, among other things, reference to one's expertise, explanations of preferences, discussion between proponents and opponents, obedience (or not) to procedures and rules and, finally, reaching agreement. To study this process of scientific reviewing and decision-making, different theoretical approaches can be used. A well-known approach which prescribes how scientists should behave according to the norms and values of science — the so called 'ethos of science' — is the Mertonian sociology of science (Bornmann, 2008). One of these norms is *universalism*, which means that the judgement of knowledge claims should be based on scientific criteria only, without interference by the personal or social backgrounds of the reviewed and reviewers (Merton, 1973 [1942]). Applied to talent selection, access to scientific careers should be based on scholarly competence alone. In this context, talent relates mainly to scientific excellence.

However, Lamont (2009) describes this type of evaluation as a social, emotional and interaction process. In an observation study of grant review panels, she shows that scientific excellence does not mean the same to everyone. Panel members from different fields, with a variety of motivations, use different criteria. And even within fields, people define excellence in various ways. As excellence is not the same for everyone but rather subject to discussion and (dis)agreement, one might consider talent to be 'socially constructed' (Smith, 2001). More generally, emerging with criticism of the Mertonian sociology of science, social constructivism poses that scientific knowledge and judgement thereof is constructed through interpretations, negotiations and accidental events (Knorr-Cetina, 1981). Cole (1992) used some elements of the constructivist approach to make a distinction between the research frontier and the core of scientific knowledge. The frontier consists of new work which is in the process of being evaluated by the community. The core involves a small number of contributions which are accepted by the community as important and true. In this respect, there is a low level of consensus on frontier knowledge and a high level of consensus on core knowledge.

Even within the Mertonian norms, grant applications (and job applicants) are not evaluated and selected separately but in comparison to competing applications (Smith, 2001). Quality is socially and contextually defined from a specific point of reference that evolves during the evaluation process (Lamont, 2009). As a result of this *contextual ranking*, one might expect that the same grant application can be valued differently across panels, process phases and time. This is exactly what Cole and Cole (1981) found in their study of the reviewing of applications for research grants from the National Science Foundation (NSF). After reviewing all and selecting half of the applications, a second group of peers reviewed and ranked the same set again. The two rankings differed substantially. Several proposals that were rejected by the NSF would have been granted if the selection had been based on the second ranking. What, then, determines whether one proposal is evaluated as being better than another? How is talent selected within peer and panel review?

Engaging peers is essential, as they are best suited to reviewing the work of 'colleagues' within their speciality (Eisenhart, 2002). However, peers are often close to the applicants, and this creates tension between peer expertise and impartiality (Eisenhart, 2002; Langfeldt & Kyvik, 2011). This relates to another tension: peer reviews ought to be neutral but not scholarly neutral. Personal interests should be eliminated and the evaluation should be based on scholarly discretion. But where are the boundaries? A third tension exists between unanimity and divergence. Grant review panels are expected to reach a unanimous decision, but at the same time divergence is considered of great value. Divergent assessments lead to discussion and contribute to the dynamics of science (Langfeldt & Kyvik, 2011). As scientific excellence is not unambiguous but defined by reviewers and panel members in their own way, grant allocation is clearly a dynamic process.

2.2. Past performance

Earlier studies on the selection of applications focused mainly on the *past performance* of the applicant.[2] Melin and Danell (2006) compared the past performance of successful and only just unsuccessful applicants to the Swedish Foundation for Strategic Research. As the mean number of publications differed only slightly between the two groups, the awarded applicants could hardly be considered to be more productive than the rejected applicants. A study of the past performance of grant applicants in the Netherlands did

[2] For a more elaborate literature review of the process of grant reviewing and group decision-making, see: van Arensbergen et al. (*forthcoming*), Olbrecht and Bornmann (2010). For an elaborate review of peer review including the reviewing of scientific articles, see Bornmann (2011).

find an expected difference between the tracked records of awarded and rejected applicants (Van den Besselaar & Leydesdorff, 2007, 2009). However, in comparing past performance in terms of the publications and citations of the awardees with the most successful rejected applicants, the latter had a slightly better average past performance than the awarded applicants. A later study found the same for German career grants (Hornbostel et al., 2009) and for international career grants in molecular biology (Bornmann et al., 2010).

In their classical study of reviews of grant applications at the NSF, Cole et al. (1981) found a weak correlation between past performance and granted funding, concluding that the allocation of grants seems to be determined about half by the characteristics of the applicant and the proposal, and about half by chance. Other research has shown that academic rank (Cole et al., 1981), research field (Laudel, 2006), the type of research (Porter & Rossini, 1985), and academic and departmental status (Cole et al., 1981; Bazeley, 1998; Jayasinghe et al., 2003; Viner et al., 2004) (weakly) correlate with quality assessments of applications or applicants. Interestingly, there is barely any literature on the predictive validity or performativity of peer review: do the selected applicants have a better *ex post* performance than the non-selected (Bornmann, 2011; Van den Besselaar, 2013), and is this because the better candidates were selected or because getting the grant produces the best researchers as they have better resources than others?

The chance element reported by Cole et al. (1981) can be partly ascribed to the subjective character of the reviewing process and the social construction of scientific quality. According to Lamont (2009), it is impossible to completely eliminate this subjectivity, given the nature of the processes. The outcomes of the review process, therefore, are affected by who is conducting the review and how the panel is composed (Langfeldt, 2001; Eisenhart, 2002; Langfeldt & Kyvik, 2011). Different mechanisms can be discerned. Firstly, panel members who are nominated by the applicants give higher ratings (Marsh et al., 2008). Secondly, relations between reviewers and applicants influence the ratings. Researchers affiliated with reviewers received better reviews than those without this type of affiliation (Sandstrom & Hallsten, 2008). Thirdly, the way in which the review process is organized influences the outcomes (Langfeldt, 2001). Finally, the importance of the gender dimension is often debated. Given the low number of females in top academic positions, and consequently the lack of female reviewers (Wennerås & Wold, 1997), as well as the persistence of the so-called 'glass ceiling', an empirical analysis is hard to come by. The available empirical evidence provides contradictory results. Broder (1993) examines the rating of proposals from the NSF and finds that female reviewers rate female-authored NSF proposals lower than do their male colleagues. A study by Zinovyeva and Bagues (2011) showed that the gender composition of committees in Spanish universities strongly affects the chances of success of candidates applying to full professorship positions but that it has no effect on promotions to associate professorships. De Paola and Scoppa (2011) did a similar study in an Italian university and showed that gender in the composition of evaluation committees does matter. In competitions in which the evaluators are exclusively male, female candidates are less likely to be promoted. However, gender discrimination almost disappears when the candidates are judged in a panel of mixed gender.

3. Data, research questions and methods

3.1. The case

Our dataset consists of 1,539 career grant applications. These involve personal grants for researchers in three different phases of their careers:

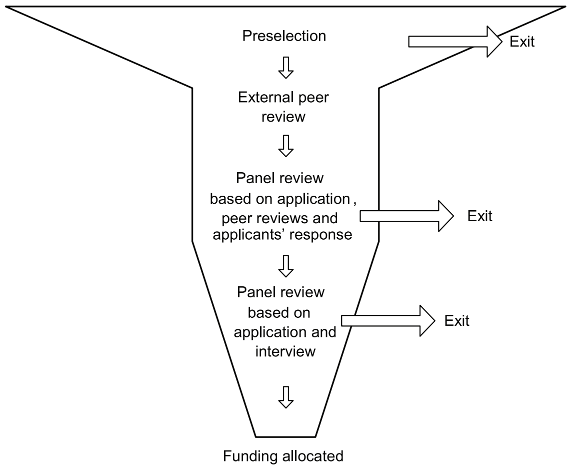
The early career grant scheme (ECG) for researchers who have received a PhD within the previous three years. The grant offers them the opportunity to develop their ideas further.

The intermediate career grant scheme (ICG) for researchers who have completed their doctorates with a maximum of eight years and who have already spent some years conducting postdoctoral research. The grant allows them to develop their own innovative research line and to appoint one or more researchers to assist them.

The advanced career grants scheme (ACG) for senior researchers with up to 15 years postdoctoral experience, and who have demonstrated the ability to successfully develop their own innovative lines of research and to act as coaches for young researchers. The grant allows them to build their own research group.

Figure 1 briefly describes the selection procedure. If the number of applications in the ECG and ICG programmes is more than four times as high as the number of applications that can be awarded (as is generally the case), a pre-selection will take place — this resulted, in our case, in an overall rejection rate of about 40 % of the applications, but with substantial differences between the fields. Because our dataset contains no further information on the criteria and assessments involved in the pre-selection, we do not include this phase in our study. In the ACG programme, researchers first submit a pre-proposal. The selected applicants are invited to submit a full, more detailed proposal. In addition, the selection of pre-proposals is left out of our study, for the same reasons. This reduces the dataset to 897 applications.

Figure 1. The general grant allocation procedure



Next, the applications are sent to external referees who are considered to be experts in relation to the research of the applicant. The number of referees varies between two and six per proposal. The reviews and the applicants' rebuttal are sent to the review panel. Partly based on this input, the panel evaluates every proposal on three criteria: the quality of the researcher (QR), the quality of the proposal[3] (QP) and research impact (RI).[4] The score on research impact is only taken into account if it is better than the proposal score.[5] When this is the case (QP<RI), the final panel score is calculated as follows:

$$\text{Total panel score} = \frac{1}{2}\,QR + \frac{1}{4}\,QP + \frac{1}{4}\,RI$$

If the research impact is scored lower than the quality of the proposal (i. e., if QP>RI), the panel score is calculated as:

$$\text{Total panel score} = \frac{1}{2}\,QR + \frac{1}{2}\,QP$$

The total panel score leads to a ranking of the applications which determines who proceeds to the next round: the interview, where the applicants present their proposal for the panel. Hereafter, the panel again evaluates every interviewed applicant (N = 552) on the same three criteria, taking into

3 More precisely, this is the quality, innovative nature and academic impact of the proposed research.

4 This is the intended societal, technological, economic, cultural or policy-related use of the knowledge to be developed over a period of 5–10 years.

5 From 2012, the Research Impact score will always be included in the calculation of the total panel score.

account the information from the previous phases. To arrive at the final panel score, the same calculation rule is used as was the case prior to the interview. The ranking of the final panel scores determines which applications will receive funding and which are rejected.

The research council consists of eight scientific divisions,[6] which are aggregated into three domains:[7] 1) the social sciences and humanities (SSH), 2) science, technology and engineering (STE), and 3) life and medical sciences (LMS). In our analyses, we will distinguish between these domains when relevant. Table 1 gives an overview of the number of applications per programme and domain. As mentioned earlier, we do not include the applications rejected in the pre-selection phase.

Our data include several attributes of the applications and applicants: gender, the grant scheme, the scientific division and the domain of the application, the referee scores, the panel scores on the three criteria, and the decisions. Between a third (ACG) and a quarter (ICG) of the applications that made it through the pre-selection received funding (table 1).

Table 1. Number of applications per scientific domain and funding programme across the selection procedure

		ECG			ICG			ACG		
		1st review*	2nd review#	Granted	1st review	2nd review	Granted	1st review	2nd review	Granted
SSH	*N*	141	129	54	111	70	28	22	22	9
	%		91.5	38.3**		63.1	25.2		100.0	40.9
STE	*N*	151	70	40	124	65	33	34	34	12
	%		46.4	26.5		52.4	26.6		100.0	35.3
LMS	*N*	161	76	49	118	56	28	35	30	10
	%		47.2	30.4		47.5	23.7		85.7	28.6
Total	*N*	453	275	143	353	191	89	91	86	31
	%		60.7	31.6		54.1	25.2		94.5	34.1

*: external reviewers & 1st panel review; # 2nd panel review
**: If we include all applications, also those rejected in the pre-selection phase, the SSH success rate is lower than the two others. This is due to the very high rejection rate in the SSH pre-selection.

6 These are the following divisions: (1) earth and life sciences (ELS); (2) chemistry (CH); (3) mathematics, computer science and astronomy (MCA); (4) physics (PH); (5) technical sciences (TS); (6) medical sciences (MS); (7) social sciences (SS); (8) humanities (HU). Around 7 % of the applications are cross-divisional (CD).

7 We aggregated the scientific dimensions to the domain level as follows: SSH: social sciences and humanities; STE: chemistry, mathematics, computer sciences and astronomy, physics, and technical sciences; LMS: earth and life sciences, and medical sciences.

3.2. Research questions

The grant allocation procedure (Figure 1) resembles a pipeline model. At the start, there is a big pool of applicants but as the procedure progresses the number of applicants decreases, with only a minority successfully reaching the end: receiving funding. In this study, we aim to understand how applications pass the selection procedure and what determines which applications are eventually successful and which are expelled along the way. This should show how talents are identified or created by the selection process. We answer the following research questions:

1) *How evident is talent?*
   How strong are the correlations between the various reviewers' scores? The stronger they correlate, the more 'evident' talent is. Secondly, do scores vary strongly? Do the selected applicants have significantly higher scores than the non-selected? Thirdly, can we clearly distinguish top talents from the other talents?
2) *Is talent selection dependent on the procedure?*
   Do the rankings of applications in the different phases of the procedure correlate? Is the result stable or does additional information in later phases result in strong fluctuations? And, are reviewers using the evaluation scales consistently throughout the procedure — do scores have a stable meaning?
3) *Which dimensions of talent can be distinguished?*
   Do the three main criteria used by the panels represent different dimensions — or do they in fact measure the same? If they are different, are the rankings dependent on weighting the dimensions? And, what does a change in weighting mean for the selection outcomes?
4) *Which phases of the process and which criteria eventually determine which applicants are considered to be talents*?
   A logistic regression analysis is used to identify which criteria and phases of the selection procedure have most influence on the final grant allocation decision.
5) *Is talent gender-sensitive?*
   Does the gender composition of the panel influence the selection outcomes?

After answering these questions, we will discuss the implications of the findings for the system of selecting and granting research proposals.

3.3. Methods

Some of the following analyses are conducted on the domain and programme levels, others on the complete dataset. In the latter case, the data is standardized beforehand on the domain and programme variables. This was done by calculating the z-scores at the levels of programmes and fields.

Agreement between reviewers is analysed by calculating the standard deviation and the maximum difference between review scores per application and by rank order correlation. We will rank the review scores for each step of the selection process and compare these rankings to see whether applicants were evaluated differently at various point in the procedure. The use of the evaluation scale is analysed with chi-square tests. Rank order correlations are calculated between the three evaluation criteria used by the panels. This will show whether talent has just one or else various dimensions. Finally, to identify the predictors for talent selection we conducted a multiple logistic regression analysis.

4. Results

Evaluation practices differ between scientific domains and funding programmes (for more details, see Van Arensbergen & Van den Besselaar, 2012). Therefore, we will distinguish between the three scientific domains and funding programmes in our analyses.

4.1. The evidence of talent

The applications are refereed by external reviewers and (twice) by a panel. The number of external reviewers per proposal varies between two and six.[8] In general, there are two reviewers for the ECG, three for the ICG and four for the ACG. The external reviewers assign scores on a six point scale ranging from excellent (1), very good (2) and very good / good (3), to good (4), fair (5) and poor (6); this scale (or a similar one) is used throughout the whole procedure. We calculated the difference between the maximum and minimum review scores per proposal. As Table 2 shows, the reviewers disagree least in the ECG scheme (M = 1.59; SD = 1.27) and most in the ACG scheme (M = 2.22; SD = 1.33). The level of disagreement differs

[8] Note that the applications are sent to different external reviewers, so generally reviewers are involved in the evaluation of a single application.

significantly between the schemes, $F(2.895) = 18.72$, $p < .001$, indicating that the further an applicant is in his career, the stronger the average disagreement about his quality.

Taking into account that the number of reviewers varies per grant scheme, we compare the average distribution of review scores per proposal (mean standard deviation, Table 2). The standard deviation can range from 0 (if all reviewers totally agree) to 3.54 (when reviewers totally disagree). However, no significant difference was found between the programmes. Although the maximum disagreement between reviewers increases with the career phases, the mean disagreement remains the same. The higher number of reviewers in the IGC and ACG schemes explains this: the more reviewers per proposal, the smaller the weight of reviews with extreme scores.

We repeated the analysis for each of the domains to find out whether agreement on talent differs between the domains. Only in the ICG scheme did the average disagreement (standard deviation) between reviewers significantly differ between the domains ($F(2.351) = 5.25$, $p < .01$). In the ECG and ACG schemes, no significant differences were found. Finally, for all career phases the reviewers in the SSH seem to disagree more strongly than in the other domains.

Table 2. Disagreement in evaluations by external referees per domain and funding program

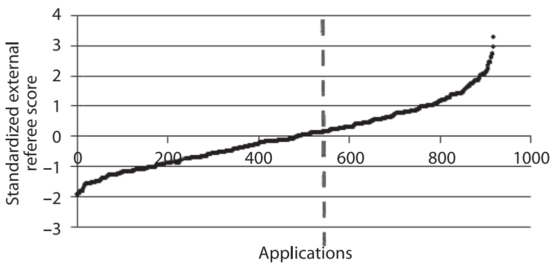
	Early Career Grant		Intermediate Career Grant		Advanced Career Grant	
	Maximum disagreement*	Average Disagreement**	Maximum disagreement*	Average disagreement**	Maximum disagreement*	Average disagreement**
All	1.57	1.05	2.06	1.10	2.22	1.06
SSH	1.60	1.13	2.25	1.21	2.75	1.28
STE	1.68	1.09	1.76	0.95	2.03	0.95
LMS	1.45	0.94	2.18	1.16	2.08	1.02

* Mean of maximum difference between review scores per application
** Mean of standard deviation review scores per application

The selection of interview candidates is done by a panel, taking into account the external reviews and the applicants' rebuttal. The correlation between the standardized external review scores and the panel reviews is used to determine the extent to which evaluators in different phases of the procedure agree on the quality of applicants. In all domains, the external reviews correlate moderately strongly (ECG and ACG: $\tau = .53$, $p < .001$; ICG: $\tau = .52$, $p < .001$) with the first panel scores.[9] After the interview, the same panel evaluates the applicants again while including the new information. The correlation between the panel scores prior to and after the interview is also moderately strong in the domains of STE and LMS ($\tau = .42$, $p < .001$) and strong in SSH ($\tau = .62$, $p < .001$).

The average scores are used to distinguish between the talented and less talented applicants, but how strongly do these scores discriminate? We ranked (for the complete set and per domain) all the applications using the standardized average review score. As Figure 2 shows for the complete set, the distribution has no clear cut-off point, and a similar pattern exists at the domain and programme levels. The dotted line indicates the *de facto* cut-off point of applications selected for the next (interview) phase. However, this selection boundary does not follow from the scores, as the difference between success and only just no success is very small. Similar patterns were found for the panel scores, where the difference between success and failure is very small too.

Figure 2. Standardized external referee scores for the complete set of applications



In conclusion, no clear 'boundaries of excellence' could be identified between selected and not-selected applicants. Moreover, the average scores in the three phases of the procedure only correlate moderately strongly, and this may reflect considerable changes between the rankings. This issue will be addressed in the next section, after we have looked into the evidence of top talents.

[9] Since the dataset is characterized by a large number of tied ranks, we use Kendall's tau instead of Spearman's rho.

4.1.1. Top talents

Figure 2 showed no clear delineation of talent but more gradual differences in talent assessment. Experienced reviewers often claim to easily identify the real top, there are always a few top talents who stand out from the beginning (Van Arensbergen, Van der Weijden & Van den Besselaar, 2013). To test this claim, we looked at the average total review scores per panel in order to identify the top talents. We determined: i) the number of positive outliers (= exceptionally high scores) in the evaluation round prior to and after the interview; ii) the distance between the outliers and the best of the gross evaluation scores; iii) the number of stable outliers (the same outliers in both evaluation rounds).

Figure 3a. Average panel scores before and after interview in panel which clearly identified a top talent in both review rounds

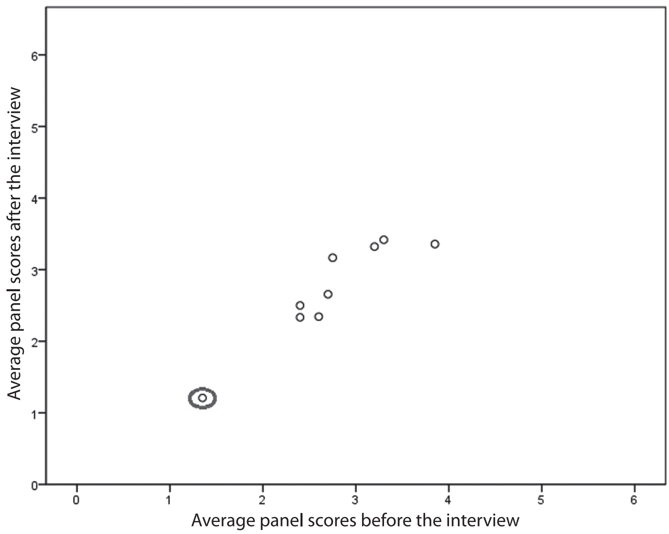


Figure 3a is an example of a panel that clearly identified a top talent both before and after the interview. Figure 3b shows that a clear top was identified only after the interview. Looking at the x-axis, the four applicants eventually identified as the top talents did not stand out in the eyes of the panel members before the interview. An example of a case where no top is recognizable but where all the applicants are close together is depicted in Figure 3c.

In general, we found that a clear top was identified more often after the interview than before (Table 3), making Figure 3b most representative for the 27 panels. In more than half of the panels, no applicants stood out from

Figure 3b. Average panel scores before and after interview in panel which identified top talents only after the interview

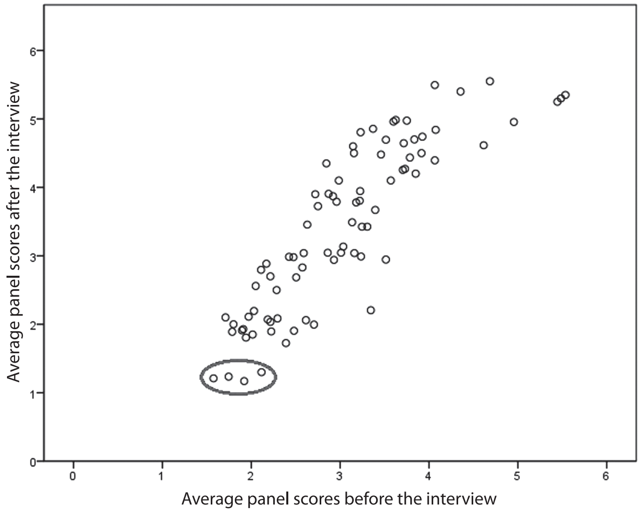
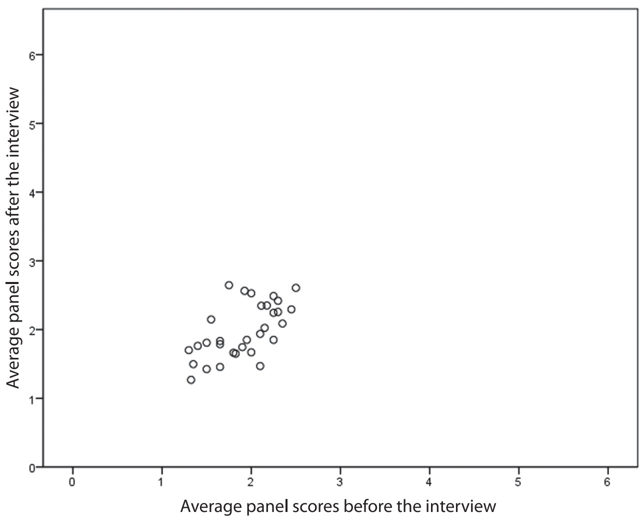


Figure 3c. Average panel scores before and after interview in panel which identified no top talents



the rest before the interview, while after the interview 20 of the panels identified a top. This top predominantly consists of one person, with a maximum of four. For example, seven panels identified one top talent in the first selection phase, whereas two panels identified four top talents.

Also, after the interview, the distance between the (lowest in the) top and the (highest in the) middle group is on average a little larger (0.51, SD = 0.19) than before the interview (0.48, SD = 0.18). Panel members use an evaluation scale from 1 to 6. These average distances of 0.48 and 0.51 clearly differentiate a top from the large middle area, where there is a great deal of overlap and where most applications are very close to each other in terms of their review scores (see Figure 2).

When we look at the stability of the top, we find that only in a few cases were the same applicants identified as top talents both before and after the interview. In 17 out of 27 panels, none of the applicants were identified as a top talent in both the evaluation rounds. In seven panels, we discerned one stable top talent. In total, of the 53 applicants who were in the top at some point of the evaluation process, 15 belonged to the top in both rounds and can be considered to be stable top talents. However, the vast majority of selected applicants (210 out of 263) were never scored as exceptional talent.

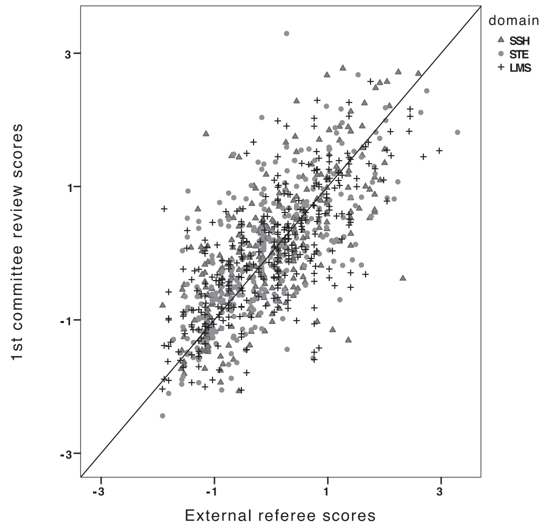
Table 3. Number of panels (n = 27) which identified top talents before and after the interview, and which identified the same top talents in both selection phases

Number of identified top talents	Before interview	After interview	Both before and after interview
0	14	7	17
1	7	8	7
2	3	3	1
3	1	6	2
4	2	3	0

4.2. Effects of the procedure

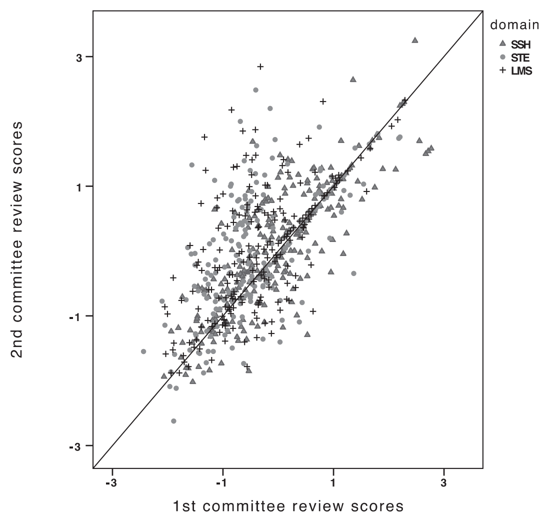
The selection procedure includes three evaluation phases in which new information is added and which may influence the resulting assessment. Figures 4 and 5 show how applications are evaluated differently at different points in the procedure based on the standardized review scores. Right of the diagonal in Figure 4 are the applications that had a better (= lower) first panel score than external review score. On the left side are the applications that had a better external review score. Clearly, the scores and the relative positions of the applications change during the procedure. If external (peer) review scores had been leading, the set of applicants invited to the interview would have been rather different. Since both evaluations are based on roughly the same information, this implies that talent evaluation depends upon the way in which it is organized — it is ‘contextual’.

Figure 4. The 1st panel review by external referee score



In Figure 5, the panel reviews before and after the interview are compared, with right from the diagonal those applications that scored lower (= better) after the interview than before, whereas left of the diagonal the opposite is the case. Panels adjust their assessments after the interview, and some applicants scored rather differently after the interview compared with before.

Figure 5. The 2nd panel review by 1st panel review



This implies that if grant allocation had been based on the evaluation scores before the interview, the outcome would have been different. How strong is this effect? To answer this question, we compare the rankings of applications between the three evaluation moments, showing the importance of the various phases of the selection process.[10] We found that 48 (17 %) of the interview candidates would not have been invited for the interview if the external referee scores had been paramount. According to the procedure, the panel score is decisive. However, there were 24 rejected applicants with a higher total panel score than the selected applicants. This means that 9 % of the successful applicants were not selected simply because they were among the highest total panel scores. The panel thus in fact has additional autonomy in decision-making.

Grant allocation is the final step in the selection procedure. If the grant allocation had been based entirely on the evaluation by the external referees, 26 % of the applicants would not have been allocated a grant. If interviews would not have been part of the procedure — and this is the case in many funding schemes — and the first panel reviews would have determined the grant allocation, 22 % would have been allocated to currently unsuccessful applicants. These findings imply that the interview considerably changes the assessment of talent.[11] As the procedure prescribes, the eventual allocation decision largely corresponds to the final panel score — only 2 % of the granted applicants had a lower panel score than the best rejected applicants.

Differentiating between the funding programmes and scientific domains, differences were found between domain-programme combinations but no overall pattern could be identified (for more details, see Van Arensbergen & Van den Besselaar, 2012).

4.2.1. What do the scores represent?

Having shown how the *perception of talent* changed, we will now study changes in the *use of the evaluation scale* (as distinct from the evaluation of the applications). As has been said, the six point scale ranges from excellent (1), very good (2) and very good / good (3), to good (4), fair (5) and poor (6). Clearly, it is an 'absolute scale'. The panel members assign a score

[10] In some divisions and in the ACG, all the applicants were invited for the interview; these are excluded from this part of the analysis.

[11] In a follow-up study, we investigate the dynamics, the criteria (implicitly) applied, and the effects of the interview (Van Arensbergen et al., forthcoming).

between one and six to each application on three criteria (quality researcher, quality proposal and research impact). Table 4 shows the mean scores and standard deviations for two typical evaluation panels both before and after the decision about which applicants are invited for an interview.

Table 4. Use of evaluation scale

Case	programme & domain		1st panel review all applications			1st panel review selected applications			2nd panel review selected applications		
			researcher	proposal	total	researcher	proposal	total	researcher	proposal	total
1	ECG-STE	N	34	34	34	18	18	18	18	18	18
		Mean	2.89	3.43	3.10	2.28	2.87	2.55	2.56	3.23	2.84
		SD	.84	.78	.73	.54	.45	.47	.83	.95	.84
2	ICG-SSH	N	34	34	34	34	34	34	34	34	34
		Mean	1.69	2.18	1.91	1.69	2.18	1.91	1.79	2.20	1.98
		SD	.38	.43	.35	.38	.43	.35	.38	.49	.39

In case one, about 50 % of the highest scoring applications were selected. As expected, the means for all applicants (first review, all applications) are lower than the means for selected applicants only (first review, selected applicants).[12] The standard deviation of the entire set of applicants is larger than for the selected candidates only — indicating an expected smaller variation among the selected applicants. However, the average and standard deviation of the scores *after* the interview (second panel score) are equal to the values for all applicants in the first review, suggesting that the panel has again applied *the whole scale*: some of the applications scoring very good and excellent in the first round are now only fair or even poor. In this case, the scale is used in a *relative* way, and not as an *absolute* one. In case two, no selection took place, as all the applicants were interviewed. The interview influenced individual scores, but the average and the standard deviation before and after the interview remained about the same. No changes in the use of the scale seem to have occurred here.

Comparing the 14 'selective' panels with the 12 'non-selective' panels (in Table 5) sees a significant correlation between the change of context (selection between the phases or not) and the change of the use of the scale (relative or absolute scale). Consequently, the assessment of talent depends on the context, on the procedure: e.g., an interview, as shown in the previous section, and the number of competitors, as shown in this section.

[12] Please also note that, here, lower scores correspond with higher numbers.

Table 5. Changing use of the scores by changing context (n = 26)

		reduction of nr applicants after 1st panel evaluation			
		yes[a]		no	
decrease average score*	no	4	(28.6 %)	10	(83.3 %)
	yes[b]	10	(71.4 %)	2	(16.7 %)
increase standard deviation**	no	4	(28.6 %)	8	(66.7 %)
	yes[b]	10	(71.4 %)	4	(33.3 %)
Total		14	(100 %)	12	(100 %)

a yes = changing context.
b yes =using the score values in a relative way.
* X^2=7.797, p=0.005; ** X^2=3.773, p=0.05.

4.3. The dimensions of talent

Earlier, we saw that the external reviews correlated moderately strongly with the panel reviews. Distinguishing between the three criteria used by the panel shows that this moderate correlation is mainly due to a relatively weak correlation between the external reviews and the panel scores for research impact, $\tau = .22$, $p < .001$ (SSH); $\tau = .29$, $p < .001$ (STE); $\tau = .36$, $p < .001$ (LMS). In the LMS domain, however, the external referee scores correlate even more weakly with the panel scores for the researcher, $\tau = .32$, $p < .001$. The external reviews are strongest in relation to the panel scores for the proposal, $\tau = .55$, $p < .001$ (SSH); $\tau = .55$ $p < .001$ (STE); $\tau = .64$, $p < .001$ (LMS).

Table 6. Correlations between the standardized panel review scores for the three criteria per domain

		SSH		STE		LMS	
		QR	QP	QR	QP	QR	QP
Before interview	QP	.50*		.50*		.44*	
	RI	.33*	.41*	.38*	.49*	.37*	.47*
After interview	QP	.57*		.56*		.59*	
	RI	.37*	.49*	.31*	.44*	.41*	.47*

QR = quality researcher; QP = quality proposal; RI = Research impact
* p<.001

The three criteria are found to correlate moderately with each other (Table 6). Research impact correlates most weakly with the quality of the researcher in all domains both before and after the interview, ranging from $\tau = .31$ to .41. The correlation between quality of the proposal and quality of the researcher increased after the interview in all domains, strongest in LMS, from τ = .44 before the interview to τ = .59 after the interview.

This suggests that the three criteria represent different dimensions. The total score of the panel (as calculated with the formulas from the method section) therefore depends on the weights attributed to the different dimensions. This may change with the decision-making context. In 2012, a change in the weighting of the research impact score was implemented in the review procedures. From now on, research impact accounts for 20 % of the total panel score, and the quality of the researcher and the proposal for 40 % each. We applied this new procedure to our dataset to explore how this would affect the selection outcomes.

The issue that comes up is: to what extent does the changing of weights influence the selection procedure? Would other applicants have been selected if the three criteria were weighted differently? To answer these questions, we performed some simulations in which we changed the weights. Two analyses can be done: (i) a rank order correlation between the different simulated scores informs us about the impact of the scores. The lower the rank order correlation, the greater the effect the weighting has on the resulting order of applicants. This, by the way, does not imply that changing the weight would also influence the decisions as the altered rank order may be within the set of successful applicants and within the set of unsuccessful applicants. Therefore, (ii) one should check whether the changed order would move applicants from below the success threshold to a place above the threshold, and vice versa.

4.3.1. Does changing weights imply changes in the rank order?

We simulated the outcomes using five different sets of weights, as shown in Table 7. We check it here for the first decision as to whether an applicant is invited or rejected for the interview. For each of the sets, we calculated the score of the applicant, and this led to five rank orders.

Table 7. Used weights for the three criteria

Weights:	1	2	3	4	5
Researcher	0.5	0.5	0.33	0.4	0.4
Proposal	0.5	0.5	0.33	0.4	0.2
Societal impact	0	+	0.33	0.2	0.4

+: If 'societal impact' scores higher than proposal, a new value for 'proposal' is calculated as the mean of the old value of 'proposal' and the value of 'societal impact'

Using these weights, we found for the interview selection that the rank order correlations are rather high. For almost all instrument/field combinations, Spearman's Rho remained between 0.83 and 0.97 (Table 8, left part). The lowest correlations (between 0.62 and 0.80) were all between weights set at 1 (where societal impact would not be taken into account) and weights set at 5 (where societal impact would be strongly taken into account). If it is taken into account, the exact weight may not be very important for the rank order of the applications, as the correlation remains in all cases above 0.83. For the grant decision, we find a similar pattern (Table 8, right part).

Table 8. Simulations: average correlations between rank orders based on five weights for each funding programme and field*

	decisions before the interview			decisions after the interview		
	ECG	ICG	ACG	ECG	ICG	ACG
ELS	0.93	**	0.90	0.89	**	0.97
CH	0.91	0.87	0.93	0.94	0.82	0.97
MCA	0.90	0.92	0.90	0.82	0.84	0.88
CD	0.94	0.90	0.97	0.95	0.90	0.83
HU	**	**	0.88	**	**	0.99
SS	0.84	0.88	0.84	0.83	0.92	0.93
PH	0.87	0.93	0.97	0.96	0.98	0.92
TS	0.88	0.88	0.96	0.89	0.89	0.99
MS	0.83	0.88	0.88	0.86	0.92	0.86

* We use here the more detailed division in fields (see notes 5 and 6)
** Societal impact scores not available

4.3.2. What would this mean in terms of the decisions and success rates in the ECG and ICG programmes?

Table 9 shows that the selection of grantees does depend on the selected weights. Scenario five would have changed the grant allocation between 10.4 % (ECG) and 14.4 % (ICG), and this is, of course, important for the involved applicants. Furthermore, the table shows that there is significant variety between the fields, as in some fields the percentage of different grantees under scenario five would be more than 50 %. Independently of whether this would have had an effect on the science system, the analysis suggests that what counts as talent is indeed context dependent.

Table 9. Scenario 5* versus scenario 2**: Number of different grantees

	ECG		ICG	
	different grantees	%	different grantees	%
ELS	1	5.6	–	–
CH	1	10.0	4	57.1
MCA	3	33.3	3	50.0
CD	1	11.1	2	28.6
SS	3	10.3	0	0.0
PH	0	0.0	0	0.0
TS	1	8.3	1	5.9
MS	3	11.1	1	5.0
Total	13	10.4	11	14.4

* Impact with heavy weight
** Reality (until 2012)

4.4. Predictors for talent selection

The first decision is when panels select and reject applications for the interview round, based on the external reviews, the applicants' responses to these reviews, and the panels' own scoring on three criteria. In order to determine which of these variables best predicts whether an application will be selected for the interview, we conducted a stepwise logistic regression analysis, including the average external referee score and the three panel scores.[13]

The model with only the external reviews correctly predicts in 69.1 % of the cases who goes through to the interview — slightly above the random correct prediction of 61.5 %. In the full model, only the panel scores for the quality of the proposal and the researcher's quality are included, whereas the other variables are excluded (Table 10). These two variables correctly predict in 77.3 % of the cases whether a researcher was invited for the interview or not.

After the interviews, the panel again scores the applications on the three criteria. A logistic regression analysis was performed to predict the allocation decisions from the external referee scores and the three panel scores (Table 11). Again, the external referee scores and the research impact scores do not contribute significantly to the prediction. The panel scores for the proposal and for the researcher result into a correct classification in 83.1 % of the cases. The model with only the external reviews correctly predicts in 65.2 % of the cases who receives funding — slightly above the random correct prediction of 52.3 %.

[13] As the following results show, the stepwise method eliminates two variables because they do not contribute significantly to the model.

Table 10. Logistic regression of the selection of interview candidates

	B (SE)	X^2 (df)	Nagelkerke R^2	% correct
Constant	–0.61* (0.10)			
Quality Researcher	0.71* (0.13)			
Quality Proposal	1.36* (0.15)			
Model		283.96* (2)	.48	77,.3
Not included				
External Reviews	0.23 (0,16)			
Research Impact	0.15 (0.14)			

*p < .001

Table 11. Logistic regression analysis to predict grant allocation decisions

	B (SE)	X^2 (df)	Nagelkerke R^2	% correct
Constant	0.46* (0.15)			
Quality Researcher	1.40* (0.23)			
Quality Proposal	1.80* (0.23)			
Model		294.97* (2)	.65	83.1
Not included				
External Reviews	0.21 (0.18)			
Research Impact	0.08 (0.19)			

*p < .001

Distinguishing between the three funding programmes, in short we found that for early career researchers to a greater extent other factors are taken into account in decision-making. Moreover, the *de facto* weights of both of the included criteria are found to differ between the funding programmes. For the early career researchers, the evaluation of the proposal and the researcher almost evenly determine the final selection decision, whereas for the intermediate and advanced career researchers, the quality of the proposal is more important than the quality of the researcher (for more details, see Van Arensbergen & Van den Besselaar, 2012).

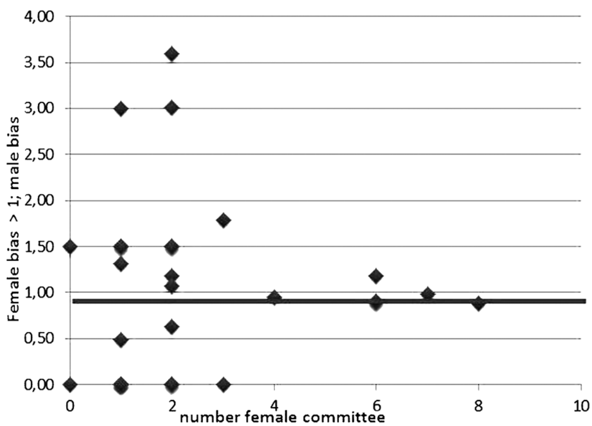
4.5. Is talent gendered?

As suggested in the literature, panel composition is often found to influence decision-making: decisions of panels with no or only a few female members are found to be gender-biased. As councils increasingly claim to support female applications, it is interesting to investigate whether this effect still exists. Do 'male dominated' panels still exist and, if so, do these panels decide more often in favour of male than of female applicants? If no gender bias were to exist, then one would expect that the percentage of granted applications within the set of female applicants is similar to the percentage of granted applications in the set of male applicants.

Of course, this is under the assumption that male and female applicants and applications are, on average, of equal quality. One way of tentatively testing this is by comparing the referee scores for female and male applicants. These are individually given by external reviewers — before the proposals enter the decision-making process. We found that the mean score of male applicants is slightly higher (9 %) than the average score of female applicants. In most fields, this difference is not statistically significant (if we consider the data as a random sample), and insofar as the differences are significant, it is in the more advanced career schemes. For the ECG, differences are small(er) and never significant. We therefore assume that the — comparable — peer review scores are hardly gender biased — if at all (Marsh et al., 2009).

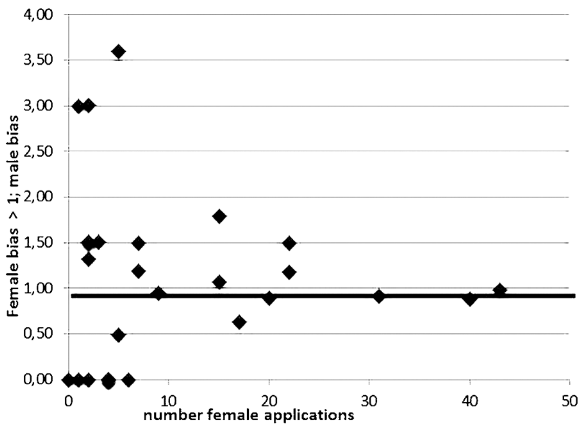
We analyse here the relation between the gender composition of panels and the final selection decision. One may do the same for the interview decision. Figure 6 shows gender bias according to the number of women in the panel. As the figure shows, there are still panels with no or only one female member. However, one cannot conclude that these panels exhibit a gender bias against female applicants. In the lower range of female panel membership, we actually find a large variation in the bias variable. If there is a pattern, it more often seems to actually be in favour of female applicants. Panels with larger numbers of female members consistently seem to have no gender bias in their decisions.

Figure 6. Gender bias by number of female panel members



Why this difference occurs needs further investigation. However, one factor may be whether a field has many or only a few female applicants. In the latter case, the success rate of women is heavily influenced by a single decision. Indeed, as Figure 7 shows, in those fields with few female applicants, the spread in the success rate is large, whereas this is not the case in those fields with many female applicants. Furthermore, one might expect that fields with only a few female applicants would also have somewhat male-dominated panels — since these fields may simply lack female researchers to occupy panels. A study of Van den Brink (2009) suggests that a gender bias in promotion decisions is due to the composition of panels. However, we cannot confirm this, as our data suggest no correlation between the number or percentage of women in a panel and the gender bias in the results.

Figure 7. Gender bias by number of female applicants



5. Conclusions and discussion

First of all, the moderate correlations between the criteria indicate that talent has different dimensions. This implies that the weight of the criteria may strongly influence the selection process. For example, the weight of research impact is very low in the case we studied, but the current tendency to include expected societal impact more strongly in the evaluation of proposals potentially leads to the selection of other types of applicants as 'the most excellent'. However, our simulations suggest that this can only happen if the weight of the societal relevance criterion were to be more substantial than currently implemented.

Secondly, the scores change considerably between the phases. Some applicants — top ranked by the external referees — are not even invited for an interview by the panels. In addition, these same panels regularly change their evaluations of applicants radically after the interview. A clear top can more often be distinguished after the interview than before; however, the actual number of identified top talents is relatively low. The interview seems decisive, but how this works needs further investigation. Does the interview bring new information, leading to a different evaluation? In that case, the procedure does influence the outcome considerably, which can of course be intended and desirable. As such, should the many existing procedures without interviews be abandoned?[14] Or is it because other aspects of talent (such as communicative skills) and several cognitive, motivational and social processes (Lamont, 2009) play a role during the interview, as well as various psychological factors (Hemlin, 2009)?

Thirdly, the role of the external peer review in the quality assessment seems modest (Langfeldt et al., 2010). Using only external review scores as predictors, the percentage of correctly predicted applications is only slightly higher than random (65.2 % versus 52.3 %) and much lower than for the two other predictors (83.1 %). Combined with the moderately (but not very) high correlation ($\tau = .52$) between review scores and panel scores, this suggests that the panel takes the review scores into account, but not very much.[15] Further study is needed, to reveal whether (and if so, how) panel members value and use the peer review reports.

Fourthly, reviewers disagree, and the further a researcher is in his/her career, the more reviewers disagree. In line with earlier studies, consensus about quality is lower in the SSH than in the natural sciences, technical sciences and life sciences (Cicchetti, 1991; Simonton, 2006). Panels and external reviewers also do not draw a clear line between talented and less-talented researchers, as for the middle group very small differences in scores eventually decide who receives a grant and who does not. As the funding decisions are of great importance for the careers of (especially) young researchers, career success becomes partly a question of luck.

Finally, the composition of the panel does not seem to result into a gender bias in the decisions. This suggests that councils' policies to stimulate female participation in science appear effective — at least at the level of their

[14] Interestingly, the very prestigious ERC advance grants do not include an interview with the applicants.

[15] This is in line with the findings by Hodgson (1995) and contrasts with the findings of Bornmann et al. (2008).

panels. Under these conditions, gender bias in outcomes seems to be related to the low number of female candidates in some fields.

In summary, our findings clearly indicate the contextuality of evaluation and decision-making. In improving the transparency, quality and legitimacy of grant allocation practices, it would therefore be desirable to analyse in more depth the details of the *de facto* (implicit and explicit) applied criteria. As the selection procedure influences the evaluation of scientific talent, we suggest using a variety of procedures instead of standardizing. The interview was found to have an important impact on the evaluation of the applicants. If communicative skills and self-confidence are decisive, the selection outcomes will be biased towards these qualities at the moment that all evaluation procedures would include interviews. Since no evident pool of talents could be identified based on the various scores, and as the differences between granted and eventually rejected applications were small, a variety of procedures may result in the selection of a variety of talent.

References

Addis, E. & Brouns, M. (eds) (2004). *Gender and excellence in the making*. Bruxelles: European Commission.

Baron-Cohen, S. (1998). Superiority on the embedded figures test in autism and in normal males: Evidence of an "innate talent"? *Behavioral & Brain Sciences,* 21 (3), 408.

Bazeley, P. (1998). Peer review and panel decisions in the assessment of Australian research council project grant applicant: What counts in a highly competitive context? *Higher Education*, 35, 435–452.

Bornmann, L. (2008). Scientific peer review. An analysis of the peer review process from the perspective of sociology of science theories. *Human Architecture: Journal of Sociology of Self-Knowledge*, 6 (2), 23–38.

Bornmann, L. (2011). Scientific peer review. *Annual Review of Information Science & Technology*, 45, 199–245.

Bornmann, L., Leydesdorff, L. & Van den Besselaar, P. (2010). A meta-evaluation of scientific research proposals: Different ways of comparing rejected to awarded applications. *Journal of Informetrics*, 4 (3), 211–220.

Bornmann, L., Mutz, R. & Daniel, H.D. (2008). Latent Markov modeling applied to grant peer review. *Journal of Informetrics*, 2 (3), 217–228.

Broder, I.E. (1993). Review of NSF economic proposals: Gender and institutional patterns. *American Economic Review*, 83 (4), 964–970.

Busse, T.V. & Mansfield, R.S. (1984). Selected personality-traits and achievement in male scientists. *Journal of Psychology,* 116 (1), 117–131.

Cicchetti, D.V. (1991). The reliability of peer-review for manuscript and grant submissions — a cross-disciplinary investigation. *Behavioral & Brain Sciences*, 14 (1), 119–134.

Cole, S. (1992). *Making science: Between nature and society*. Cambridge, MA: Harvard University Press.

Cole, S., Cole, J.R. & Simon, G.A. (1981). Chance and consensus in peer review. *Science,* 214, 881–886.

De Grande, H., De Boyser, K. & Van Rossem, R. (2010). Carrièrepaden van doctoraathouders in België. Loopbaanpatronen naar wetenschapsgebied. *HR2 e-document.*

De Paola, M. & Scoppa, V. (2011). Gender discrimination and evaluators gender: Evidence from the Italian academy. Italy, Department of Economics and Statistics. University of Calabria. Working paper No. 06–2011.

Eisenhart, M. (2002). The paradox of peer review: Admitting too much or allowing too little? *Research in Science Education*, 32 (2), 241–255.

Ericsson, K.A., Roring, R.W. & Nandagopal, K. (2007). Giftedness and evidence for reproducibly superior performance: An account based on the expert performance framework. *High Ability Studies*, 18 (1), 3–56.

Feist, G.J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality & Social Psychology Review*, 2 (4), 290–309.

Feist, G.J. & Barron, F.X. (2003). Predicting creativity from early to late adulthood: Intellect, potential, and personality. *Journal of Research in Personality,* 37 (2), 62–88.

Gross, M.U.M. (1993). *Nurturing the talents of exceptionally gifted individuals.* In: K.A. Heller, F.J. Mönks & A.H. Passow (Eds.), *International handbook of research and development of giftedness and talent*. (pp. 473–490). Passow: Routledge.

Hemlin, S. (1993). Scientific quality in the eyes of the scientist — a questionnaire study. *Scientometrics*, 27 (1), 3–18.

Hemlin, S. (2009). Peer review agreement or peer review disagreement. Which is better? *Journal of Psychology of Science & Technology,* 2 (1), 5–12.

Hodgson, C. (1995). Evaluation of cardiovascular grant-in-aid applications by peer-review — influence of internal and external reviewers and committees. *Canadian Journal of Cardiology,* 11 (10), 864–868.

Hornbostel, S., Bohmer, S., Klingsporn, B., Neufeld, J. & von Ins, M. (2009). Funding of young scientist and scientific excellence. *Scientometrics,* 79 (1), 171–190.

Howe, M.J.A., Davidson, J.W. & Sloboda, J.A. (1998). Innate talents: Reality or myth? *Behavioral & Brain Sciences*, 21 (3), 399.

Huisman, J., de Weert. E. & Bartelse, J. (2002). Academic careers from a European perspective — the declining desirability of the faculty position. *Journal of Higher Education,* 73 (1), 141.

Jayasinghe, U.W., Marsh, H.W. & Bond, N. (2003). A multilevel cross-classified modelling approach to peer review of grant proposals: The effects of assessor and researcher attributes on assessor ratings. *Journal of the Royal Statistical Society Series a-Statistics in Society*, 166, 279–300.

Knorr-Cetina, K. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford, UK: Pergamon Press.

Lamont, M. (2009). *How professors think. Inside the curious world of academic judgment*. Cambridge, MA: Harvard University Press.

Langfeldt, L. (2001). The decision-making constraints and processes of grant peer review, and their effects on the review outcome. *Social Studies of Science*, 31 (6), 820–841.

Langfeldt, L. & Kyvik, S. (2011). Researchers as evaluators: Tasks, tensions and politics. *Higher Education*, 62, 199–212.

Langfeldt, L., Stensaker, B., Harvey, L., Huisman, J. & Westerheijden, D.F. (2010). The role of peer review in Norwegian quality assurance: Potential consequences for excellence and diversity. *Higher Education,* 59 (4), 391–405.

Laudel, G. (2006). The 'quality myth': Promoting and hindering conditions for acquiring research funds. *Higher Education,* 52, 375–403.

Marsh, H.W., Bornmann, L., Mutz, R.D. & O'Mara, A. (2009). Gender effects in the peer reviews of grant proposals: A comprehensive meta-analysis comparing traditional and multilevel approaches. *Review of Educational Research,* 79, 1290–1326.

Marsh, H.W., Jayasinghe, U.W. & Bond, N.W. (2008). Improving the peer-review process for grant applications. Reliability, validity, bias, and generalizability. *American Psychologist,* 63 (3), 160–168.

Melin, G. & Danell, R. (2006). The top eight percent: Development of approved and rejected applicants for a prestigious grant in Sweden. *Science & Public Policy,* 33 (10), 702–712.

Merton, R.K. (1973 [1942]). *The normative structure of science.* In: R.K. Merton (Ed.), *The sociology of science* (pp. 267–278). Chicago, IL: The University of Chicago Press.

Olbrecht, M. & Bornmann, L. (2010). Panel peer review of grant applications: What do we know from research in social psychology on judgment and decision-making in groups? *Research Evaluation*, 19 (4), 293–304.

Porter, A.L. & Rossini, F.A. (1985). Peer review of interdisciplinary research proposals. *Science, Technology & Human Values*, 10 (3), 33–38.

Sandstrom, U. & Hallsten, M. (2008). Persistent nepotism in peer-review. *Scientometrics*, 74 (2), 175–189.

Simonton, D.K. (2006). Scientific status of disciplines, individuals, and ideas: Empirical analyses of the potential impact of theory. *Review of General Psychology,* 10 (2), 98–112.

Simonton, D.K. (2008). Scientific talent, training, and performance: Intellect, personality, and genetic endowment. *Review of General Psychology,* 12 (1), 28–46.

Smith, S.R. (2001). The social construction of talent: A defence of justice as reciprocity. *Journal of Political Philosophy,* 9 (1), 19–37.

Van Arensbergen, P. & Van den Besselaar, P. (2012). The selection of scientific talent in the allocation of research grants. *Higher Education Policy,* 25, 381–405.

Van Arensbergen, P., Van der Weijden, I. & Van den Besselaar, P. (*forthcoming*). The selection of talent as a group process.

Van Arensbergen, P., Van der Weijden, I. & Van den Besselaar, P. The notion of talent; what are the talents we are looking for in science? In: S. Hinze et al., (Eds.), *Translational twists and turns: Science as a socio-economic endeavor*; Proceedings 18th STI, Berlin, 2013, 378–384.

Van Balen, B. (2010). *Op het juiste moment op de juiste plaats. Waarom wetenschappelijk talent een wetenschappelijke carrière volgt*. The Hague: Rathenau Institute.

Van den Besselaar, P. More competition, better science — on the predictive validity of grant selection. In: S. Hinze, et al., (Eds.), *Translational twists and turns: Science as a socio-economic endeavor*; Proceedings 18th STI, Berlin, 2013, 385–392.

Van den Besselaar, P. & Leydesdorff, L. (2007). *Past performance as predictor of successful grant applications.* Den Haag: Rathenau Instituut.

Van den Besselaar, P. & Leydesdorff, L. (2009). Past performance, peer review, and project selection: A case study in the social and behavioral sciences. *Research Evaluation,* 18 (4), 273–288.

Van den Besselaar, P. & Van Arensbergen, P. (2013). Talent selection and funding of research. *Higher Education Policy,* 26, 421–427.

Van den Brink, M. (2009). *Behind the scenes of science: Gender in the recruitment and selection of professors in the Netherlands*. Nijmegen: Radboud Universiteit.

Viner, N., P. Powell & Green, R. (2004). Institutionalized biases in the award of research grants: A preliminary analysis revisiting the principle of accumulative advantage. *Research Policy,* 33, 443–454.

Wennerås, C. & Wold, A. (1997). Nepotism and sexism in peer-review. *Nature*, 387, 341–343.

Zinovyeva, N. & Bagues, M. (2011). *Does gender matter for academic promotion? Evidence from a randomized natural experiment?* IZA Discussion Paper No. 5537.

The dynamics of academic promotion in Spanish universities[1]

Laura Cruz-Castro and Luis Sanz-Menéndez
(with the collaboration of Kenedy Alva)[2]

This study attempts to understand the timing in receiving a permanent position and the relevant factors that account for this transition in the context of dilemmas between mobility and permanence faced by organizations. Using event history analysis, the paper shows that research productivity contributes to career acceleration, but that other variables are also significantly associated to a faster transition. Factors associated with the social elements of academic life also play a role in reducing the time from PhD graduation to tenure. However, mobility significantly increases the duration of the non-tenure stage. In contrast with previous findings, the role of sex is minor. The variations in the length of time to promotion across different scientific domains are confirmed. The results show clear effects of seniority and rewards for loyalty, in addition to some measurements of performance and the quality of the university granting the PhD as key elements speeding up career advancement. The findings suggest the existence of a system based on granting early permanent jobs to those who combine social embeddedness and team integration with some good credentials regarding past and potential future performance rather than high levels of mobility.

1. Introduction

Despite public acceptance of the Mertonian normative model in academia and the existence of evaluation and promotion regulations in many universities, little is known about the extent to which granting permanent

[1] This paper is significantly based on work presented in detail in Sanz-Menéndez et al. (2013). This research has been funded by the Spanish National R&D Plan (Ministry of Science and Innovation grant CS0–2008-03100 and Ministry of Economy and Competitiveness grant CSO2011–29431). A previous version of the paper was presented at the Atlanta Conference on Science and Innovation Policy (16 September 2011) and at the Workshop on Career Development in Academia organized by the SSNET of the European Sociological Association (ESA) in St. Petersburg (July 2012). We acknowledge comments from Louise Atkinson, Kieron Flanagan, Hugo Horta, Elvira Uyarra, John Walsh, Paul Wouters, and other participants in those conferences. Also, suggestions and comments to the draft version from Fabrizio Bernardi, Marta Fraile, Koen Jonkers and Jesús Rey, as well as the book external reviewer, are acknowledged.

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jobs is based on performance, productivity or other factors, and to what extent mobility contributes to career advancement. The analysis of the labour markets of academics and their careers, access to tenure and academic promotion, has a long tradition of studies referring to the US (for a review, see Long and Fox, 1995), where the tenure model exists and wages are subjected to negotiation. However, the ability of organizations to develop strategies to recruit and retain the best possible talent is conditioned by institutional structures and the availability of resources; those are key factors in providing understanding and making sense of the career models that universities develop in practice, despite the acceptance of the normative models of merit and mobility.

Because the bulk of the literature on academic promotion refers to the institutional context of US research universities, it is rare to find the structural features of academic systems taken into account in the analyses. However, these features are essential for understanding the different effects that the same factors could have. Universities operate in the context of institutionally embedded organizational dilemmas (Blau, 1973/1994). In different academic systems, departments have to choose between diverse levels of faculty retention and turnover, loyalty and mobility, universalism and particularism, etc. These choices are strongly influenced by the organization and legal regulation of the academic labour market, and by the capacity of organizations to manage their financial and human resources (degrees of centralization), to negotiate salary and working conditions and, more generally, to incentivize their staff. The general levels of differentiation and competition among universities are also key features of the institutional academic context.

In fact, in Europe, we know little about whether, in practice, access to a permanent academic position is governed by merit and universalism or by more parochial and particularistic factors; we also lack a proper understanding of how institutional incentives and mechanisms for assigning recognition shape access to a permanent job and the consequences of organizational strategies in academic careers and how universities cope with dilemmas. The analysis of academic labour markets in Europe has been fragmented (Musselin, 2004) and, in many countries with different university governance structures, knowledge about recruitment, access to tenure and academic promotion as elements of diverse career models is also partial and usually has been addressed on descriptive grounds and country comparisons.[3] To contribute

[3] For example, Pedró (2004), Enders (Ed.) (2001) and some special issues of certain journals (e.g., Journal of Higher Education 2001, vol. 41).

to addressing this knowledge gap, this chapter, constructed with empirical data from the Spanish case, aims to discover what factors account for this academic reward and its timing, and how they relate to the incentive and opportunity structures and resource endowments that organizations have. The Spanish university system is a state-led model managed by professional groups that also characterizes other university systems in Europe and Latin America. The elements summarized in Table 1 create a context favourable to retention strategies and rewarding loyalty.

Table 1. Institutional features of the public university system in Spain: snapshots

Basic Features	Description
Publicness	Public universities account for the greatest share of the system.
Governance and autonomy	It is a state-led model managed by professional academic corporations, constitutionally autonomous from Government but subject to public sector rules as regards budgeting, human resources management, contracting, etc.
Funding	Direct funding is not provided on the basis of performance (Gonzalez Lopez., 2006), but mainly on the number of students and type of degree. Universities have very limited needs to compete for the best professors to keep going or to advance financially, since the contribution of research overheads to their overall funding is small.
Status of academic staff	The university academic employment structure is dual: – Temporary professors. – Permanent (tenured) professors.
Management capability of departments	Departments have some capacity relating to the creation of temporary positions but very little as to the creation of new permanent ones, a function that is highly centralized in university authorities. If a permanent faculty member leaves the institution, the position is often completely lost for the department. There are no salary negotiations in academic recruitment, with salaries are set on the basis of bureaucratic rules.
Selection procedure for tenure	The means of filling out a new permanent position has long been a public call for a tournament.
Decision-making and incentive structure	A life employment (civil servant status) in this context is also part of a feedback mechanism; once the academic is granted tenure he/she becomes institutionally "trapped", with no chance of changing university without again going through a formal tournament (exam).

Source: Sanz-Menéndez et al. (2013)

In fact, even in the US (Berelson, 1960; Caplow & McGee, 1958), some organizations respond to the dilemma regarding mobility and loyalty by developing a strategy based on rewarding commitment and involvement in team activities, combined with some assessment of the potential of the candidates based of indirect elements regarding their performance; all these are elements of the implicit contracts. In some European countries, inbreeding practices are accepted and could play a role similar to those analysed in US universities many years ago (Cruz-Castro & Sanz-Menéndez, 2010; Horta, 2013); in those countries, providing early tenure is key factor of the organizational strategic response to recruitment and retaining.

To provide a micro foundation of the institutional comparison of university systems and career models, we need to understand the timing of tenure and the transition to initial permanent employment; this change is an essential element in explaining how retention becomes a key structural feature allowing universities to compete with other institutions that can negotiate salaries and working conditions.

In fact, the analysis of the differences in duration among those who receive tenure is an empirical task requiring a better understanding of the practical responses of universities to the dilemmas raised by Blau (1973/1994) between turnover and retention, mobility and loyalty, and universalism and particularism. Addressing this issue is relevant from a theoretical as well as from a policy point of view.

From the methodological point of view, previous studies of academic promotion have been dominated by cross-sectional designs; however, these methodologies are known to have important deficiencies regarding the treatment of time (Box-Steffensmeier & Jones, 2004); this is why, in this chapter, we use a longitudinal analysis and survival models to explore duration and time to promotion and its covariates.

2. How long does it take to receive tenure and why?

There is a general agreement that access to permanent life employment is probably the key reward in university careers, especially in systems where wage differentials are marginal and mobility is low. Moreover, the timing of promotion is important because it affects personal incentives to mobility as well as the capacity of organizations to attract and retain talent.

Most of the literature in this area has focused on the likelihood of access to tenure, and there has been little research on academic promotion regarding the issue of timing.[4] The seminal work by Long et al. (1993) was an exception; more recently, users of longitudinal approaches have addressed the duration differences between male and female academics in promotion, with a focus on gender gaps (Xie & Shauman, 2003) and the effects of marriage and parenting (Morrison et al., 2011; Wolfinger et al., 2008), rather than on the general factors which account for promotion and its timing, which has been the case for other countries like Taiwan, Canada and France (Tien, 2007; Nakhaie, 2007; Sabatier, 2010).

According to the literature, we could group most of the thinking regarding transition to tenure according to three explanations (academic performance, social embeddedness and mobility) and capture all the relevant variables.

Academic performance or research productivity — usually associated with publications — has been identified as a central element in academia; thus, in a merit-based system, it should play a central role in the advancement of careers (Fox, 1983; Stephan & Levin, 1991). Moreover, cumulative advantage career processes (Merton, 1968; Allison & Steward, 1974) have been identified as being relevant, whereby we should expect early publication (Clemente, 1973) to play a positive role in promotion.

Long et al. (1993) focused specifically on the length of time to promotion; variation in the timing of promotion was a key component of the dependent variable (i.e., whether or not the scientist was promoted and, if promoted, how many years elapsed before that event). Overall, they found that promotion to associate professorship was influenced by the number of articles published while at the rank of assistant professor. They also reported a lower expected probability of promotion for women; in fact, the positive effect of publications was found to benefit only a minority of extremely productive women. The problem for the generalization of the results was that their sample was field-specific, composed only of biochemists.

Another set of classical variables used in predicting the future performance of the candidates have been the reputation of the universities granting the doctoral degree and indicators of fast educational attainment, such as a short time to doctoral degree (Crane, 1965; Hagstrom, 1971; Long & McGinnis, 1981). As a summary, we expect promotion to tenure to be accelerated by higher levels of individual scientific productivity, the higher reputation of the PhD granting universities and previous fast rates of educational attainment.

[4] The use of longitudinal models is quite extended in other areas of research, such as the analysis of time to graduation (Siegfried & Stock, 2001; Lassibille & Navarro Gomez, 2011) or the study of promotion systems in organizations or companies and their consequences the use of longitudinal analysis (Brüderl, Diekmann & Preisendörfer, 1991; Ishida, Su & Spilerman, 2002).

Researchers work in social interaction, because research and science are a collective enterprise. To advance in their careers, researchers also need to have some level of established social capital (Bozeman et al., 2001). The literature has identified a set of factors related to the social embeddedness of researchers, and those variables, linked to research and organizational contexts, may sometimes be shaped by "particularistic" processes associated with loyal integration in the local environment.

To be socially integrated means to be a part of research groups, and this is especially important in the experimental sciences (Melkers & Kiopa, 2010; Forret & Dougherty, 2004; Martin-Sempere et al., 2008). A specific type of networking in academic life takes place in the context of the relationship with the PhD supervisor if he/she becomes the source of mentorship (Blackburn et al., 1981; Long & McGinnis, 1985; Bozeman & Feeney, 2007). Also, the involvement of the faculty in management tasks and the academic structures of universities — what has been called "institutional service" — could increase social interaction and improve the perceived contribution of candidates to university activities over academic performance (Porter, 2007). Finally, inbreeding, a lack of mobility between the PhD granting university and the university granting tenure (Berelson, 1960; Caplow & McGee, 1958), and staying at the same university for an entire career, could have the effect of reinforcing relations with the local environment; previous research has found that an inbred faculty was at a relative advantage to getting early tenure compared to the non-inbred, although the relationship was barely statistically significant (Cruz-Castro & Sanz-Menéndez, 2010).

All these factors, not necessarily correlated with productivity and performance, are likely to increase the social integration of candidates in the local and organizational environment and create a context in which social familiarity and proximity (Pfeffer et al., 1976) could emerge as particularistic criteria. As a summary, we expect that the transition to permanent job will be accelerated by being a member of a research team following the PhD, developing research collaboration with the supervisor, becoming involved in university service, and by having obtained a PhD at the same university that granted the tenure.

A variety of forms of mobility appear to be relevant factors in understanding academic careers and access to tenure. Geographical mobility has long been claimed to be an important causal factor of promotion (Hargens, 1969; Hargens & Hastrom, 1967) and even as being a key role in gender differences (Shauman & Xie, 1996). A specific valuable form of mobility is having received the PhD abroad. In many countries, the reputation of having a foreign degree could be considered a relevant career factor (Tien, 2007). Internationally mobile researchers (especially postdoctoral) have access to international networks, socialization and to opportunities for increasing their productivity (Aran & Ben-David, 1968; Reskin, 1977), but this type of mobility could also have negative career effects (Melin, 2005) because these mobile researchers could face more difficult integration in local environments. In this vein, previous findings referred to the impact of mobility at early career in Spain revealed that they mainly delay career advancement (Cruz-Castro & Sanz-Menéndez, 2010); when it made a positive contribution this was in the form of sponsored and short-term mobility (Cañibano et al., 2011).

A further form of mobility — moving into the non-academic labour market or into firms — could have the effect of delaying a career in the academic world, especially in the early stages of careers, and could have negative effects, in the short-term, on productivity (Dietz & Bozeman, 2005). Finally, mobility across research groups overlaps with the social integration dimension; this mobility has been identified as an essential means of promoting interdisciplinarity (Sanz-Menéndez et al., 2001; Leahey et al., 2010). However, if contextualized in terms of the local and organizational environments conditioning research activities, it could weaken social embeddedness and delay career advancement, at least in the early phases (Martin-Sempere et al., 2008). In fact, there is no consensus in the literature regarding the universal effects of mobility in the advancement of careers. The expected effect of this set of factors is likely to be conditioned by the general incentive structure of the academic system which, in the Spanish case, does not favour mobility.

There are other relevant factors that should be controlled for, among them: socio-demographic factors (such as age and sex), the field of research, the level of demand and the reputation of universities granting tenure (Hargens, 2012).

3. Methodology

It is well recognized that the previous research on academic careers and promotion has suffered from some important defects, methodological problems and limitations that question the generalization of results: single year studies and cross-sectional datasets, too small N samples, studies referring to a single scientific field or research organization, validity problems of self-reported productivity variables or, in many gender studies, a lack of productivity data, have been mentioned as factors weakening the findings (Chubin et al., 1981; Long & Fox, 1995; Stewart et al., 2009).

In the collection of data for this analysis we tried to cope with these weaknesses. More information on the data and the variables can be found in previous publications of the partial results of the project (Cruz-Castro & Sanz-Menéndez, 2010; Sanz-Menéndez et al., 2013).

For the analysis here, the universe of reference was the faculty of all those in scientific fields who received their first permanent tenure position between 1997 and 2001 at any of the 48 public universities, which represents most of the Spanish higher education sector. University professors who receive a permanent position are granted "civil servant" status; 7,637 individuals received their first permanent position in all research domains at Spanish public universities during the years of reference (3,804 in the science, biomedical and engineering faculties). In order to get valid results by scientific field and the size of the institution, a representative sample of 5,306 individuals was selected from the database (register of civil servants). The sample included faculty members who received tenure in 37 universities.

A mailed, structured, self-administered questionnaire addressing research and professional trajectories was used to construct the different individual and career variables. We received a total of 2,588 valid questionnaires (50 % response rate) with a sample error of 1.58 % and lower than 5 % for the representative sub-samples. Individuals were surveyed using a national mail survey conducted in 2005.

In order to complement the information obtained from the questionnaires and considering that scientific publications in peer reviewed journals are generally accepted as one of the most important elements for a career (Fox, 1983), we constructed a database of the individuals' pre-tenure publications records in journals between 1990 and 2004, included in the Science Citation Index Expanded (SCI) from Thomson-Reuters, by matching the names of the individuals in our survey. We use whole counting. For the present analysis, in order to guarantee the comparability of the measurement of scientific output (publications[5]) we dropped individuals from the social sciences and humanities;[6] thus, our analysis covered three scientific fields, defined according the OECD fields of science (FOS) classification: the biological and medical sciences, exact and natural sciences and the engineering and technological sciences.

[5] Impact or citation of production could also be relevant, but it not included in the analysis in order to avoid the problems of making comparisons across disciplines that have diverse citation models (Cozzens, 1985).

[6] Only a limited number of researchers in those fields (less than 15 % in our original sample) had any of their publications included in these databases, confirming the different publication patterns of the majority of academics in the social sciences and the humanities and the difficulties of analysing scientific performance in these fields based only on international papers (Nederhof et al., 1989).

We collected the data with reference to the moment at which individuals received their tenure rather than when they earned their PhD. This option coheres with our choice of focusing our research on the timing of those getting a permanent job, in the context of retention strategies; we also organized our sample by cohorts (Kamiski & Geisler, 2012), and we have selected the central cohorts as an additional means of reduce the potential bias of the estimates.

Our dependent variable measures the duration (time-to-tenure) that an academic spends as a PhD before gaining tenure, but we are also interested in the relationships between the observed duration and some independent variables of theoretical interest previously identified in the literature. The description of the variable is presented in Table 2.

Table 2. Description of the variables

Variable	Description
Time-to-tenure	Number of years elapsed between doctoral degree and tenure.
	Measures of performance
Postdoctoral publications	It is a quantitative variable representing the individual annual scientific productivity between the year of PhD and the year of tenure (1).
Early publications	It is a quantitative variable representing individual annual scientific productivity during or before the year they are awarded their PhD.
Research competitiveness of the university granting the PhD	A categorical variable that classifies individual universities at which the academics receive their PhDs according to their success rates in getting competitive funding (2).
Time to PhD	A quantitative variable calculated to represent the number of years elapsed between receiving a bachelor's degree and receiving a PhD. It is used as a proxy of the rate of educational progress.
	Measures of social embeddedness
Involvement in research groups	A dummy variable measuring whether or not the individual has carried out their activity during the postdoc period, in the context of research groups or teams.
Collaboration with PhD supervisor	A dummy variable measuring whether or not the respondent has continued collaborating in research with their PhD supervisor after receiving their PhD.
University service	A dummy variable measuring whether or not the respondent has been involved in representative, administrative, managerial or bureaucratic positions in the university after the PhD.
Inbreeding status	A dummy variable measuring whether or not the individual received tenure at a different university from the one that awarded him/her the PhD degree (3).

Table 2 (continued)

Variable	Description
	Measures of mobility
PhD at a foreign university	Dummy variable that measures whether or not the individual has been granted the PhD by a foreign university.
Postdoctoral international mobility	A categorical variable that measures if the respondent reports academic postdoctoral stays abroad (of more than one month).
Mobility across research groups	A dummy variable measuring whether or not the individual has worked with more than one research group during the postdoc period.
Mobility outside academia	A dummy variable measuring whether or not the respondent received their first post-PhD employment in a non-academic or non-research organization.
	Control variables
Age at PhD	A quantitative variable representing the age of individuals at the time of receiving the PhD.
Sex	Male or Female.
Research field	A categorical variable of the researcher's main domain of activity.
Research competitiveness of the university granting tenure	A categorical variable that classifies individual universities in which the academic had tenure, according to their success rates in getting competitive funding (2).
University demand level	A categorical variable that classifies individual universities in which the academic received tenure according to the average aggregate rate level of growth in new tenured positions for the years under consideration (1997–2001) (4).

Notes:

(1). This variable was transformed into its natural logarithm because of the skewness of the distribution.

(2). Because, in Spain, there is no recognized ranking of reputation, we use this proxy of university "research orientation" to stratify the universities. The tiers are constructed based on the ranking of research competitiveness (Garcia & Sanz-Menéndez, 2005), which represents the position of each university with regard to the ratio of success in applications for the competitive funding of R&D projects.

(3). It includes the so-called "silver corded" scholars (Berelson, 1960).

(4). The average rate of growth, for 1997 to 2001, in the number of associate professors in Spanish public universities was 56 %.

The units of analysis (individual researchers) are each in a state (PhDs without tenure) that allows them to take part in the permanent position competitions at the universities. Units are observed over time since the year of PhD and, at any given time of the process, each unit is "at risk" of experiencing the event (getting a permanent job) at any specific time. Their survival time, in the transition process, is modelled as a probability of survival hazard rate (or rate of transition). Next, we use event history analysis (EHA) to model both the length of time spent in the initial state and the transition to a subsequent state (that is, the event). The simplest approach to this kind of data is to use regression models; however, inspection of the data reveals a non-linear relationship with time — a standard ordinary least squares regression is not appropriate.

EHA, through the use of parametric models, is better suited for dealing with non-linear processes and estimating the function of transition to tenure. We have also controlled for unobserved heterogeneity — an important issue in case there are theoretically relevant variables not included in the model.

4. Time-to-tenure in Spanish universities

We present the empirical results in two stages. First, we present a descriptive analysis and, second, we run some models to explore the nature and strength of the relationships between the variables. Finally, we summarize the results of modelling based on another publication (Sanz-Menéndez et al., 2013).

As mentioned, the final size of the valid dataset for this analysis was 1,257 science, biomedical and engineering faculty members (32 % of them women, representing the same percentage as in the universe of reference), the majority of whom were in their mid-careers (mostly in their early forties, with an average age in 2005 of 42 years old, a median and mode of 41, and with an average of 5.7 years after tenure).

The descriptive statistics of the quantitative and categorical variables are presented in Table 3. As regards our main dependent variable, we might observe that it takes an average of almost six years (5.8) to receive a tenure position once the individual has been granted his/her PhD degree, but we see that the standard deviation is rather high (3.4). It is also interesting to note that the doctoral dissertation is completed in six and a half years — approximately — and that our respondents were around thirty years old upon completion. Around two thirds of our respondents are male (68 %) and their distribution by field is quite balanced; the same applies to the distribution of the research competitiveness of the university granting the tenure and the university demand levels.

Descriptive results of the mobility variables show generally low mobility patterns. For example, almost half of the sample (47 %) had no experience of postdoctoral international mobility. Moreover, seven out of 10 individuals in our sample got tenure at the same university that granted their PhDs. Mobility across research groups is not frequent either, and temporal mobility outside academia is extremely limited. It is worth noting that the variables measuring social embeddedness reflect a considerable degree of social

Table 3. Descriptive statistics of the variables

Quantitative Variables	Mean	Median	S.D.
Time-to-tenure (years)	5.8	5	3.40
Postdoctoral publications by year	2.9	1.0	5.90
Early publications, annual	1.5	0.2	4.64
Time to PhD degree (years)	6.6	6	3.17
Age at PhD	30.5	29	3.86

Categorical Variables	Proportions
Research competitiveness of the university granting the PhD	
– High (reference)	0.29
– Medium	0.37
– Low	0.34
Involvement in research groups (Yes)	0.94
Collaboration with PhD supervisor (Yes)	0.81
University service (Yes)	0.55
Inbred status (Yes)	0.71
PhD at a foreign university (Yes)	0.02
Postdoctoral international mobility	
– No (reference)	0.47
– Yes, short stay (< 6 months)	0.24
– Yes	0.29
Mobility across research groups (Yes)	0.27
Mobility outside academia (Yes)	0.03
Sex (men)	0.68
Research field:	
– Biology and biomedical sciences (reference)	0.29
– Exact and natural sciences	0.37
– Engineering and technological sciences	0.34
Research competitiveness of the university granting tenure	
– High (reference)	0.31
– Medium	0.33
– Low	0.36
University demand level	
– Low growth (reference)	0.37
– Medium growth	0.30
– High growth	0.33

N valid = 1,257 cases

academic integration. For instance, the great majority of the sample (94 %) develop their research activities in the context of groups, and more than 80 % have collaborated with their PhD supervisor. Finally, the proportion of those involved in university service is 55 %.

Table 4 shows the descriptive statistics of the different categories of the variables in relation to the dependent variable; for the quantitative variables, the estimated duration of time-to-tenure is calculated with reference to the position (above or below) with respect to the mean value. For example, those with a number of annual early publications above the mean experience an average duration of time-to-tenure of 4.74 years as compared with 6.27 years for those with early publications below the mean. However, the differences are shorter for annual postdoctoral publications (less than half a year).

Table 4. Independent variables and time-to-tenure

Quantitative Variables		Duration (in years)		
		N	Mean	S.D.
Postdoctoral publications (ln)	< mean	697	5.57	3.52
	>= mean	560	6.03	3.22
Early publications (ln)	< mean	851	6.27	3.72
	>= mean	406	4.74	2.28
Time to PhD	< mean	801	6.08	3.32
	>= mean	456	5.23	3.48
Age at PhD	< mean	782	6.27	3.35
	>= mean	475	4.95	3.32

Categorical Variables		Duration (in years)		
		N	Mean	S.D.
Research competitiveness of the university granting the PhD	High	355	4.87	3.27
	Medium	470	6.63	3.53
	Low	432	5.58	3.14
Involvement in research groups	No	78	7.18	3.79
	Yes	1179	5.68	3.35
Collaboration with PhD supervisor	No	244	6.64	3.75
	Yes	1013	5.56	3.28
University service	No	569	6.18	3.41
	Yes	688	5.43	3.36
Inbred status	No	364	6.29	3.52
	Yes	893	5.56	3.33
PhD in a foreign university	No	1235	5.76	3.41
	Yes	22	6.50	2.97

Table 4 (continued)

Categorical Variables		Duration (in years)		
		N	Mean	S.D.
Postdoctoral international mobility	No	600	4.96	3.33
	Yes, short stay	296	5.83	3.44
	Yes, long stay	361	7.08	3.05
Mobility across research groups	No	917	5.48	3.39
	Yes	340	6.55	3.32
Mobility outside academia	No	1217	5.67	3.30
	Yes	40	8.90	4.74
Sex	Women	398	6.44	3.18
	Men	859	5.46	3.45
Research field	Biology and biomedical sciences	371	7.64	3.34
	Exact and natural sciences	463	6.02	3.00
	Engineering and technological sciences	423	3.87	2.82
Research competitiveness of the university granting tenure	High	388	5.63	3.49
	Medium	418	6.11	3.52
	Low	451	5.58	3.18
University demand level	Low growth	461	6.66	3.43
	Medium growth	375	5.64	3.48
	High growth	421	4.93	3.05

The second part of the table refers to the categorical variables, and thus differences in the mean duration can be compared for each variable. We observe that the duration of time-to-tenure is one year longer for women. Larger differences are found across scientific areas, with researchers in engineering and the technological sciences experiencing a mean duration to tenure much lower than the rest. The mobility variables results are also interesting. For example, the mean values' differences are high if we compare those who moved temporarily outside academia with those who did not experience such mobility. The same holds true for those with international long-term mobility. Among the variables measuring social integration, we note that of those who belong to research groups, the majority of the sample have a mean duration to tenure of 5.68 years, more than one and a half years less on average than those who work individually.

Our analysis continues with an estimate of the empirical survival functions for some of the relevant variables to account for promotion. The Kaplan and Meier survival function is a non-parametric descriptive method for estimating risk; in this case, the event at risk is promotion. The survival function represents the duration until the event (promotion); those surviving in the initial state were not subjects of the event; therefore, survivors take more time to receive tenure in every period. We proved the log-rank test on the Kaplan-Meier survival curve estimate; we rejected the null hypothesis that the survival functions are the same for the selected groups at a level of significance of less than 1 % for the full sample, and we found that only in the case of the variable PhD abroad are the differences not significant. Thus, without controlling for covariates, the hazard of not being promoted differs depending on the control variable. In Figure 1, we plot the general survival function (1) estimated in Table 5. We can clearly observe that survival decreases along time, with fewer and fewer individuals surviving in a non-tenure situation.

Table 5. Survival function of Kaplan-Meier

t_k	R_k	E_k	$\hat{S}(t)$
Time	Beg. Total	Fail	Survivor F.
1	1257	73	0.9419
2	1184	138	0.8321
3	1046	167	0.6993
4	879	121	0.6030
5	758	173	0.4654
…	…	…	…

In Figures 2–12, we can observe differences across categories of dummy variables. Examining first the differences in the survival functions representing the variables related to performance, we note that those without publications before PhD (Figure 2) show similar survival rates immediately after graduation but that differences are very visible and increase over time, showing how those with this kind of publication survive less in a non-tenure situation. Another measure related to performance is age at PhD (Figure 3), which is also regarded as a proxy for what is known in the literature as the rate of educational attainment. In this case, the results are unexpected: initially, those in older categories are those witnessing less survival (that is, they experience the event of promotion). This is visible up to the seventh year after PhD. It is also clear that those in the younger categories survive more. Approximately 10 years after PhD, the functions tend to converge. We believe that this pattern indicates that some seniority or age effects reduce time-to-tenure once the PhD is obtained.

Figure 1. Survival function from PhD to tenure: general

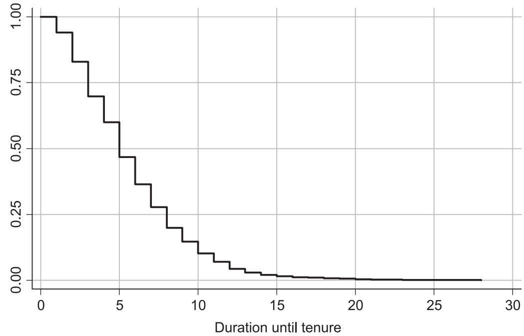


Figure 2. Survival function from PhD to tenure: early publications

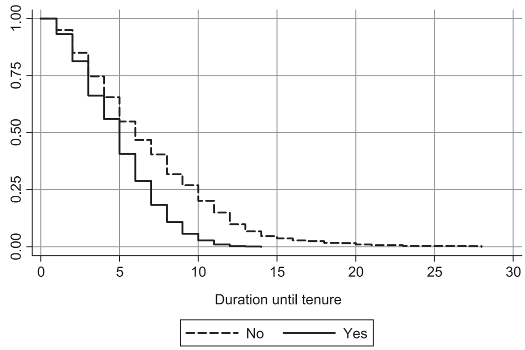
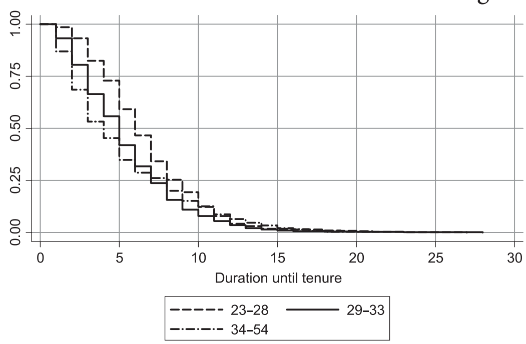


Figure 3. Survival function from PhD to tenure: age at PhD



Turning to the variables relating to mobility, an interesting question arises as regards the differences for those who obtained a PhD abroad (Figure 4). The survival functions do not suggest a very clear pattern, in this case probably due to the small number of cases in the foreign degree catego-

Figure 4. Survival function from PhD to tenure: PhD abroad

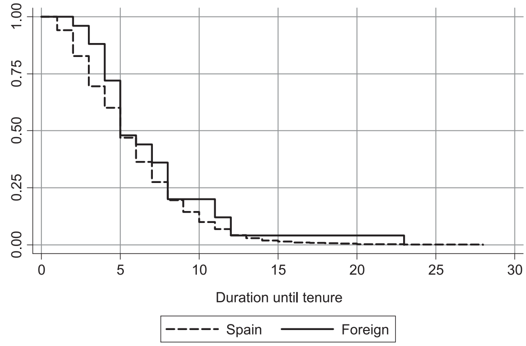


Figure 5. Survival function from PhD to tenure: postdoctoral international mobility

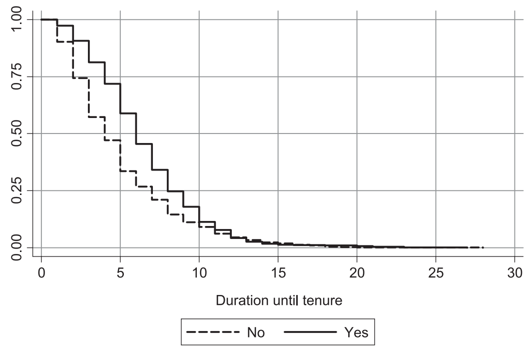
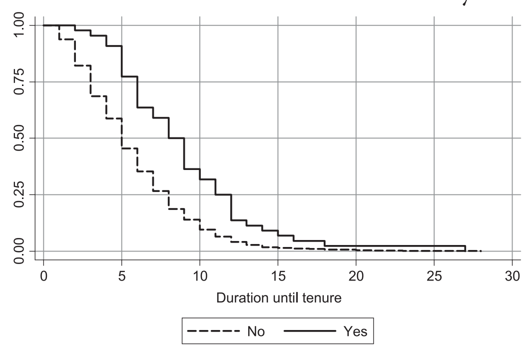


Figure 6. Survival function from PhD to tenure: mobility outside academia



ry; however, although the differences are small, we observe that those with a PhD from a foreign university survive for longer in a non-tenure situation. The results are much clearer as regards postdoctoral international mobility (Figure 5). Survival in a non-tenure situation is consistently higher for those with such mobility, and it is only after more than a decade since graduation that the functions tend to converge. A specific type of mobility which seems to clearly penalize promotion is inter-sectorial mobility outside academia for the first job after PhD (Figure 6). Mobility between different research groups (Figure 7) also seems to affect promotion negatively.

Figure 7. Survival function from PhD to tenure: mobility across research groups

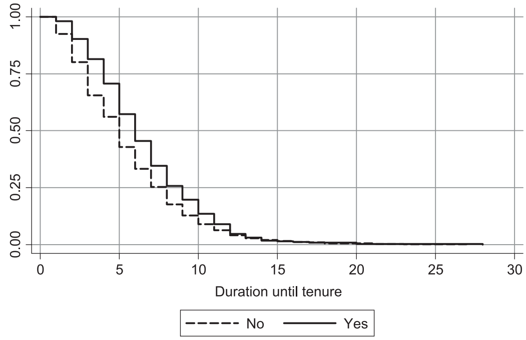
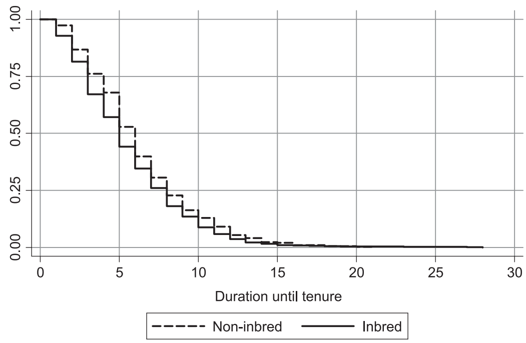


Figure 8. Survival function from PhD to tenure: tenure in a centre different from PhD



For the group of factors measuring academic integration or social embeddedness, we can observe that the survival functions show opposite patterns if compared to the mobility factors. For example, those who obtained tenure at a centre different to the one that granted the PhD (Figure 8) have higher survival rates in a non-tenure situation as compared with their inbred counterparts; nevertheless, the differences are small. Two further indicators of this dimension reinforce the argument that social integration and social capital are related to career advancement. First, those researchers who belong to research groups (Figure 9) experience the event of promotion at higher rates than researchers without such membership; furthermore, those who have not collaborated with their PhD supervisor during the postdoctoral phase show a higher survival function in the non-tenure situation (Figure 10).

Figure 9. Survival function from PhD to tenure: involvement in research groups

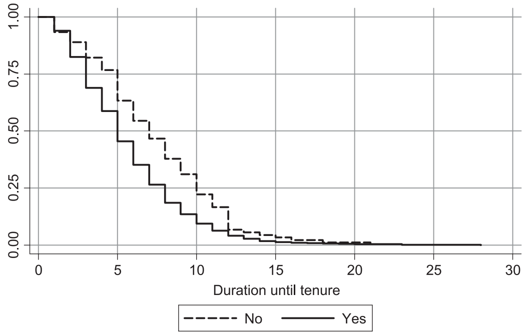
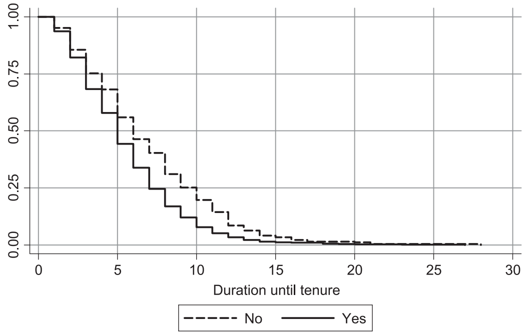


Figure 10. Survival function from PhD to tenure: collaboration with PhD supervisor



Sex (Figure 11) and field (Figure 12) are important variables to look at. The results show that women have small but constant higher survival rates in the non-tenure situation than men. Differences start to disappear a decade after the PhD. We find much greater differences across research fields. Researchers from the engineering and technological fields experience the event of promotion to tenure earlier than any of the other two fields. Differences in survival functions are very visible, with the group of biologists and biomedical scientists showing the highest survival rates in a non-tenure situation.

As we mentioned, we have tried diverse models to fit our data: four parametric and one non-parametric model. Specifications of the models and complete results are presented in Sanz-Menéndez et al. (2013). From this

Figure 11. Survival function from PhD to tenure: sex

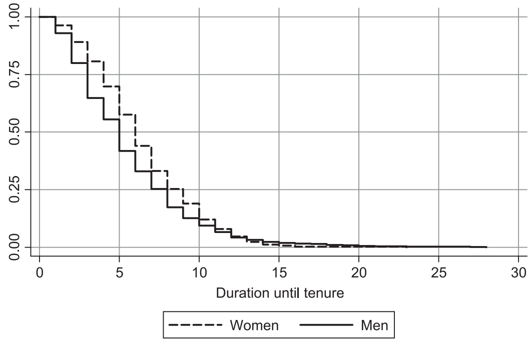
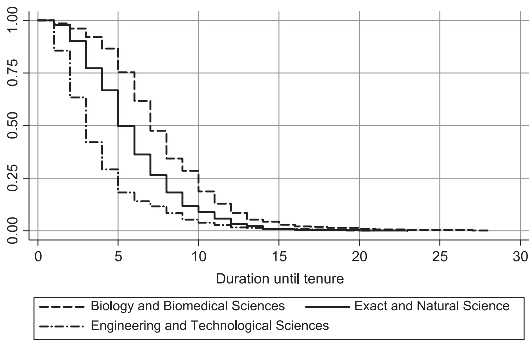


Figure 12. Survival function from PhD to tenure: research field



publication, we extract the main results of the model that fit better with our data: the log-logistics.

In Tables 6 and 7, we present the estimates of the duration of the log logistic model for time-to-tenure, with specification by research fields and the form of international mobility. Coefficients are reported in the left column as time ratios; a value higher than one means that the variable produces the effect of increasing the duration, while a value of the time ratio below one means that the variable contributes to the acceleration of the transition. We also report the marginal effect or differences in the expected duration (in years) of each covariate. Examining the direction of the effects on promotion of the set of variables that we have considered as measures of performance, productivity or academic potential, we found somewhat contradictory results. On the one hand, the more that an academic has published before receiving their PhD (early publication), the faster he/she advances in his/her career, with a reduction in duration of more than 10 months. But on the other hand, we observe that postdoctoral productivity is not significant.[7] The effect of the research orientation of the university granting the degree goes in the expected way — those having a degree in universities with a stronger research orientation advance faster and receive tenure earlier.

All those variables indicating social embeddedness produce the effect of reducing the duration of time-to-tenure. Having collaborated with their PhD supervisor during the period preceding tenure, and carrying out research activity mainly in the context of research groups (as opposed to not belonging to groups), both accelerate promotion and reduce the duration of the non-tenure situation. Involvement in institutional service is not statistically significant, but inbred status (that is, receiving tenure at the same university that granted the PhD) reduces time-to-tenure. In general, the size of the effects of the social embeddedness variable are small; for example, collaboration with the PhD supervisor after obtaining the PhD accelerates career advancement by almost a month and a half, while involvement in research groups does so by less than a month with respect to those who are not involved. Inbred status advances a career by almost three months.

All forms of mobility affect advancement in careers negatively. Having obtained a PhD abroad is not statistically significant, but having experienced international mobility as a part of the postdoc period, and having taken a job in a non-academic sector, do increase duration. A further form of mobility — related to changing research groups — also extends duration. In summary, all kinds of mobility have negative effects on the advancement of careers in universities and on the speed of the transition to tenure, and the size of the effects are very relevant. Among them, mobility outside academia increases the duration to tenure by 21 months and international mobility (long stays) by more than nine months (see also Table 7 for more details).

Regarding the rest of the variables, and despite the differences in duration by sex, when the effects of other variables are introduced in the model we cannot find significant effects. The effect of age at PhD is significant: as age at PhD increases, the duration of the period until tenure diminishes. There is also significant diversity in time-to-tenure by scientific fields. In fact, this is the variable that affects duration most. For faculties from the engineering and technological fields, it takes almost two years less to obtain tenure than for academics from the biological and biomedical sciences, whereas for faculties from the exact and natural sciences, the difference is

[7] In Sanz-Menéndez et al. (2013), we considered postdoctoral publications as a time-varying covariate and we found the results significant and reducing the duration — a merit associated effect.

Table 6. Log-logistic survival model and expected length of time-to-tenure (general and by research field)

Variables		General			Biology and Biomedical Sciences			Exact and Natural Sciences			Engineering and Technological Sciences		
		Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Early publications (ln)		0.783	0.000	−0.86	0.752	0.000	−1.16	0.741	0.000	−1.02	0.889	0.067	−0.32
Postdoctoral publications by year (ln)		0.985	0.604	−0.07	1.011	0.707	0.08	1.099	0.002	0.49	1.055	0.410	0.18
Research orientation of the university granting the PhD (reference: high)	Medium	1.216	0.000	0.71	1.218	0.010	0.90	1.115	0.092	0.38	1.732	0.000	1.72
	Low	1.145	0.011	0.51	1.276	0.007	1.18	0.955	0.438	−0.18	1.303	0.005	0.70
Time to PhD degree		1.015	0.079	0.27	1.024	0.156	0.56	0.982	0.241	−0.31	1.028	0.055	0.35
Involvement in research groups (reference: no)		0.797	0.000	−0.08	0.945	0.615	−0.03	0.830	0.042	−0.07	0.705	0.003	−0.07
Collaboration with the supervisor (reference: no)		0.883	0.001	−0.13	0.860	0.005	−0.21	0.953	0.443	−0.06	0.847	0.011	−0.11
University service (reference: no)		0.988	0.698	−0.03	0.939	0.136	−0.22	1.044	0.315	0.14	0.964	0.731	−0.04
Inbred status (reference: no)		0.859	0.002	−0.23	0.953	0.807	−0.10	0.902	0.174	−0.20	0.691	0.000	−0.32
Place of PhD (reference: Spain)		1.055	0.607	0.29	1.090	0.846	0.70	0.934	0.612	−0.39	1.084	0.417	0.28
Postdoctoral international mobility (reference: no)	Yes, short stay (<6 months)	1.089	0.051	0.37	1.062	0.815	0.36	1.110	0.096	0.49	1.054	0.393	0.14
	Yes, long stay	1.209	0.014	0.79	1.082	0.136	0.40	1.289	0.024	0.99	1.319	0.876	0.94
Mobility across research groups (reference: no)		1.110	0.001	0.43	1.074	0.092	0.38	1.076	0.093	0.31	1.212	0.004	0.58
Mobility outside academia (reference: no)		1.333	0.000	1.75	1.048	0.657	0.35	1.640	0.000	3.71	1.489	0.011	1.60
Sex (reference: women)		0.960	0.157	−0.07	1.042	0.306	0.14	0.899	0.012	−0.21	1.008	0.687	0.01
Age at PhD		0.959	0.000	−0.82	0.967	0.023	−0.81	0.976	0.036	−0.48	0.948	0.000	−0.71

Table 6 (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Research field (reference: biology and biomedical sciences)	Exact and natural sciences	0.742	0.000	−0.94	–	–	–	–	–	–	–	–	–
	Engineering and technological sciences	0.503	0.000	−2.00	–	–	–	–	–	–	–	–	–
Research field × postdoctoral publications (PPUB) by year (ln) (reference: biology and biomedical sciences × PPUB)	Exact and natural sciences × PPUB	1.090	0.028	0.34	–	–	–	–	–	–	–	–	–
	Engineering and technological sciences × PPUB	1.180	0.000	0.54	–	–	–	–	–	–	–	–	–
Research orientation of the university granting the tenure (reference: high)	Medium	0.922	0.059	−0.29	0.943	0.364	−0.29	0.982	0.800	−0.07	0.684	0.000	−0.79
	Low	0.887	0.015	−0.40	0.898	0.130	−0.49	1.016	0.766	0.06	0.701	0.000	−0.73
Labour market (reference: low)	Medium	0.932	0.055	−0.26	0.900	0.049	−0.57	0.915	0.092	−0.37	1.048	0.500	0.11
	High	0.828	0.000	−0.64	0.813	0.002	−1.19	0.881	0.021	−0.46	0.832	0.019	−0.34
Constant		34.33	0.000		20.473	0.000		16.316	0.000		29.236	0.000	
Time at risk		7256			2835			2786			1635		
Number of subjects		1257			371			463			423		
Number of failures		1257			371			463			423		
Log likelihood		−912.1			−195.1			−291.7			−360.1		
LR chi–square		718.3			96.41			164.21			153.97		
Prob.>chi–square		0.000			0.000			0.000			0.000		
Akaike		1875			432.7			625.9			762.8		
Natural logarithm of gamma		−1.3			−1.48			−1.39			−1.15		
Expected general duration				5.45			7.74			5.97			3.36

Table 7. Log-logistic survival model and expected length of time-to-tenure by type of postdoctoral international mobility

Variables		General			Postdoctoral international mobility: No			Postdoctoral international mobility: Yes, short stay (<6 months)			Postdoctoral international mobility: Yes, long stay.		
		Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).	Time ratio	P>|z|	Diff (years).
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Early publications (ln)		0.783	0.000	–0.86	0.808	0.000	–0.66	0.838	0.002	–0.70	0.736	0.000	–1.17
Postdoctoral publications by year (ln)		0.985	0.604	–0.07	0.967	0.501	–0.14	0.992	0.901	–0.04	1.015	0.697	0.09
Research orientation of the university granting the PhD (reference: high)	Medium	1.216	0.000	0.71	1.319	0.000	0.94	1.323	0.002	1.12	1.009	0.882	0.03
	Low	1.145	0.011	0.51	1.224	0.014	0.70	1.198	0.069	0.60	0.928	0.347	–0.34
Time to PhD degree		1.015	0.079	0.27	1.027	0.034	0.49	1.020	0.248	0.31	0.958	0.016	–1.41
Involvement in research groups (reference: no)		0.797	0.000	–0.08	0.726	0.001	–0.10	0.874	0.333	–0.03	0.909	0.261	–0.04
Collaboration with the supervisor (reference: no)		0.883	0.001	–0.13	0.810	0.000	–0.18	1.022	0.778	0.02	0.883	0.007	–0.19
University service (reference: no)		0.988	0.698	–0.03	1.003	0.953	0.00	0.950	0.378	–0.10	1.004	0.916	0.02
Inbred status (reference: no)		0.859	0.002	–0.23	0.853	0.007	–0.20	0.718	0.000	–0.50	1.012	0.820	0.03
Place of PhD (reference: Spain)		1.055	0.607	0.29	1.065	0.764	0.30	0.951	0.811	–0.26	1.049	0.745	0.34
Postdoctoral international mobility (reference: No)	Yes, short stay (<6 months)	1.089	0.051	0.37	–	–	–	–	–	–	–	–	–
	Yes, long stay	1.209	0.014	0.79	–	–	–	–	–	–	–	–	–
Mobility across research groups (reference: no)		1.110	0.001	0.43	1.132	0.027	0.49	1.044	0.523	0.18	1.114	0.007	0.46
Mobility outside academia (reference: no)		1.333	0.000	1.75	1.331	0.011	1.48	1.266	0.164	1.39	1.602	0.002	4.08

Table 7 (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sex (reference: women)		0.960	0.157	−0.07	1.019	0.702	0.03	0.866	0.024	−0.22	0.967	0.390	−0.08
Age at PhD		0.959	0.000	−0.82	0.949	0.000	−0.95	0.957	0.002	−0.77	0.998	0.847	−0.12
Research field (reference: biology and biomedical sciences)	Exact and natural sciences	0.742	0.000	−0.94	0.657	0.000	−1.22	0.705	0.001	−1.06	0.864	0.025	−0.48
	Engineering and technological sciences	0.503	0.000	−2.00	0.486	0.000	−1.48	0.459	0.000	−2.24	0.635	0.000	−2.29
Research field × postdoctoral publications (PPUB) by year (ln) (reference: biology and biomedical sciences x PPUB)	Exact and natural sciences × PPUB	1.090	0.028	0.34	1.111	0.108	0.31	1.091	0.252	0.36	1.035	0.482	0.18
	Engineering and technological sciences × PPUB	1.180	0.000	0.54	1.126	0.046	0.36	1.225	0.010	0.79	1.094	0.221	0.27
Research orientation of the university granting the tenure (reference: high)	Medium	0.922	0.059	−0.29	0.836	0.016	−0.55	0.835	0.028	−0.62	1.127	0.037	0.53
	Low	0.887	0.015	−0.40	0.822	0.011	−0.56	0.778	0.006	−0.78	1.159	0.034	0.69
Labour market (reference: low)	Medium	0.932	0.055	−0.26	0.947	0.352	−0.17	0.923	0.290	−0.31	0.918	0.090	−0.41
	High	0.828	0.000	−0.64	0.824	0.002	−0.54	0.774	0.001	−0.80	0.900	0.053	−0.52
Constant		34.33	0.000		52.138	0.000		41.123	0.000		12.696	0.000	
Time at risk		7256			2973			1727			2556		
Number of subjects		1257			600			296			361		
Number of failures		1257			600			296			361		
Log likelihood		−912.1			−494.0			−245.4			−145.8		
LR chi-square		718.3			309.7			182.8			148.1		
Prob.>chi-square		0.000			0.000			0.000			0.000		
Akaike		1875			1035			457			338		
Natural logarithm of gamma		−1.3			−1.2			−1.3			−1.6		
Expected general duration				5.45			4.68			5.41			6.97

more than 11 months less. We also introduced in the model the interaction between scientific fields and postdoctoral publications, with the aim of better understanding the effect of postdoctoral publications. The results are clear — it is in the engineering and technological fields where the model of career advancement is less associated with scientific productivity in terms of academic publications.

The effect of the research orientation of the university granting tenure is only significant for the less research competitive universities, which speed up advancement in rank. Receiving tenure at less research-competitive universities reduces the duration by almost five months compared to receiving tenure at universities with high research competitiveness. Finally, the effect of the demand level or growth of the universities granting tenure — as a measure of the dynamism of the labour markets — is an important variable to account for the duration: receiving tenure at universities with high rates of growth reduces the duration by almost eight months in comparison with universities with a low level of positions' growth.

5. Conclusion

We have analysed the process of transition to tenure in academia to address the factors that explain time to a permanent job at Spanish universities. The variables that appear relevant are mainly related to stable integration into the academic social environment. The negative effects of mobility on time-to-tenure do not just provide negative incentives for researchers to change jobs, organizations or countries — they are also a clear expression of the absence of open academic job markets, and of the existence of mechanisms of accessing the profession that could be shaped by particularistic dynamics. On the other side, a promotion system characterized by accelerated tenure could be grounded on the construction of research teams and on a strategy of retention developed by the departments (which control the process of hiring but not the process of the provision of new positions) as a way to cope with the rigidities and risks (uncertainties) of the hiring process.

Our results as regards the role of past academic performance confirm some feedback and cumulative effects on careers as far as the publications prior to PhD are concerned. Our postdoctoral productivity measure, when considered as a time-varying covariate, is also associated with a reduction in the duration of the transition.

The results of our study (seniority effects, inbreeding and the engineering field effect) also suggest the existence of internal academic labour markets and retention dynamics as a way of protecting investments and competing with the outside world (when higher salaries and more differentiation exist). We found a strong effect of mobility factors on academic promotion. In fact, the major predictors of fast access to a permanent job are related to the absence of mobility: international, sectorial mobility or even mobility across research groups imply a longer time to promotion. The effect of the mobility variables is far more important than those measuring academic social embeddedness. It seems that the Spanish university system — in aggregate terms — is characterized by career advancement and not grounded in a strictly merit-based system, but in elements associated with the integration and permanence of the candidates in their local academic environments to promote productive team work.

As expected, our findings confirm that the level of demand in those universities providing new positions is an important factor in accounting for duration and time-to-tenure, meaning that the context of the academic labour market is relevant, because candidates in high growth universities experience lower duration.

Our analysis of promotion has not found significant differences in the timing of promotion against women. This result is in line with some recent work reporting that the career trajectories of men and women are converging at junior levels (access to associate professor) and that men have only very slight or non-significant advantages in terms of first promotion.

Some research and policy implications can be drawn from our study and some of them could be generalized to similar countries in Europe and Latin America. Our results suggest the existence of diverse models of the relationships between mobility, merit and academic promotion, and question the argument that mobility is rewarded. In some systems, it seems that having a stable and non-mobile postdoctoral trajectory is much more important than the place of PhD training. Institutions and their strategies play a key role in shaping what is valued at each moment of a career. On the methodological side, longitudinal analysis and EHA have proven to be quite robust techniques in modelling and understanding the functioning of systems that promote retention. On the policy side, it is difficult to reconcile the emphasis placed on the desirability of mobility as a way of ensuring knowledge circulation and research collaboration, with the evidence suggesting that it is negatively associated with the duration of transition to tenure, and more so in times of the relative dualization of public research employment.

References

Allison, P.D. & Stewart, J.A. (1974). Productivity differences among scientist: Evidence from accumulative advantage. *American Sociological Review,* 39 (4), 596–606.

Aran, L. & Ben-David, J. (1968). Socialization and career patterns as determinants of productivity of medical researchers. *Journal of Health and Social Behavior,* 9 (1), 3–15.

Berelson, B. (1960). *Graduate education in the United States*. New York: McGraw-Hill.

Blackburn, R.T., Chapman, D.W. & Cameron, S.M. (1981). "Cloning" in academe: Mentorship and academic careers. *Research in Higher Education,* 15 (4), 315–327.

Blau, P.M. (1973/1994). *The organization of academic work*. New Brunswick & London: Transaction Publishers, (second edition).

Box-Steffensmeier, J.M. & Jones, B.S. (2004). *Event history modeling: A guide for social scientists*. Cambridge: Cambridge University Press.

Bozeman, B., Dietz, J.S & Gaughan, M. (2001). Scientific and technical human capital: An alternative approach to R&D evaluation. *International Journal of Technology Management,* 22 (8), 716–40.

Bozeman, B. & Feeney, M.K. (2007). Toward a useful theory of mentoring: A conceptual analysis and critique. *Administration & Society* 39 (6), 719–739.

Brüderl, J., Diekmann, A. & Preisendörfer, P. (1991). Patterns of intraorganizational mobility: Tournament models, path dependency, and early promotion effects. *Social Science Research,* 20, 197–216.

Cañibano, C.F., Otamendi, J. & Solís, F. (2011) International temporary mobility of researchers: a cross-discipline study. *Scientometrics,* 89 (2), 653–675.

Caplow, T. & McGee, R.J. (1958). *The academic marketplace*. New York: Basic Books.

Chubin, D.E., Porter, A.L. & Boeckmann, M.E. (1981). Career patterns of scientists: A case for complementary data. *American Sociological Review,* 46 (4), 488–496.

Clemente, F. (1973). Early career determinants of research productivity. *The American Journal of Sociology,* 79 (2), 404–419.

Cozzens, S.E. (1985). Comparing the sciences: Citation context analysis of papers from neuropharmacology and the sociology of science. *Social Studies of Science,* 15 (1), 127–153.

Crane, D. (1965). Scientists at major and minor universities. A study of productivity and recognition. *American Sociological Review* 30 (5), 699–714.

Cruz-Castro, L. & Sanz-Menéndez, L. (2010). Mobility versus job stability: Assessing tenure and productivity outcomes. *Research Policy,* 39 (1), 27–38.

Dietz, J.S. & Bozeman, B. (2005). Academic careers, patents, and productivity: Industry experience as scientific and technical human capital. *Research Policy,* 34 (3), 349–367.

Enders, J. ed. (2001). *Academic staff in Europe: Changing contexts and conditions*. Westport (CT): Greenwood Press. IAP — Information Age Publishing Inc.

Forret, M.L. & Dougherty, T.W. (2004). Networking behaviors and career outcomes: Differences for men and women? *Journal of Organizational Behavior,* 25 (3), 419–437.

Fox, M.F. (1983). Publication productivity among scientists: A critical review. *Social Studies of Science,* 13 (2), 285 –305.

García, C.E. & Sanz-Menéndez, L. (2005). Competition for funding as an indicator of research competitiveness: The Spanish R&D government funding. *Scientometrics*, 64 (3), 271–300.

Hagstrom, W.O. (1971). Inputs, outputs, and the prestige of university science departments. *Sociology of Education,* 44 (4), 375–397.

Hargens, L.L. (1969). Patterns of mobility of new Ph.D.'s among American academic institutions. *Sociology of Education,* 42 (1), 18–37.

Hargens, L.L. (2012). Academic labor markets and assistant professors' employment outcomes. *Research in Higher Education,* 53 (3), 311–324.

Hargens, L.L. & Hagstrom, W.O. (1967). Sponsored and contest mobility of American academic scientists. *Sociology of Education,* 40 (1), 24–38.

Horta, H. (2013). Deepening our understanding of academic inbreeding effects on research information exchange and scientific output: new insights for academic based research. *Higher Education,* 65 (4), 487–510.

Ishida, H., Su, K.-H. & Spilerman, S. (2002). Models of career advancement in organizations. *European Sociological Review,* 18 (2), 179–198.

Kaminiski, D. & Geisler, C. (2012). Survival analysis of faculty retention in science and engineering by gender. *Science* 335, 17 February, 864–866.

Lassibille, G. & Navarro Gómez, M.L. (2010). How long does it take to earn a higher education degree in Spain? *Research in Higher Education,* 52 (1), 63–80.

Leahey, E., Keith, B. & Crockett, J. (2010). Specialization and promotion in an academic discipline. *Research in Social Stratification and Mobility,* 28, 135–155.

Long, J.S. & Fox, M.F. (1995). Scientific careers: Universalism and particularism. *Annual Review of Sociology,* 21, 45–71.

Long, J.S. & McGinnis, R. (1981). Organizational context and scientific productivity. *American Sociological Review,* 46 (4), 422–442.

Long, J.S. & McGinnis, R. (1985). The effects of the mentor on the academic career. *Scientometrics,* 7 (3–6), 255–280.

Long, J.S., Allison. P.D. & McGinnis, R. (1993). Rank advancement in academic careers: Sex differences and the effects of productivity. *American Sociological Review,* 58 (5), 703–722.

Martín-Sempere, M.J., Garzón-García, B. & Rey-Rocha, J. (2008). Team consolidation, social integration and scientists' research performance: An empirical study in the biology and biomedicine field. *Scientometrics,* 76 (3), 457–482.

Melin, G. (2005). The dark side of mobility: Negative experiences of doing a postdoc period abroad. *Research Evaluation,* 14 (3), 229–237.

Melkers, J. & Kiopa, A. (2010). The social capital of global ties in science: The added value of international collaboration. *Review of Policy Research,* 27 (4), 389–414.

Merton, R.K. (1968). The Matthew effect in science: The reward and communication systems of science are considered. *Science,* 159 (3810), 56–63.

Morrison, E., Rudd, E. & Maresi, N. (2011). Onto, up, off the academic faculty ladder: The gendered effects of family on career transitions for a cohort of social science Ph.D.s. *The Review of Higher Education,* 34 (4), 525–553.

Musselin, C. (2004). Towards a European academic labour market? Some lessons drawn from empirical studies of academic a labour market. *Higher Education,* 48 (1), 55–78.

Nakhaie, M.R. (2007). Universalism, ascription and academic rank: Canadian professors, 1987–2000. *Canadian Review of Sociology and Anthropology (CRSA/RCSA)*, 44 (3), 361–386.

Nederhof, A.J., Zwaan, R.A., De Bruin, R.E. & Dekker, P.J. (1989). Assessing the usefulness of bibliometrics indicators for the humanities and the social and behavioral sciences: A comparative study, *Scientometrics,* 15 (5–6), 423–435.

Pedró i Garcia, F. (2004). *Fauna académica: la profesión docente en las universidades europeas*. Barcelona: Editorial UOC.

Pfeffer, J., Salanzik, G.R. & Leblebici, H. (1976). The effects of uncertainty on the use of social influence in organizational decision making. *Administrative Science Quarterly,* 21 (2), 227–245.

Reskin, B.F. (1977). Scientific productivity and the reward structure of science. *American Sociological Review,* 42 (3), 491–504.

Sabatier, M. (2010). Do female researchers face a glass ceiling in France? A hazard model of promotions. *Applied Economics,* 42 (16), 2053–2062.

Salancik, G.R. & Pfeffer, J. (1978). Uncertainty, secrecy, and the choice of similar others. *Social Psychology,* 41 (3), 246–255.

Sanz-Menéndez, L., Bordons, M. & Zulueta, M.A. (2001). Interdisciplinarity as a multidimensional concept: Its measure in three different research areas. *Research Evaluation,* 10 (1), 47–58.

Sanz-Menéndez L, Cruz-Castro L. & Alva K. (2013). Time to tenure in Spanish universities: An event history analysis. *PLoS ONE* 8 (10): e77028. doi:10.1371/journal.pone.0077028.

Stephan, P.E. & Levin, S.G. (1991). Inequality in scientific performance: Adjustment for attribution and journal Impact. *Social Studies of Science* 21 (2), 351–368.

Stewart, P., Ornstein, M. & Drakich, J. (2009). Gender and promotion at Canadian universities. *Canadian Review of Sociology/Revue Canadienne de Sociologie,* 46 (1), 59–85.

Tien, F.F. (2007). To what degree does the promotion system reward faculty research productivity? *British Journal of Sociology of Education,* 28 (1), 105–123.

Wolfinger, N.H., Mason, M.A. & Goulden, M. (2008). Problems in the pipeline: Gender, marriage, and fertility in the ivory tower. *Journal of Higher Education,* 79 (4), 389–405.

Xie, Y. & Shauman, K.A. (2003). *Women in science: career processes and outcomes*. Cambridge, MA: Harvard University Press.

Academic women leaders' career and their potential as gendered organizational change agents

Felizitas Sagebiel

In this paper, the 'change potential' of female professors in organizations of higher education, focusing on science and technology, will be investigated. Three aspects will be focused upon: leadership style, organizational cultures (measured by division of labour, communication, conflict management, competition and handling of gender issues) and third networks. The background of the paper is a German research project, lasting from April 2009 to March 2012, financed by the Ministry of Education and Research and the European Social Funds, which combined the expertise of two institutions, the University of Wuppertal and the Wuppertal Institute for Climate, Environment and Energy. With a qualitative methodological design (especially interviews and focus discussion groups), case studies were conducted in companies, political institutions, governmental research organizations and universities. The results included in this paper were taken only from the latter two. The data were analysed by research questions, focusing on gender differences in the acceptance of leadership position and styles, gender awareness and networking.

1. Introduction

The background to this chapter is the German research project 'Women on Top: the Impact of Women in Leadership Positions in Engineering, Science and Environmental Organizations'.[1] The context of this research is supplied by several earlier European research projects on gender and engineering and the natural sciences.[2] The research problem arises from the educational

[1] This paper will focus on the results of research in two case studies analysed at the University of Wuppertal. I wish to thank Ulla Hendrix and Christine T. Schrettenbrunner for their contribution to this research.

[2] These projects were conducted between 2001 and 2010. They were: INDECS — Potentials of Interdisciplinary Degree Courses in Engineering, Information Technology, Natural and Socio-economic Sciences in a Changing Society (2001–2002) (www.INDECS.uni-wuppertal.de); Womeng — Creating cultures of success for women engineers (2002–2005) (www.womeng.net); PROMETEA — Empowering Women Engineers in Industrial and Academic Research (2005–2007) (www.prometa.

and professional segregation which leads to women's underrepresentation in science, engineering and technology (SET).

Gender inequality persists in SET throughout the European Union. Only 32 % of scientists and engineers are women (EC, 2013: 5). While female PhD graduates now equal or outnumber men, in engineering they are still significantly underrepresented (26 %). Although *positive trends can be observed such as the considerable growth in the proportion of female scientists and engineers… horizontal gender segregation across different economic sectors and fields of science persist* (EC, 2013: 14). In terms of career progression, in science and engineering, the attrition of women increases at post-PhD level and *improvement over time is small and slow* (EC, 2013: 89). It is, therefore, not surprising that in the fields of engineering only 7.9 % of women hold full professorships (EC, 2013: 6). In Germany, the natural sciences and engineering remain bastions of male domination (EC, 2013: 62).

Krais (2010: 23), taking her cue from Bourdieu's concept of science as social process, investigated gender as a social dimension and the reason for the biased outcome in terms of women's under-representation in German higher education and especially in top positions. She analysed the impact of mentors on women's academic careers as an important characteristic in the German system of higher education. The German 'co-optation principle' for obtaining a first professorship — which stems from the organization of higher education — has more negative effects on women precisely because they cannot necessarily rely upon the help of their mentors as much as men do. Another barrier for women in academia is the lack of recognition for women within the scientific community. Historically, scholarship has been defined as a masculine preserve, with the result that women have been defined as outsiders — as the 'other' — especially if they have children, a condition which has been perceived as being in conflict with a lifestyle totally dedicated to research in the natural sciences. Krais (2010) also refers to a gendered competitive style in the natural sciences which disadvantages female scientists, with men fighting for positions in a (male) hierarchy, whereas women were more interested in the scientific subject itself.

Prpić (2009: 14–15), referring to Schiffbänker (2009), notes that at the intersection of career and gender studies *"the classical sociological concept of career [has been] subjected to feminist criticism, and, by integrating*

info); MOTIVATION — Promoting positive images of SET in young people under gender perspective (2008-2010) (www.motivation-project.com); and Meta-analysis of Gender and Science Research (2008-2010) (www.genderandscience.org).

aspects such as the reconciliation of work and family which are neglected but important for women, a better understanding can be gained of the career trajectories and the deconstruction of traditional gender roles". Schiffbänker (2009) explains that there is a need to integrate the private sphere into career theories. Analysing gender as a dimension of inequality, she found that most career theories proposed by Weber, Giddens, Kohli and Sennett, all of which are based on male employment concepts, did not take into account what this career model means for women based on the existing traditional division of labour. However, she argues that focusing on gender differences is not productive in trying to correct gender stereotypes, because this approach neglects the similarities in male and female careers. For this reason, including a comparison with men's careers in the analysis could help.

The most comprehensive overview of the relevant comparative research on gender segregation, stereotypes and scholarly careers in all European countries has been undertaken in the European project Meta-Analysis of Gender and Science Research (EC, 2012a).The report claims that the frequently described phenomenon of the '*glass ceiling*', *which points to the existence of visible or invisible obstacles that lead to the scarcity of women in power and decision-making positions* will not change spontaneously and that *the absence of women in leadership positions tends to be more acute in science and technology occupations than in other fields* (EC, 2012: 15). The report points to the possible effects of the process of the *restructuring of universities under new managerial criteria, the erosion of hierarchy and individual competition*, and concludes that *gender-blind performance criteria are not necessarily gender-neutral* (EC, 2012: 23).

Research results presented in the report clearly reveal the gendered nature of academic careers in two broader aspects. First, they confirm the disproportionate disadvantages for women during their early careers because of conflicts between careers in research and family demands. *Many studies show that the family-or-science dilemma is not only gendered, but exacerbated by institutional constraints and implicit academic norms, values and expectations that take the traditional male life-course as the norm* (EC, 2012: 17). These constraints can be identified as non-existing possibilities of flexibility in balancing professional and private lives, women's poorer networking resources together with *an accumulative logic of 'non-occurrences' and slight exclusionary practices that progressively disadvantage women's careers and cause a sensation of isolation, difficulty in assuming the risks inherent to the scientific career and low professional self-esteem* (EC, 2012: 18).

Secondly, research results underscore gender biases in the production of knowledge. In particular, research which goes beyond universally applicable criteria and strict norms unmasks *power relations, gate-keeping practices and informal networks as a source of tacit knowledge, support and recognition* (EC, 2012: 18). There is also a bias in formal assessment procedures that leads to unequal access to research funding or academic positions. *The definition and assessment of scientific excellence (the recognition of merit) is not independent of gender relations in academia and society at large* (EC, 2012: 18).

Women's slight disadvantages during the early stages of their scholarly careers might turn into wide differences in subsequent career outcomes due to cumulative (dis)advantages (see Faulkner, 2005). For this reason, it is necessary to focus on gender discrimination and its relation to cumulative advantages and disadvantages in SET.

In the following chapter, the 'change potential' of women in higher education management positions, with a particular focus on the natural sciences and technology, will be investigated. The chapter will explore the questions of whether, what and how women in leadership positions would change the organizational culture. The chapter will focus on four aspects of this change potential: first, leadership style; second, outcome orientation, commitment and availability; third, networks; and fourth understanding of technology. The data has been gathered from male and female engineers in different organizational settings and the differences in gender responses were analysed.

2. Some selected theoretical and research references

The conceptual framework consists of theoretical perspectives taken from feminist technology studies, gender-based organization studies, and gender in academia research as well as critical men's studies. Feminist studies of technology focus on the gendered nature of organizational/university-based research in the natural sciences, technology and engineering, such as the reproduction of gender stereotypes in technology (Wajcman, 1996). Gender and technique stereotypes have been applied to reinforce the exclusion of women as outsiders based on their perceived 'otherness'. Studies on international gender-based differences in engineering studies have reached similar conclusions. The processes deployed to reproduce or reinforce male domination by seemingly informal strategies, such as storytelling, fraternization, fun and sports, as originally outlined in Australian research (McLean et al., 1996), have been confirmed by the ethnographer Wendy Faulkner in the UK (Faulkner, 2000) and in Europe (Sagebiel & Dahmen, 2006). What possibilities do women have in a male domain like engineering? Powell et al. came to the conclusion that while in direct competition with men in a male domain like engineering the coping strategies of women are: *acting like one of the boys, accepting gender discrimination, achieving a reputation, seeing more advantages than disadvantages* (Powell et al., 2009: 425).

Gender-based organization studies focus on the formal ways in which organizations are gendered (Acker, 1990; Wilz, 2004) and the informal ways of excluding women from male domains, especially from men's networks in areas such as engineering. Engineering and management in engineering are perceived as being 'archetypical' men's careers (Evetts, 1998: 283). To succeed in a man's field, women have to adapt (Wajcman, 1998). Gender expectations are in conflict with managerial responsibilities: *if the woman is an efficient, competent manager, she is likely to be judged as "unfeminine", but if she demonstrates the supposedly female qualities of care and sensitivity she is likely to assessed either as an inappropriate and inefficient manager (Kanter, 1977; Marshall, 1984) or as a good female manager.* (Evetts, 1997: 229)

More women scientists in leading positions mean more direct competition with men at the same level. The fear of this threat from women strengthens informal activities within men's networks which exclude women (Miller, 2002; Ohlendieck, 2003). Networks in general management (Burt, 1998; Funken et al., 2011) and in engineering research are gendered (Sagebiel, 2010). The homosocial culture of leading management is a barrier for the recruitment of women to top positions: *Male homosocial networks exhibit personal exclusion, selective procedures for the recruitment of new members, and they maintain power through secrets and the withholding of information, polarizing members and non-members. Women and "Other" men are excluded. Male alliance helps to construct and to reproduce male identity, power, and privilege through the accumulation of resources relevant to career relevant success* (see Rastetter, 1998: 171 as per Sagebiel 2007: 154). For this reason, the various equal opportunity and diversity programmes of companies, which aim to reverse discrimination, can be easily vitiated by vested informal men's networks (Sagebiel, 2007:155).

Gender in academia[3] could be seen as a special research field of organizational studies focused on universities as institutions and organizations of higher education (see, for instance, Bagilhole & Goode, 2001; Husu, 2005; Metz-Göckel, 1999; Morley, 1999). One issue is the invisibility of women in

[3] There is a large amount of research on gender and higher education in Germany. For an overview, see: Lind (2006) and Hildegard Matthies and Karin Zimmermann (2010).

academia, stemming from an ideology of scholarly acceptance based on individual performance. This strategy in practice means that female scholars are somehow not good enough. It ignores the fact that reaching leadership positions depends on relevant networks — formal and informal ones — that are all male-dominated, as a demonstration of professional ability. For this reason, a gender-based ideology of meritocracy, where getting ahead results solely from individual merit, ignores the informal support system that exists among men (Bagilhole & Goode, 2001).

Critical men's studies proposes Connell's concept of hegemonic masculinity (Connell, 1999) for analyses of careers in higher education. Polarized gender stereotypes help to reproduce the hegemonic masculine ideal, particularly in leadership positions, and helps to reproduce the values and norms of organizational culture (Höyng & Lange, 2004; Sagebiel, 2007: 150). Beginning in their youth, men learn in sports — that is, in "serious competitive matches" (Meuser 2006) — basic management skills, such as cooperating and competing, at one and the same time.

Defined gender differences (gender stereotypes) (Wajcman, 1996; Knight & Keerfoot, 2004) and men's networks have consistently been deployed to manipulate and weaken women's chances for a successful career and work. Top academic women meet gender stereotypes embedded in a binary system. There are only two coping strategies available for women leaders to overcome this binary thinking combined with the devaluation of women as the weaker: that they play the game or else that there exists a culture of acceptance of different truths (Knights & Keerfoot, 2004: 432).

3. Qualitative methodology

The central issue has been to examine the impact of women in leadership positions and their power and options to change organizations. Their careers on the way to leadership positions will be discussed here in terms of the barriers, struggles and help which these women have said that they encountered along the way. Both female and male leaders in engineering and the natural sciences, in higher education and governmental research organizations, have been investigated. The objectives were to study how women engineers on top manage to change organizational culture, to consider the role of networks and networking for successful change, and to analyse gendered promoters and barriers so as to determine whether there is a gendered understanding of technology.

A qualitative methodology was applied to investigate these research objectives. Eight case studies in total were carried out in companies, governmental research organizations, political institutions and universities in Germany. Different types of organizations were chosen to ascertain whether there are different barriers and promoters for leadership positions. The analysis for this paper focuses on results gained in one technical university in the north-eastern part of Germany and seven institutes of a governmental research organization spread across different regions of Germany. Both organizations should (at least theoretically) employ representative numbers of women engineers in leadership positions. This pre-condition was particularly necessary for selecting research institutes, because many of them in fact had either no or very few women engineers to ask participate in focus groups. For the selection of interviewees in the governmental research organizations, the central human relations staff helped. At the same time, the selection of professors in the technical university was helped by the equal opportunity officer there. The data were collected between 2010 and 2011.

The methodological instruments were website analysis, focus discussion groups and guided interviews. In each selected organization, three guided expert interviews were carried out with women in leadership positions and two interviews were done with men in leadership positions. Two further guided interviews were performed with key personnel from human resources and equal opportunity offices (in total, 56 interviews have been conducted). In each organization investigated, two gender-separated focus discussion groups with women and men in leadership positions were carried out (16 in total, including between three and 10 participants in each focus discussion group). In the technical university and the governmental research institutes, in total 22 participants took part in four focus discussion groups. The interviews lasted between one and a half and two hours, and were audio taped, transcribed and analysed by themes. The focus discussion groups lasted two hours and were audio and video typed and analysed according to the six themes included (gendered leadership, change potential in leadership positions, promoters and barriers, use of networks, gender sensitivity, and power and change potential).

The research questions for individual interviews focused on gender differences in the acceptance of leadership position and styles, gender awareness and networking. Questions included: What role do structural changes in the production of knowledge play, especially the observed growing importance of university-industry-government relations and the commercialization of science? What are the differences compared to other types of organizations in industry and the public sphere that have also been investigated? Are there any gendered styles? What is the impact on leadership styles and change potential of the interviewed female professors in comparison to male professors? What role do gender stereotypes still play? How are gender awareness and sensitivity connected with making decisions; do women focus more on gender mainstreaming? Are there any differences between men and women in terms of their careers and the way in which they start their leadership position? How can engineering departments as a male domain be overcome? How do women leaders in academia use existing men's networks and create their own? What strategies do they use to overcome the barriers they are confronted with during their careers?

4. Results

The results presented and discussed in this paper focus on leadership style, outcome orientation, commitment and availability, the role of networks and the understanding of technology. It was possible to identify specifically female aspects as well as results common to both men and women in similar positions in all the issues investigated.

4.1. Leadership style and gender stereotypes

Wajcman (1998: 63) in her analysis of several studies on management styles found numerous gender stereotypes regarding leadership. If women leaders manage in a 'feminine' way which differs from men's management styles in similar positions, is this a reflexion of gender stereotypes or can evidence of this difference be found in the interviews? Do women meet conflicts between gender and managerial expectations (Evetts, 1997: 229) or do leading women simply manage like men (Powell et al., 2009; Wajcman, 1998)?

What does it mean when female interviewees relate that they are focusing on a managerial style that differs from that of their male predecessors?

> *My predecessor concentrated all around himself. He made the acquisition of projects for himself and gave the projects to his employees afterwards. This is probably the reason why the working group remained relatively small, which has been manageable for one person with 40 people. This is*

> *manageable for one person, but to create an institute means 100 people, means a changing process for the whole team.*

In this example, the female professor wanted to expand her research institute and to this end she changed the team's work and organization. By including employees in project acquisition, she delegated responsibility to researchers to enhance their work. She explained that she did her job differently from her male predecessor, by focusing on being 'the best', showing a competitive attitude normally expected from leading men (the 'alpha male' syndrome). Nevertheless, even though she performed her job differently from her predecessor, she did not necessarily do so in a 'woman's way'.

Whereas the woman pointed out this discontinuity, a male colleague for his own part felt that there was continuity with his predecessor, leading in the same way like his former chiefs and supervisor *who were effective scientific managers* and from whom he had learnt the principle of hierarchy and delegation with which one can manage a bigger unit, *because I experienced how much more you can do if you are ready to separate a bit from scientific daily duties [ready to have some perspective on everyday scholarly obligations].*

In comparison, both descriptions of leadership style are similar, even though the female leader explains her management style in terms of distance to her male predecessor, whereas the male leader follows his male predecessors. For their aim of managing a large unit, both stress the delegation principle. For the female professor, the delegation of project acquisition to the researchers is an innovation which has to be re-enforced, all the while overcoming resistance to the changes. The male professor follows the structure already in place. It seems that these leadership principles are more dependent on the size of the unit than on the gender of the leader. But, in order to achieve the same results, the woman has to be more assertive and put in more energy.

Another example shows a professor who, in her own perception, preferred a different leadership style in comparison with men, focusing more on communication and less on hierarchical decisions:

> *I have weekly leaders' meetings, where the most important things are talked about and not as a taking-note-of-decision activity, but… I would like to get opinions, therefore really an exchange... On the other hand, I delegate some things concretely and say, that is your responsibility, these are the tasks. First, I trust that it is done by them themselves and independently up to a certain degree, and if there are problems, they have to refer it back up to me.*

Communication is being used here to exchange ideas and information and, at the same time, to transfer decision-making by delegating tasks and thereby responsibility. In her own view, the woman professor would take over and control only in those cases where this delegation of tasks was not functioning. The question is: what functions does the change of communication structure have? Is it to change the culture to a more participatory model, and in so doing, does it help to get agreement from employees with a strategy like 'relational work' (Fletcher, 1999)? Or does the structure follow the aim of compensating a lack of information due to a lack of network integration? If, in this way, a woman follows a different leadership style in comparison with men, the reason could be that she operates in a different situation with less social capital in terms of network possibilities in a male domain like engineering. This situation means that the leadership style of a woman cannot be evaluated without taking into account her situation within a gendered organizational environment. For this reason, this woman is behaving essentially like a man, except that she is forced to do more in changing organizational culture in order to obtain similar results.

Do women professors experience the prejudice that they are not suitable for leadership roles? One female interviewee reported this:

> *And I have the feeling that people thought they had an easy task to handle a woman who would subordinate herself, and who would agree to everything and cause no problems… This was a fight which I had to take on. I wanted to change the situation.*

She spoke of her impression that she was being tested at the beginning as to whether she could be dominated by men and, in her view, she had to react directly in response to this perceived provocation. The question is whether this result was due to her attempt to effect organizational change (about which she also spoke) when she took up her leading position, or whether she was less accepted because of gender stereotypes that still do not expect women to have leadership competencies?

Another woman mentioned a similar experience:

> *Their being able to perceive me objectively as a fellow scholar has only now begun. At the initial stage, I had to work hard to assert myself… because I was invisible. And there have been situations which have been beyond the pale… they would not have dared with a man.*

In order to be accepted, these two women had to do more than a man would have had to do in order to be accepted in their leadership positions. A male professor remembers his situation at the beginning of his professorship in the following way:

> *I felt accepted, not liked… but at least properly accepted. This was not so simple with me because I had been… here before. This meant that I already knew people from several years before for whom I was now the boss, but this situation worked out very well, although it was not originally clear how it would work out.*

He was not sure if he would be accepted at the beginning because there was a change in hierarchical order between former colleagues on the same level. But once accepted, he did not have to fight.

Regarding their leadership position, it is interesting how female professors think about and handle power. Reflecting upon existing gender stereotypes[4] and feminist discussions, one could expect that the achievement and exercise of power are ambivalent for female professors. The majority of the female professors interviewed, however, did not feel ambivalence. They said that they wanted power to influence and shape existing structures, to change work details, organizational culture and, last but not least, to set their own agenda as professors. This reaction is the same for women and men. At the same time, several female interviewees rejected power in the self-serving sense, seeing this behaviour as typically male from which they wanted explicitly to distance themselves:

> *I think women handle things differently. I think that this feeling of having power, with which I am confronted most of the time, is always about male power. Men want power. This can manifest itself in power over people or over a budget, but power is always the first priority.*

This woman's view of men's relationship to power reflects the dominant pattern of hegemonic masculinity (Connell, 1999), and perhaps also reflects her experiences in the engineering workplace culture. This was not unique, and all the other interviewed women wanted to distance themselves from this pattern. In their own minds they wanted power, to be sure, but they explained that they wanted it for different purposes than those motivating male engineers.

[4] A comprehensive overview of studies on gender stereotypes in technology under a socialization perspective is given by Susana Vázquez-Cupeiro (2013).

4.2. Output orientation, commitment and availability[5]

In the natural sciences and engineering, output means high performance which, in practice, means extensive publications and successfully securing research grants and (particularly for engineers) patents. Frequently, the quantification of high output has not been analysed thoroughly. Those factors favouring success, such as mentoring and networks, have been neglected by focusing only on the final output, especially in academia (Bagilhole & Goode, 2001; Morley, 1999). Nearly all the interviewees considered a high output as the unquestioned norm.

In this regard, one woman stated bluntly:

> *Output is what counts, but hitherto it had not been measured, so that now I focus on it. This is the difference which is difficult for some employees to understand… Until now, output had not been checked quantifiably. I changed this. Now all acquisitions must go over my desk and therefore I know who is working efficiently.*

In order to guarantee a higher output in the form of securing research grants, this woman had to change her control structures fundamentally, in a gesture which is reminiscent of a stereotypical 'male style' — it is neither 'female' (i.e., passive) nor 'soft'. Little wonder that her staff reacted in part by opposing this professor's expectations.

Output orientation has been combined with a change in the evaluation of dependent work in research institutes within the public sector, which have fixed working hours. In comparison to the technical university in this study, in the past more engineering employees in the research institutes used to have open-ended, full-time employment contracts; what is similar to the university situation is that both groups of researchers were expected to finish a dissertation during the course of their employment. Time pressure has sometimes been justified on the grounds that the staff must acquire new skills for further promotion in a timely manner.

I expect that everyone, even if she/he is not paid full time, will work full time… and what I tell employees at the beginning is that 40 hours is not enough… I say this because I know that otherwise it will be very difficult for them to get their PhD on time.

This young female professor has a so-called 'fixed-term' on 'non-tenured' junior professorship, which means that she herself must acquire

[5] For more detail regarding outcome in connection with efficiency, see also Part 2 in Hendrix and Sagebiel (2013).

skills to be appointed to a tenured professorship, which in turn puts her under additional pressure to convince her doctoral students to work harder as well.

Most interviewees in academia think that traditional rules governing working hours do not apply to academic organizations. However, this attitude does not mean that working hours (in this case overtime) in academia cannot be compared to those in industry. The fact that expectations to work overtime cannot be explained as a gender-based rejection of traditional working hours (i.e., nine-to-five-work) can be seen in the following two quotations, the first from a man and the second from a woman, both in leadership positions:

I expect that the people will focus their life on it. That doesn't mean that they have to be here for 20 hours, but if I have the feeling that someone shows up at nine in the morning and leaves at five in the afternoon — and not because he has finished his work at five, but because it is five — this would lead to a conflict with me.

And the mentality of 'I do research and leave for home at five o'clock', turns out to be is a strategy that is not really successful… some employees don't like the new situation…

These quotations reveal an ambivalence about expected overtime as well as about flexible working arrangements as well as a focus on output. Monitoring staff presence ultimately entails giving up the idea that researchers can, in principle, work anywhere and everywhere. At the same time, the traditional 'nine-to-five' work schedule can be seen as a metaphor for conducting intense research under time constraints.

Many women professors refer to their deep professional commitment with virtually no separation between professional and private/family life. Besides speaking of a pattern of intensive work on special occasions, leading women in the governmental research institutes also noted that they had to work these long hours all the time:

One has two jobs, two full-time jobs. One has a full professorship… and to lead a small- to medium-sized enterprise, this is the research institute... That means between 70 and 80 hours, otherwise it is not possible… that means from morning to evening and night, if one is travelling, weekends that is clear, one has only very little time.

Another woman states, self-confidently:

I am always available. I can be reached on my cell phone or, of course, by e-mail… And I think few people really understand this. Many preferred the situation where my predecessor was not always available, which gave them a week-long calm. And with me they always get a rapid response… which causes a problem for many employees. They go off on holiday and leave their cell phones and laptops at home. Tough luck, when a project is working out badly and they don't have the slightest clue.

If leading persons want to be successful, they must dedicate themselves totally to their work and be available at all times, which leaves no prospect for off-time, either for the leader or for the research, as the second quotation shows. One can object that this result reflects a particular work-ethic, which in fact suggests that the answers given by interviewees do not tell the whole truth but, instead, reflect the existing organizational working culture in the institutes.

Generally in research in the natural sciences and engineering, even having a family does not mean regular working hours because one is expected to continue working at home and to organize one's own work/life balance:

I expect from researchers that they will sometimes work at night because they are enthusiastic about their research. But this does not mean that they cannot take care of their children. We have fathers and mothers who leave at pre-determined times.

While here the staff members have the responsibility for organizing output-oriented work, in the next example a female professor differentiated between her own commitment and what she expected from her staff:

I don't expect that one is permanently at the workplace and always available — an employer also has a duty to care about their holidays and recreation… and often I have to remind people that it is Sunday and they don't have to reply to my e-mails immediately.

These different statements underscore several ambiguities about the culture of working hours: what is the first priority? Who is responsible for the organization of working hours? What are the working hours in the first place? And, is output really the first aim? Besides the question as to whether this culture of long working hours depends on subjective or ideological factors rather than objective ones, the answers here nevertheless suggest that this structure has neither been questioned nor changed by most of the female interviewees.

Regardless, this working culture of total dedication in the natural sciences and engineering, especially among persons in leading positions, has long been questioned as being masculine because it ignores a work-life-balance. Bourdieu (according to Krais, 2010) construed academia as a special masculine field where total dedication is the traditional work ethos, based on traditionally separate spheres of private and working life with a gendered division of labour.

Gendered organizational studies and feminist studies have criticized this long hours rule as an exemplar of traditional hegemonic masculinity workplace culture. Critical labour studies have analysed this change in the division of responsibility for output between superiors and employees as a fundamental change in the labour environment. It has been criticized as erasing the boundaries between work and privacy as a residual sphere. Equal opportunity policies applied in society in general — and in labour organizations in particular — have based their practices on these assumptions in order to influence the formal rules governing working hours and the scheduling of official meetings; yet these formal policies are largely ineffective in changing the informal spheres of scientific engineering working culture.

4.3. The role of networking and networks

In order to achieve — at least on paper — success in an academic career, the importance of networking cannot be stressed enough. Getting the right information at the right time in the right place is one of the main challenges of a leadership position. For women professors in the natural sciences and technology, the strategic handling of information is one of the most important prerequisites. For this reason, proposals for research projects must be communicated carefully, taking into account cooperation and competition at the same time. For the same reason, they must manage different networks very carefully. During the course of an academic career, there should be an equal focus on enhancing performance and on cultivating networks, as sensitivity to networking is a very important precondition (Sagebiel, 2010, 2013). For this reason, women professors must be aware that networks are indispensable in performing several functions: for acquiring information on time; for cooperation in research projects; for securing funding for research projects (and, since research projects and third-party funding are central for success, networking is a necessary precondition); for recruiting qualified staff members; for developing an academic career in a technical field; and for enhancing their influence in implementing their ideas.

In Germany, qualifying for a professorship entails various complicated selection processes. However, while in practice these are necessary, they are not enough:

> *…During a search a lot works via selection processes. But, then again, who will be asked to serve as the outside evaluator of the list of finalists? How will the list of finalists for a professorship be constructed in the first place?... We always want to think that these processes are fair, but this is far from true… I would be naive to think that this is the case… that they don't function via collusive behaviour... Yes, and when you look at who is ranked first, and if you piece together the story of the search afterwards, then you will quickly identify the connections which caused the result…*

This female interviewee has precisely described the critical points in the course of a search process where networks and networking come into play. Their influence is largely hidden but it is enormous, virtually replacing objective criteria such as qualifications and performance. Academic biographies for various candidates come to be construed (sometimes fictionalized) as apt or not, and if the network functions true to form, evaluators will be selected to bias the outcome.

The processes described above are not limited to engineering but can be found in all professorial searches, and apply to both women and men. Nevertheless, gender stereotypes are still applied to women who are candidates for leadership positions. A male professor in a focus group (who observed the entire procedure as a member of a search committee) remarked that a search committee with a male majority would not regard the slightest uncertainty in the presentation of a woman scientist/engineer as evidence of critical self-reflection but rather as a sign of weakness. He suggested that the intervention of an equal opportunity officer who would articulate the issues involved could remedy this inequity.

4.3.1. Fitting into men's networks? Barriers against women

For female professors in engineering who hold leadership roles, cooperation with men is an everyday job, yet becoming integrated into men's networks is a different issue altogether. In particular, the homosocial culture of men's networks represents a barrier for the recruitment of women (Sagebiel, 2007), so it is little wonder that our study shows that women's participation in men's networks is limited. Women are no longer formally excluded from most networks, but their integration is seen as a question of 'fitting into' male-defined institutions. For this reason, as long as women are defined as the 'others', following gender and technique stereotypes, they can hardly be expected to fit into these institutions as well as men:

> *The men are afraid, perhaps, of damaging their reputation if they have a woman as a network partner. And men probably see that there are more common characteristics among themselves. Are women defined as the 'others'?*[6]

In the view of this interviewee, women are defined as the 'other' and this constructed otherness — an inevitable deduction from binary thinking — certainly undermines their competence in male networks. In the homosocial culture of men's networks described above, women cannot fit because — not being men — they cannot be trusted. Since trust seems to be a prerequisite for choosing network partners (see Vaske & Schweer, 2013), women are automatically discriminated in this process.

Another example of discrimination because of 'non-fitting' is one young female professor (36) who described an important conference where she was the only woman representing her discipline. Other women present were either wives or journalists. She summarized up her experience by noting that men liked to sit next to her, but would not take her seriously on a professional level, as a professional peer; that is, she was not perceived as being qualified for networking or cooperating on research projects. From the perspective of dualistic gender and technique stereotypes, this interviewee was seen as an attractive woman, but not as real engineering colleague, not as a peer. This informal discrimination of a woman is what Gail M. McGuire (2002: 316) also found in her research: *Women may have been perceived by network members as poor or risky investments because of cultural beliefs that ranked them below that of a white man according to status characteristics theory*.

Several interviewees also described their perceptions that somehow men's networks did not fit for them either. Space, time, media and activities separate them from networking with men (separate restrooms, meeting at unpredictable times, phoning, drinking at night, doing extreme sports). They

[6] This quotation from an interviewed woman engineer was taken from a former research project. She tried to assume the constructed perspective of male colleagues' perception of women as potential networking partners and articulated the reasons arguing against women's fitting in.

immediately perceived the unspoken barriers, but they also did not want to try to be part of network where they would feel excluded or which they would not want to join in the first place:

> *I believe that many great deals are still [made] on a male level… while drinking beer at the bar — I don't do that, I don't drink… even with my partners in Japan… this is what my male colleagues do. And I am very convinced — this may be strange — that I simply meet a barrier… I believe that this being together from man to man would open some additional doors.*

This female leader of a research institute (who does not drink alcohol) will inevitably, at a certain point, feel a barrier to men's networks because drinking rituals often occupy a central role in informal networking, especially at night. The quotation also shows that this woman is keenly aware of these informal discriminatory processes. Even if she were to join such networks, she could expect to profit less from information sharing and cooperation with male colleagues. Her feeling of 'belonging' (Faulkner, 2005) separates herself from networking men. Being aware of informal discrimination, however, spurs her on to find a way to react to the situation in an individual way, but it does not change the culture of men's networking and discrimination because there is no general awareness arising among participating men:

> *The most important thing that I try to teach my doctoral students is this: Be there until the end of the evening, and stay in the right hotel, in the right bar — all of this will help. And the number of male colleagues is disproportionally higher than the number of female ones… My wife always says that I don't have to drink, and I say, I know, but, if I don't drink in Russia, then I don't get the project, it is really that simple.*

Another male respondent in a focus discussion group went even further:

> *My theory is that men are often in top positions because they are active in different networks and have more connections… Most of the decisions are informally made over a beer, and become formal afterwards… and one cannot underestimate the importance of this beer culture where men function in a more skilful and more integrated manner than women.*

Informal drinking rituals function as fitting symbols in these examples given by male respondents. The men are convinced by the efficiency of this kind of networking. Comparable cultural characteristics have been reported by several other research projects, including European ones (Sagebiel, 2007, 2010). At the same time, nothing seems to have been undertaken against these excluding working cultures, on either a consciousness-raising or an ethical level. On the contrary, this culture of informality between men has been growing in direct competition with increasing professional interactions between female and male professors (Ohlendieck, 2003).

4.3.2. The necessity of mentoring for networking as career promotion

Networking as a precondition for obtaining a professorship in engineering is an acquired, learnt skill. From men's studies, we know that men learn basic skills like cooperating and competing at the same time from juvenile play (Meuser, 2006). In the field of the natural sciences and engineering, junior members of the network are traditionally introduced by (male) seniors (mentors):

> *I was just a beginning graduate student… then he took me to France for a week with him… Well, you have to get to know the people… He didn't have to go there himself, but he also couldn't have sent me there alone because I would have been a little helpless, but like that, it matched quite well... after all, networks don't just drop down from the sky, and so one must start at some point and at some time.*

While this male professor was able to learn thanks to the help of his major professor how to network in practice, a female interviewee presented a contrasting story:

> *...As for conference visits or something similar — nothing has yet been set up. I did not go inside very much, was never introduced and when, subsequently, I had travel monies, I practised networking more intensively and noticed myself how important it is… I had been left very much alone and had to discover how necessary networking was by myself.*

In her recollection, she felt like an outsider within the engineering community, being left alone in her career planning yet realizing the importance of networking while not knowing how to do it practically. Working in a male domain, one would expect that women would have needed more mentoring in making a career in higher education, but in fact they received less. Moreover, as Vaske and Schweer (2013) show, on the basis of their review of the pertinent literature, women in particular need strategic protégées. However, because they cannot rely on established power networks, women need extended mentoring even when they find themselves in leading positions.

The comparison of these two cases demonstrates a gendered difference in career promotion based on inclusion and exclusion. In the recollection of the male interviewee, this common conference together with his boss was a decisive career step which the female interviewee missed. She learnt networking not at the beginning of her career but at a much later stage, and she now tries to help her employees in beginning to network as early as possible.

4.3.3. Using the potential of women's networks

Women's networks in engineering exist and successfully promote academic careers. There are formal women's engineering networks, mostly as sections of a large, general (but also more or less male) network. In Germany, for instance, the VDI (The Association of German Engineers) has one such women's section. In addition, several women's engineering networks exist, such as the DIB (The German Association of Women Engineers). The power and influence of these women's networks over academic careers is probably not extensive at the moment because of the low number of leading women in the field of engineering who could potentially promote other women's careers. Moreover, the internal influence in academic organizations which is most important for career advancement is probably even less extensive. Nevertheless, these formal women's networks function for information exchange and solidarity. The interviewees did not speak about internal women's networks in academia.[7]

As far as direct cooperation among women is concerned, one interviewee spoke of her appreciation of connecting women with each other as a less complicated option:

> *I think that sometimes women engineers handle problems more impartially. In the case of technical ones as well, I can handle them more personally and collegially.*

This cooperation among women is not easy in practice because the lower proportion of women in the engineering sector means that most are working in isolation from one another.

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[7] Only in the investigated large company has a women engineers' network been established by two leading women engineers, a move which received the company's acceptance and support. This network experienced a very critical reaction from male engineers in this company (see Schrettenbrunner/ Sagebiel/ Hendrix, 2012).

Another possibility is to use an external women's network, without a specific engineering focus:

> *I personally most appreciate the network 'Generation CEO', which is a women's leadership-level network.*

An external network such as this affords emotional and intellectual support, but cannot directly advance a career in any particular organization. Interestingly, this elite women's network was founded by a man and is financially supported by private industry. This gesture can be interpreted as the male-dominated industry itself weakening the power of informal men's networking in order to advance women to leadership positions.

4.4. Understanding technology

Understanding technology is combined with dualistic gender stereotypes (Wajcman, 1991, 1996) which construct a mastery of technical skills as being a male preserve and the opposite of the female pole. The core skills of engineering have been constructed as gendered (Faulkner, 2001). Faulkner (2005) sees the dichotomy between technical skills assigned to men and social skills assigned to women as the main hindrance to women's equal integration in the workplace culture. This fact arises not because women have better social abilities, but because this dichotomy perpetuates an image of technical engineering skills — gendered male — as opposed to social skills, even if in reality technical skills imply social ones.

Questions regarding the interviewees' own understanding of technology were formulated along biographical lines: they were asked to give a narrative about how their understanding of technical skills and technology had changed over time (childhood, youth, university and professional experience). One focus was to ascertain the breadth of the interviewees' understanding of technical skills and technology; did they see a connection between the technology of the military-industrial complex(es) and the technology of everyday life, such as cell phones and kitchen appliances? Another focus was to identify which interests and motives lay behind their decisions to become engineers.

In their biographical narratives, the interviewees — men and women — spoke about their broad interest in maths and the natural sciences. Two women in university positions also spoke of their practical technical skills which contradict the classic gender stereotypes. Men and women also talked about user orientation, interdisciplinary interests even in non-technical subjects, and interests in sustainability. However, a specific gender difference was the fact that female interviewees spoke of the resistance they experienced both at home and in school, a resistance conspicuously absent in the narrative of the male interviewees. A comparison between two cases of a male and a female professor revealed that both had been advised not to take a subject course they had wanted, but that the man was advised about selecting courses better suited for his future career, whereas the woman was discriminated against because she was told the subject in question would be too difficult for girls. For this reason, the beginning of this female professor's subsequent academic career was marked from the outset by the experience of gender prejudice.

If one were to argue from the position of women's socialization as well as from gender role expectations, one might suppose that women engineers would have a different view of technology, focusing more on people, everyday techniques and sustainability. One example of an innovation in transportation research demonstrates an understanding of technology which combines user orientation and interdisciplinarity, but which questions at the same time gender and technology stereotypes:

> *…it is important that one understands that technical possibilities enable people to find better solutions… What I want to do is think of traffic planning, starting with people, and moving to technology. That means determining functional applications for various technologies.*
> *This accelerated efficiency didn't even interest the men. We asked as many men as women what was new then… in the group of people preferring technological solutions there were more women, and in the group preferring more comfort, there were more men. This was considered revolutionary when I presented the results.*

The female traffic planner cited above articulated an alternative understanding of comfort which effectively deconstructs gender stereotypes in engineering. Her research on mobility needs could demonstrate that women as users of this technology are more interested in practical applications for gaining mobility whereas men are more interested in comfort. Her results were initially dismissed by her colleagues, who reacted according to gender stereotypes and disqualified her subject as social pedagogy rather than engineering, but they later respected her approach. During the period that she worked for a tenured appointment, she had to spend a lot of time justifying her research methodology as being indeed appropriate to the field of engineering.

In understanding technology, we generally found different priorities depending on the academic organization, research institute or technical university. While a general user orientation was characteristic of the research institutes focusing on application, in the technical university it depended on individual preferences regarding basic or applied research. Especially in the two focus discussion groups at the technical university, women as well as men expressed their love of the freedom to choose their own subjects.

Interestingly, gender stereotypes — which connected 'applied engineering' to women and 'abstract engineering' to men — could not be detected in the study.

> *We as a group have always been in applied engineering… and then I followed my boss when I got the new position… and from the first day on we became the theorists, who did not do any applied science… What one learns is that, when someone is identified as being in applied or theoretical research, this depends on the perspective as well as on own culture in the discipline.*

These categories 'applied'/'abstract' were also constructed differently depending on who was evaluating the work, as the above male interviewee noted.

There is also a gendered hierarchy of engineering tasks. Work on the practical application or transfer of technical results to the public sector has often been delegated to women; in the investigated technical university, the professors in the women's focus discussion group exchanged their views on this issue, observing that they like this transfer work and, therefore, they often take over this task, all the while knowing their male colleagues discount it as 'soft' and give it less recognition.

5. Summary of results and conclusions

While the leadership style of several female professors can be characterized as a break or discontinuity with their male predecessors, the analysis of one case in detail, based on a comparison with how a male professor favoured continuity, showed similar aims and strategies. How can this result be explained? In order to manage a large unit, both resorted to delegating responsibility. What was different were their starting points: the woman had to confront an organization structure which was not intact; she did not have the benefit of the social capital of a male network and she faced a lack of acceptance. For this reason, while our results show that women in leadership positions manage much like men, in the particular case study the woman had to devote more time and energy to achieve the same end (Powell et al., 2009; Wajcman, 1998).

In addition, the suggestion that some women respondents who showed 'nurturing' behaviour — focusing on communication in order to reach decisions — practised a different 'female' leadership style is doubtful, because to achieve a consensus with their working demands, this style was instrumental. Moreover, it is also possible that they did not have other channels of information.

Power as the ability to succeed even against resistance (Max Weber) appears to be the leadership style practised by women in cases of 'discontinuity'. For this reason, and in this way, they did not exhibit ambivalence or hesitation against power as an instrument to reach their goals. Some of them, however, blamed men for using power to control people and money as such. This can be interpreted as gender stereotyping by the women themselves but it might just as well be an interpretation of their experience.

As leading women, they exhibit a strong performance- and output-orientation, and in this way are similar to male professors. Enforcing output-orientation often proved strenuous for many women professors. Controlling the staff's output and/or working time successfully did not prove to be an easy management task, even though there was no gender difference in the attitudes toward working behaviour which they expected from employees.

Most women did not care more about work-life-balance than men. Flexibility and self-responsibility for organizing work and private life reveal themselves to be the prominent strategies for individuals in the natural sciences and engineering in academia. For this reason, it is unrealistic to expect women — in principle — to seek organizational changes to achieve a better reconciliation of work and family/private life.

The fact that women are poorly integrated in men's informal networks is a disadvantaging factor for output success. As a matter of practice, women are not integrated in the masculine 'beer culture' which is a place and where many research projects are developed. Some female professors experience an ambivalence in joining these informal drinking sessions in the evening, even though they know that this strategy might be a successful one. In such an informal situation, these leading women fear harassment, which would not take place at the workplace. Others definitively avoid these situations, arguing they do not feel comfortable because they would be outsiders and that the end result would be negative. These women also miss the feeling of belonging (Faulkner, 2005).

Some female interviewees were not aware of the high importance of networking at the beginning of their academic careers, and thus lacked the initiation into the networking culture which men enjoyed. In teaching informal networking for the next generation, attention needs to be paid to gender differences.

Women's networks in engineering are mostly formal and help to disseminate general information and reinforce solidarity. In a male domain like engineering, and given the low number of female engineers in any given organization, informal networking between female colleagues is frequently not possible. At the same time, women's networks are of limited importance for the research work of female scientists and engineers because of their small number in a specialized field. Women's networks can help, especially as a coaching element, but they have less power in comparison with men's networks.

Most of the interviewees in academia seemed to have a similar broad understanding of technology. Nevertheless, technology-gender dualisms (Wajcman, 1991) remain. Whereas some women had experienced resistance and, subsequently, even surprising questions regarding their choice of profession, none of the men talked about such a negative experience. The necessity that women felt of always having to justify their professional decision is not only tiresome, but can also lead to a feeling of uncertainty.

We found one female engineer in academia who used a gender studies approach in her understanding of technology and her research. With her results, she could successfully question gender stereotypes in the field of transportation studies. The criticisms which male colleagues raised to her approach invoked the public image of engineering which defines technical skills as being in opposition to social ones (Faulkner, 2005).

In our reflections on academic leadership and careers from a gender perspective, three important conclusions arise:

First, gendered disadvantages for women in the natural sciences and engineering have often been summarized as a cumulative process of discriminating events during the course of life (EC, 2012), a phenomenon which many studies have confirmed (Faulkner, 2005, 2009). Analysing the 'discontinuity' examples of women professors in our study, the results can also be interpreted as 'cumulative processes of reduction of hindrances' against successful academic leadership. Working as a minority in a male field and looking to their own professional careers, women engineers in leading academic positions are sensitive to gender issues, most of them having experienced discrimination in different forms. However, these women did not dwell on these negative events, and instead emphasized their own aims and scientific questions. What is the difference in insight using the different perspectives? The latter focuses on activities which are — or can be — successful. Nevertheless, many of these women engineers are aware that this approach meant that they had to struggle for success in a way in which they believe their male colleagues did not have to do.

Second, the case of the female traffic planner shows the enormous energy which she had to apply in order to realize her conceptual and organizational goals. Following a gender-based approach in engineering research was an exceptional innovation for which she had to fight for recognition, not only in the academic promotion committees but also within the scientific community. Adapting to an established agenda in a scientific field is much easier, whereas an innovative approach often promises little success, and traditional research suffers barely any discrimination compared to research with a gender approach. In addition to the additional effort required here at the outset for this scholar came new, additional challenges in changing the organizational culture after she was appointed a professor. She had stayed at the institute for a long time beforehand and now had to work with people who had been her former collaborators. Instead of using a hierarchical structure from the beginning to solve possible problems, and given her experience in private industry, she decided that an assessment centre in the department institute should clarify the situation for team building and future cooperation. Such an approach had never been taken before in this institution. Her model of change, which bypassed traditional structural elements and old networks, was exceptional.

Third, the 'continuity' example from a male professor could teach a gender lesson about networking. Receiving and giving information is connected to networking, and being a part of the relevant networks is a prerequisite for a leadership position. In their careers, women have to learn how to network; in order to realize this objective, there is an urgent need for mentoring for understanding and learning networking. Men's networks still exist and integration in or working with them almost seems to be more important than performance in successfully modernizing academic institutions and research in the natural sciences and engineering.

In our example, the man has been able to rely on pre-existing networks in the scientific field as well as in the research institute. He tends to experience continuity in his career progression, including the evidence of successfully networking in the selection committees. This male professor could start or continue his research without any time lag or hindrances, supported by formal and informal networks. Hopefully, these male strategies will work efficiently and will be translated into many publications, projects and patents. In comparison with a female professor in a 'discontinuity' situation, it is obvious that this male professor has a numerical advantage. Hitherto, the presence of informal male-bonding groups or 'rope teams' within leading management circles has not been taken in account.

We give the final word to a female professor who voiced her dilemma regarding men's networks:

> *In these networks you really cannot be incorporated, especially not if you ask for it. Either you belong or you don't… The initiation is the doctoral thesis under the supervision of the right professor… in general, one is not good enough if one does not belong to this group from the outset… And if you ask to become a member, nobody will say no… but will you really belong? No, and this is because one also does not fit the unwritten code, and perhaps because one does not show the special worship for special people, a worship which one cannot comprehend… I know male colleagues, most of them male colleagues, who will tell you that they come from this special school.*

References

Acker, J. (1990). Hierarchies, jobs, bodies. A theory of gendered organizations. *Gender & Society,* 4 (2), 139–58.

Bagilhole B. & Goode J. (2001). The contradiction of the myth of individual merit, and the reality of a patriarchal support system in academic careers: A feminist investigation. *European Journal of Women's Studies,* 8 (2), 161–80.

Burt, R.S. (1998). The gender of social capital. *Rationality and Society,* 10 (1), 5–46.

Connell, R.W. (1999). *Der gemachte Mann: Konstruktion und Krise von Maennlichkeiten*, Opladen: Leske & Budrich.

Doppler, D. (2005). Maennerbuendisches Management — Verbuendete Manager. Der Maennerbund als komplexer Schließungsmechanismus im organisationalen Management. *IFF Info — Zeitschrift des Interdisziplinären Zentrums für Frauen- und Geschlechterforschung,* 22 (30), 35–47.

EC (2012). *Meta-analysis of gender and science research. Synthesis report*. / Caprile, M. et al. (Eds.). Brussels: European Commission.

EC (2013). *She Figures 2012. Gender in research and innovation*. Brussels: European Commission.

Evetts, J. (1997). Women and careers in engineering: Management changes in the work organization. *Women in Management Review,* 12 (6), 228–233.

Evetts, J. (1998). Managing the technology but not the organization: Women and career in engineering. *Women in Management Review* 13 (8), 283–290.

Faulkner, W. (2000). The power and the pleasure: How does gender 'stick' to engineers? *Science, Technology & Human Values,* 25 (1), 87–119.

Faulkner, W. (2001). The technology question in feminism: A view from feminist technology studies. *Women's Studies International Forum,* 24 (1), 79–95.

Faulkner, W. (2005). Belonging and becoming: Gendered processes in engineering. In: J. Archibald, J. Emms, F. Brundy & E. Turner (Eds.), The gender politics of ICT, Middlesex: Middlesex University Press, 15–26.

Fletcher, J.K. (1999). *Disappearing acts. Gender, power and relational practice at work*. Massachusetts: The MIT Press.

Funken, C., Stoll, A. & Hörlin, S. (2011). *Die Projektdarsteller: Karriere als Inszenierung. Paradoxien und Geschlechterfallen in der Wissensoekonomie*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Gheradi, S. (1994). The gender we think, the gender we do in our everyday lives. *Human Relations,* 47 (6), 591–610.

Hendrix, U. & Sagebiel, F. (2013). Erfolg, Technik und Geschlecht — Fuehrungsfrauen zwischen Anpassung und Diskontinuitaet. In: D. Hänzi, H. Matthies & D. Simon (Eds.), Erfolg. Auspraegungen und Ambivalenzen einer gesellschaftlichen Leitorientierung. Leviathan-Sonderband (in printing).

Höyng, S. & Lange, R. (2004). Gender Mainstreaming — ein Ansatz zur Aufloesung maennerbuendischer Arbeits- und Organisationskultur? In: M. Meuser & C. Neusüß (Eds.), *Gender Mainstreaming. Konzepte — Handlungsfelder — Instrumente* (pp. 103–119). Bonn: Bundeszentrale für politische Bildung.

Husu, L. (2005). Women's work-related and family-related discrimination and support in academia. *Gender Realities: Local and Global Advances in Gender Research,* 9: 161–99.

Knights, D. & Keerfoot, D. (2004). Representations and subjectivity: Gender binaries and the politics of organisational transformation. *Gender, Work and Organisation*, 11 (4) July, 430–454.

Krais, B. (2010). Das Projekt „Gleichstellung in der Wissenschaft": Anmerkungen zu den Muehen der Ebenen. In: C. Bauschke-Urban, M. Kamphans & F. Sagebiel (Eds.), *Subversion und Intervention. Wissenschaft und Geschlechter(un)ordnung.* (pp. 23–45). Opladen: Verlag Barbara Budrich.

Lind, I. (2006). Kurzexpertise zum Themenfeld Frauen in Wissenschaft und Forschung. Bonn: Robert Bosch Stiftung; CEWS, Kompetenzzentrum Frauen in Wissenschaft und Forschung. URL: http://www.bosch-stiftung.de/content/language1/downloads/Publikation.pdf

Matthies, H. & Zimmermann, K. (2010). Arbeitsfeld Wissenschaft und Geschlechtersegregation. *WSI-Mitteilungen*, 63 (5), 264–270.

McGuire, G.M. (2002). Gender, race, and the shadow structure: A study of informal networks and inequality in a work organization. *Gender & Society,* 16 (3), 303–322.

McLean, C., Lewis, S., Copeland, J., O'Neill, B. & Lintern, S. (1996). Masculinity and the culture of engineering. In: *Third Australasian Women in Engineering Forum,* (pp. 32–41): Sydney: University of Technology Sydney.

Metz-Goeckel, S. (1999). Hochschulreform als Personalentwicklung. Zur Produktivitaet von WissenschaftlerInnen. In: A. Neusel & A. Wetterer (Eds.), *Vielfaeltige Verschiedenheiten* (pp. 162–191).Frankfurt: Campus Verlag.

Meuser, M. (2006). Riskante Praktiken. Zur Aneignung von Maennlichkeit in den ernsten Spielen des Wettbewerbs. In: H. Bilden & B. Dausien (Eds.), Sozialisation und Geschlecht. Theoretische und methodologische Aspekte. Opladen: Barbara Budrich, 163–178.

Miller, G. (2002). The frontier, entrepreneurialism and engineers: Women coping with a web of masculinities in organizational culture. *Culture and Organization,* 8 (2), 145–160.

Morley, L. (1999). *Organising feminisms. The micropolitics of the academy*, New York, NY: St. Martin's Press.

Ohlendieck, L. (2003). Gender Trouble in Organisationen und Netzwerken. In: U. Pasero & C. Weinbach (Eds.), *Frauen, Maenner, Gender Trouble, systemtheoretische Essays* (pp. 171–85). Frankfurt: Suhrkamp Verlag.

Powell, A., Bagilhole, B. & Dainty, A. (2009). How women engineers do and undo gender: Consequences for gender equality. *Gender, Work & Organization,* 16 (4) July, 211–228.

Prpić, K. (2009). Why another book on women in science and technology? In: K. Prpić, L. Oliviera & S. Hemlin (Eds.), *Women in science and technology* (pp. 11–24). Zagreb: Institute for Social Research.

Rastetter, D. (1998). Maennerbund Management. Ist Gleichstellung von Frauen und Maennern trotz archaischer Gegenkraefte moeglich? *ZfP* 2: 167–186.

Sagebiel, F. (2003). Masculinity cultures in engineering departments in institutions of higher education and perspectives for social change. In: J. Naugah, P. Parmessur, Y. Ramma, A. Ramdinny & P. Mohadeb (Eds.), *Proceedings of the 11th International GASAT Conference Mauritius* (pp. 104–13). Mauritius: Best Graphics Ltd.

Sagebiel, F. (2007). Gendered organisational engineering cultures in Europe. In: I. Welpe, B. Reschka & J. Larkin (Eds.), *Gender and engineering — problems and possibilities* (pp. 149–173). Bern, Berlin, Brüssel, Frankfurt am Main, New York City, Oxford und Wien: Peter Lang Verlag.

Sagebiel, F. (2010). Gendered organisational cultures and networks in engineering research. In: A.-S. Godfroy-Genin (Ed.), *Prometea International Conference Proceedings, 'Women in Engineering and Technology Research', Paris (France), October 26–27, 2007* (pp. 183–207. Berlin, Hamburg, London, Münster, New York, Wien, Zürich: LIT Verlag.

Sagebiel, F. (2013). Organisationskultur und Macht — Veraenderungspotenziale durch Fuehrungsfrauen in der Technik. In: Sagebiel, Felizitas (Ed.), *Organisationskultur und Macht — Veraenderungspotenziale und Gender.* (pp. 49–83). Berlin, Hamburg, London, Münster, New York, Wien, Zürich: LIT Verlag.

Sagebiel, F. & Dahmen, J. (2006). Masculinities in organisational cultures in engineering education in Europe. Results of European project WomEng. *European Journal of Engineering Education,* 31 (1), 5–14.

Schrettenbrunner, C.T., Sagebiel, F. & Hendrix, U. (2012). Netzwerke als Gestaltungspotenziale von Fuehrungsfrauen in Umwelt und Technik, Broschüre, ed. BMBF. Wuppertal.

Schiffbänker, H. (2009). Gender specific career aspects in science and technology. In: K. Prpić, Oliviera, L. & S. Hemlin (Eds.), *Women in Science and Technology* (pp. 85–107). Zagreb: Institute for Social Research.

Vaske, A.-K- & Schweer, M., K.W. (2013). Zur Bedeutung von Vertrauen für eine geschlechterintegrierende Netzwerkarbeit. In: F. Sagebiel (Ed.), *Organisationskultur und Macht — Veraenderungspotenziale und Gender* (pp. 145–157). Münster et al.: LIT Verlag.

Vázquez-Cupeiro, S. (2013). Socialization agents and the gendered choice of educational paths: Perpetuation or fragility of gender stereotypes? In: F. Sagebiel (Ed.), *MOTIVATION. Gender, image and choice of science and engineering,* (pp. 29–44). Opladen: Verlag Barbara Budrich.

Wajcman, J. (1991, 1996). *Feminism confronts technology,* Cambridge: Polity Press.

Wajcman, J. (1998). *Managing like a man. Women and men in corporate management,* Cambridge: The Pennsylvania State University Press: Polity Press in association with Blackwell Publisher Ltd.

Wilz, S.M. (2004). Organisation: Die Debatte um ‚Gendered Organizations'. In: R. Becker & B. Kortendiek (Eds.), *Handbuch der Frauen- und Geschlechterforschung. Theorie, Methoden, Empirie* (pp. 443–449). Wiesbaden: VS Verlag für Sozialwissenschaften.

Part II

Research career context and preconditions

Changes in the institutional context and academic profession — a case from Portugal

Teresa Carvalho, Sónia Cardoso and Sofia Branco Sousa

Over recent decades, the academic profession in European countries has been subjected to relevant transformations. These have contributed to changing both the way academics develop their work and their working conditions. This chapter aims to analyse the main characteristics of academics' working conditions in Portugal in an environment of change promoted by increasing financial constraints. The study is empirically supported by the analysis of a dataset referring to the entire Portuguese academic population. The analysis of two specific dimensions of academics' work and employment — the duration of contract (tenured or non-tenured) and the time regime (full-time or part-time) — reveals that differences exist between higher education institutions (public/private, university/polytechnic) and also between junior and senior academic staff.

1. Introduction

One of the most popular concepts classifying contemporary societies is that of the 'knowledge society'. Particularly since its use in the definition of European societies since the *Lisbon Strategy*, the concept intends to affirm knowledge as the most significant means of production with talent becoming the world's most sought-after commodity.

Within this context, it is expected that the academic community, traditionally defined as assembling higher education (HE) professors and researchers, would benefit from this social valorization of knowledge.

Nevertheless, wider changes in the roles of the state in society, with the deconstruction of the idea of the welfare state, and in public bureaucracies, under new public management (NPM) and the influence of managerialism, have contributed to bringing into question the traditional power and status of professional groups in modern societies.

According to some authors, these changes in professional groups configure a deprofessionalization process (Freidson, 1994; MacDonald, 1995;

Kirkpatrick et al., 2005; Ferlie et al., 1996). Can we expect the same process to affect the academic professional group? Academics have long benefited from a privileged position in society and protection by the state as a condition *sine qua non* for their autonomy and the production of unbiased knowledge (Neave & Rhodes, 1987). This has also been the case in Portugal. Throughout the twentieth century, the academic profession was an elite profession, firstly protected and ideologically used by the dictatorship and, after 1974, acting as an 'arm' of the democratic regime (Carvalho, 2012). However, the first decade of the twenty-first century brought important legal changes to the academic career. Nevertheless, it remains unknown if these changes promoted deep transformations in the working conditions of this professional group.

How are academic working conditions characterized in the new environment? Are there relevant differences between institutions?

Based on an analysis of a database of every academic working in the Portuguese HE system, this chapter tries to answer these questions. More specifically, it aims to characterize academics' working conditions by analysing two dimensions of work and employment, namely the duration of contract (tenured or non-tenured) and the time regime (full-time or part-time). The chapter begins with an overall synthesis of the main challenges currently faced by the academic profession. Next, the major changes affecting Portuguese academics are discussed. The third section of the chapter summarizes the methodological strategies employed to define the study sample and analyse the data. An overview of the findings is presented in the subsequent section. Finally, a conclusion stressing the main results and directions for further research on academics is presented.

2. Current challenges to the academic profession

The importance of knowledge has been emphasized by researchers aiming to characterize major changes in post-industrial capitalism (Bell, 1976; Drucker, 1969; Castells, 1996; Sen, 1999). Knowledge is assumed as the main driver of innovation and European economic competitiveness. European policies have been developed for the purpose of implementing the so-called 'knowledge society'. The assumption of knowledge as the most important device of our societies also presupposes that intensive knowledge-based professions gather more power and status than others.

Even if sociologists have been analysing professional groups for a long time, it was only during the 1970s that relevant variables were introduced, such as ‘market’, ‘monopoly’ and ‘professional self-interest’. Since then, the discussion about professional projects became progressively anchored in the political, social and economic contradictions of capitalist society (Johnson, 1972; Navarro, 1976; Zola, 1972). This was an important step towards replacing the emphasis on professions by an emphasis on professionalism — the norms and values underlying professional practices and professionalization — that collective project professionals define to be able to obtain more prestige and power in society (Abbott, 1988; Larson, 1977; Perkin, 1987).

In Europe, the state has been the driving force behind shaping professional projects (Bureau et al., 2004; Torstendahl & Burrage, 1990). However, more recently, important changes have also been noticed in the state’s roles in society perceived as impacting on professionals and professionalism. Since the 1970s, these changes have been analysed in the literature as being mainly driven by NPM and managerialism (Kirkpatrick et al., 2005; Ferlie et al., 1996; Enders, 1999, 2001; Musselin, 2004, 2008). The influence of NPM and managerialism is reflected in the use of the same recipe in different public domains: imperatives of efficiency and efficacy; orientation to the customer in substitution for the citizen; the creation of *quasi*-market mechanisms based on a great diversity of institutions delivering the service; complex relations between public and private service providers competing for resources; and decentralized control and accountability for results sustaining the idea of a flowing chain of contracts between the state, institutions and professionals (Carvalho & Bruckman, 2014).

The imposition of a technocratic ideology by NPM/managerialism has led to the degradation of the working conditions of professional groups. This is particularly true for public professionals, who see such conditions as becoming increasingly insecure and precarious (Farnham and Horton, 1996) and, therefore, closer to those usually predominant in the private sector. These transformations may configure a deprofessionalization process, marked by a decrease in the power and prestige traditionally held by professional groups.

Nevertheless there seems to be no consensus on the impact of these changes on professions. Some authors claim that changes in state and institutional attitudes towards professional groups led to a decline in their autonomy, their power to exercise control, their capacity to self-regulate their own work, and even in their professionalism (Carvalho, 2012; Carvalho & Santiago, 2010; Evetts, 2003; Fournier, 1999, 2000; Freidson, 1988, 1994; Macdonald, 1995; Reed, 2002). Other authors emphasize professional groups’ ability to avoid NPM/managerialism threats by adopting strategies allowing them to maintain or increase their power and status within institutions (Carvalho, 2012; Ferlie et al., 1996; Exworthy & Halford, 1999; Kirkpatrick & Ackroyd, 2003; Kirkpatrick, et al., 2005; Salter, 1999).

The so-called 'knowledge society' and the NPM/managerialism context present contradictory tendencies to academics as a professional group. On the one hand, the alleged valorization of knowledge increases the possibilities for academics' social valorization. However, on the other hand, while imposing a technocratic and hard management culture, the influence of NPM/managerialism may induce a devaluing of the academic professional group, which is visible in the deterioration of its employment terms and conditions.

3. The Portuguese context

During the dictatorship (*Estado Novo* — 1932–1974), the academic profession was an elite and homogeneous profession. Following Burton Clark (1983), the system was highly hierarchical and based on strong bureaucratic control, both centralized and ideological.

With the democratic regime (*post*–1974), significant changes occurred in the HE system and, therefore, in the academic professional group. To begin with, academics' professionalism changed by including democratic values. On the other hand, the creation of a binary system through the institutionalization of the polytechnic subsystem, with its more vocational nature, promoted the emergence of more practice-orientated academic profiles.

However, the profession's elite character remained. The country's commitment towards social and economic development, together with the increasing diversification and massification of HE and the scarce number of qualified academics to support it, provided the conditions for a privileged career highly protected by the state.

Due to the system's binary character, two different careers were defined, one for universities (Decree-Law 448/79), the other for polytechnics (Decree-Law 185/81). The distinctive pathways of the academic career in both institutions are linked with the main objectives defined by law for each subsystem: universities were supposed to be more academically driven and polytechnics more vocationally orientated in order to meet the needs of the labour market (Santiago & Carvalho, 2008). Furthermore, an academic career (both in universities and polytechnics) was based upon two main values: employment security and the improvement of academic qualifications through the state's direct financial support to higher education institutions (HEIs).

The university career was based on five levels: trainee assistant,[1] assistant, auxiliary professor,[2] associated professor and full professor. Trainee assistant was the first rank in the career and recruitment to this position was mainly based on a student pool (under a national competition). The best students could be recruited as trainee assistants and, after completing their master's degree, they could access an assistant position. Within this position, academics had a five-year contract that could be extended for two more years. During this period of time, they were expected to obtain a PhD with which they could automatically access the auxiliary professor position. However, as security of employment was one of the major objectives of the public university career, assistants who were not able to complete their PhD within that time could obtain positions as qualified workers in the public sector (Decree-Law 448/79). In the auxiliary position, professors had a five-year contract after which they could apply for a permanent contract as public servants. To have access to the two top positions of the career — full and associate professor — academics had to wait for the state to open a vacancy and, after a national competition, they obtained a permanent position. In the case of full professors, they also had to have the *agregação* title.[3] Employment security was assured in any of these positions (full and associate professor). If the permanent position was refused, academics would have a new contract for the same five-year period and if, after that, the position was again denied, the state ensured their placement in another public institution, earning the same salary (Decree-Law 448/79).

As with the university career, the polytechnic career also had five ranks — assistant (first triennial), assistant (second triennial), adjunct professor, coordinator professor and principal coordinator (with *agregação*). However, unlike the practice in universities, additional qualifications did not guarantee automatic promotion to a higher category, as professors at all levels had to wait for a vacancy. Academics could obtain a permanent appointment three years after holding a position as adjunct professor, which they could access by holding a master's degree.

In addition to 'formal' career positions, both universities and polytechnics could hire professionals under individual fixed-term contracts (provided

[1] Students in the last two years of the first degree (which usually lasted five years) could be recruited to help professors in practical lessons as monitors (monitores).

[2] The assistant category corresponds to the monitor in the USA, while the auxiliary professor category corresponds to the assistant position (the first rank in an academic career).

[3] Agregação is a title awarded by Portuguese universities to attest the quality of academic, professional, scientific and research capacity, as well as the ability to develop independent scientific work.

that they had a relevant pedagogical and professional curriculum) to overcome the scarce number of qualified academics. This was the case for 'invited' academic staff in universities and the 'equivalent' academic staff in polytechnics, positions which corresponded to the equivalent categories (or levels) in the formal career. Invited professors could be recruited based on their pedagogical and professional merit with one year contracts that could be extended for an equal period of time.

In the 1980s, the emergence and consolidation of a private HE subsystem helped to strengthen the segmentation of the academic professional group (Carvalho, 2012). The academic profession lost its elite status to become a key profession in society (Perkin, 1987), assuming the responsibility for creating the needed expertise to support other professional groups (Carvalho, 2012).

As in virtually all developed countries, Portuguese HE has — since the 1990s — been submitted to NPM and managerialism influences. As a result, important changes in the academic institutional context have occurred, such as: increased control and barriers to entering the profession; the questioning of autonomy with an increasing imposition of models of individual responsibility (accountability); the transformation in the modes of knowledge production; and the enforcement of changes in professional practice led by new performance assessment systems (Santiago & Carvalho, 2008). Apart from these changes, two other important developments were verified: on the one hand, the increased recruitment of academics as invited (in universities) and equivalent (in polytechnics) professors; on the other hand, the dismissal of the state in relation to the financial support of HEIs to improve the qualifications of the academic staff.

Since the 1990s, governments have been replacing HEIs' direct financing by support academics' qualification with individual scholarships and grants (Carvalho, 2012). From 1994 to 1999, 3,486 PhD grants were awarded through one specific programme — Praxis XXI (OCES, 2003). More recently, in just four years (2006 to 2010) the FCT (National Research Foundation) awarded 12,454 PhD grants (FCT, 2012). As a result, the number of PhDs in Portugal increased from 116 in 1980 to 1,666 in 2010 (GPEARI, 2011; Pordata, 2013).

Owing to the previous developments, there emerged a large number of highly qualified human resources that were unable to enter a formal academic career. Instead, institutions increasingly started to recruit academics as invited or equivalent professors, which contributed to the development of a parallel or informal career (Santiago & Carvalho, 2008). Although performing the same activities as other academics, those in this career do not have a permanent contract and therefore have less secure contractual relations with HEIs (Santiago & Carvalho, 2008).

In force for 30 years, the legal framework for an academic career was replaced under the influence of NPM/managerialism by Decree-Law 205/2009 (for universities) and Decree-Law 207/2009 (for polytechnics). Issuing from this, the state divested itself from supporting academics' qualifications.

In universities, the PhD degree emerges as the minimum requirement for entering an academic career. This career was reduced to only three categories: full, associated and auxiliary professor. Auxiliary professors are now recruited based on an international competition for a five-year period. After that, they have the opportunity to apply for a permanent contract. If they do not succeed in this application, the HEI can dismiss them. Turning down a permanent contract was a very uncommon practice within the former legal framework. However, it has become more frequent, even before the implementation of the new legal framework.

In polytechnics, the new legal career framework aims to strengthen the distinction between the respective missions of the universities and polytechnics. It also introduced the PhD or the specialist[4] title as the *minimum* requirement for entering the career; a new top category of principal coordinator professor (with a PhD for more than five years and with *agregação*); and attempts to improve polytechnics and enterprises' relations.

In both careers, two professional categories were suppressed — assistant and trainee assistant. However, academics in these categories were given the opportunity to keep them as well as their inherent working conditions until their progression to a category above.

Besides all these changes, the new legal framework for an academic career also introduced another novelty for public institutions: the tenure. For the legislator, the tenure is a professional condition granting academics the maintenance of their employment, in the same career and professional category, in all possible situations, such as the closure of the institution (due to a reorganization of the system) or of the study programmes. Only full and associated professors, in universities, and principal coordinators and coordinator professors, in polytechnics, can benefit from this tenure position and, therefore, be tenured staff. According to the legal rules, these staff benefit from open-ended contracts. Those who are not in such a position have a fixed-term contract (with the exception of adjunct or auxiliary professors

[4] The specialist is someone with a high relevant curriculum who can obtain this title by submitting a 'professional report' to a jury. To submit such a report, the candidate must have a higher education degree and 10 years relevant professional experience.

who have finished their probation period with success and have a permanent contract). However, they can either be on the tenure track (i.e., in a category allowing them to progress to tenure position, such as auxiliary professor, assistant and trainee assistant), or on a non-tenure track, with no such possibility (invited full professor, invited associated professor, invited auxiliary professor, invited assistant and invited trainee assistant). Academics on the non-tenure track are those occupying categories of invited or equivalent professors and, by definition, are those subject to the worst working conditions. In fact, these academics are the expression of the casualization of the profession, as they have only temporary contracts depending on temporary teaching requirements. 'Casualization' in this context refers to the recruitment and employment of regular workers on a casual or short-term basis.

In recent years, some studies were conducted of the academic profession as it was framed by the former legal framework (Decree-Law 205/2009 and Decree-Law 207/2009). This is the case with Santiago and Carvalho's study (2008), which focuses only on public institutions and suggests a deterioration in the working conditions of academics, namely through the increase of a part-time regime and non-tenure career positions. Framed by the implementation of the new legal framework for the career, and based on data for the whole HE system, the present paper intends to characterize academics' working conditions and analyse the main differences according to the type of institution.

4. Method

This study aims to analyse the main characteristics of Portuguese academic working conditions and their variability between HE sector (public/private) and type of HEI (university/polytechnic). Following Santiago and Carvalho (2008), these conditions are influenced by the terms of academics' employment and empirically defined by the duration (length of time) of contracts (tenured staff, non-tenured staff in a tenure track and non-tenured staff in a non-tenure track) and by the time regime (full-time with exclusivity, full-time and part-time dedication). The full-time contract (FT) corresponds to academics who work thirty-five working hours *per* week. A full-time contract with exclusivity (FTE) means that academics cannot perform any other economic activity or duty, public or private, including liberal professions (earning more than 30 % in their salaries for working only in one HEI). As a rule, permanent academic staff are employed full time and with exclusivity (e.g., 35 working hours *per* week). A part-time contract (PT) implies a reduction in working hours and also the possibility of undertaking other teaching duties, in other HEIs, or other economic activities.

The duration of contract and the regime of time are influenced by academic rank (professional categories for universities and for polytechnics) and educational attainment (academic qualifications, namely PhD, master's or bachelor's degree). Specifically regarding academic rank, the five professional categories defined by the former legal framework are considered (Decrees-Law 448/79 and 185/81). This is due to the fact that during the transitory period to the new legal framework, the maintenance of the former categories was allowed. The analysis of these variables was based on descriptive statistics supported by SPSS, namely crossed analysis and chi-square tests.

The case study conducted was empirically based on the analysis of a database of Portuguese academics. This database was constructed by resorting to data compiled by the national Agency for the Assessment and Accreditation of Higher Education (A3ES) under the preliminary accreditation process (2010).[5]

The database constitutes the entire population of academics (n = 34,986) developing their work in the Portuguese HE system. These academics are not distributed in the HE subsystem equally: 14,927 academics are from public universities; 6,482 are from private universities; 9,689 are from public polytechnics; and 3,804 are from private polytechnics (Table 1).

Table 1. Academics' distribution by HE subsector and type of HEI

HE Subsector	HEI Type	N	%
Public	University	14927	42.7
	Polytechnic	9689	27.7
Private	University	6482	18.5
	Polytechnic	3804	10,9
Total		34902	100
Missing		84	
Total		34986	

Evidencing the late emergence of polytechnics and private institutions, with the consequent segmentation of academic professionals, following the 1974 democratic revolution, the distribution of academics is characterized

[5] More specifically, the data derives from the process of study programmes' preliminary accreditation, e.g., the accreditation of the study programmes already running in 2010, the year when the accreditation process was started in Portugal.

by a heavy concentration in the public sector (42.7 % in public universities and 27.7 % in polytechnics). This distribution is similar to that of HE students. According to data from the Ministry of Education (DGEEC, 2013), in the 2011/2012 academic year the majority of students enrolled in HE were in public institutions (79.9 %), namely in public universities (49.9 % vs. 30 % in public polytechnics).

Even though the Portuguese HE system is divided into two sectors — public and private — there have been insufficient data to study the private. This has had an impact on the privileged focus on the public HE sector and the lack of studies of private HEIs and their professionals. This study might contribute towards minimizing this gap by increasing knowledge concerning these professionals.

5. Findings

One of the main assumptions of this study is that recent changes in the Portuguese HEI environment — with attempts to implement the knowledge society and NPM/managerialism — influence academics' working conditions. It is also presumed that the impact of these changes is not similar in the subsystems, owing to differences in their legal frameworks. Aligned with these suppositions, the study's main aim is to analyse academics' working conditions by trying to understand the main differences between distinct types of institution — public and private universities and polytechnics. Next, the main findings on such working conditions are presented based on academics' terms of employment defined by the duration of the contracts and the time regime.

5.1. Contract duration

As mentioned, the tenure figures exist only for public HEIs and some professional categories. Therefore, the following analysis only applies to these institutions.

As evidenced by Table 2, in public universities and polytechnics, the proportion of tenured staff is considerably smaller than that of non-tenured staff (16.2 % vs. 83.8 %). This means that, in Portugal, the percentage of academics benefiting from the guarantee of not losing their employment is very low. However, when looking at the differences between the two types of institution, it is possible to see that academics from universities ben-

Table 2. Academics' distribution by tenured and non-tenured positions in public universities and polytechnics

Type of tenure		Public HEI		Total
		Universities	Polytechnics	
Tenured staff	N	3064	674	3738
	%	22.4	7.2	16.2
Non-tenured staff on the tenure track	N	6569	4678	11247
	%	48.1	50	48.9
Non-tenured staff on the non-tenure track	N	4022	3997	8019
	%	29.5	42.8	34.9
Total	N	13655	9349	23004
	%	100	100	100

Chi-square = 1.077,885; df = 2; p = .000

efit more. In fact, these academics constitute the great majority of tenured staff (22.4 % vs. 7.2 % in polytechnics). Data analysis using cross tabulation with a chi-square test reveals that there is a significant relationship between tenured position and the type of institution (chi-square value = 1077,885, df = 2, p<.000).

Within non-tenured staff, relevant differences between the two institutions also exist. Academics in a non-tenured position but in a tenure track assume very similar proportions in universities (48.1 %) and polytechnics (50 %). Actually, some of these academics (with an auxiliary or adjunct position) can have an open-ended contract even if they do not benefit from tenure. However, polytechnics have a higher proportion of academics in a non-tenured position on the non-tenure track (42.8 % vs. 29.5 % in universities). This means that public polytechnics resort more to the parallel career than public universities.

However, greater insecurity and precariousness among polytechnics can also derive from their mission. As polytechnics are expected to be more vocational and employability-orientated, they also tend to recruit academics who develop through professional activities outside the HE system.

One of the major factors influencing academics' career positions and progression within public institutions comprises their qualifications or educational attainment. Therefore, data seem to suggest that in the polytechnic subsystem, an academic career has less secure and more precarious employment conditions. This may be due to the fact that, in public polytechnics in contrast to public universities, academics do not automatically progress in their careers even when holding the mandatory academic degree. In recent years, owing to economic restrictions and state constraints on opening new vacancies, academics tend to remain in the initial ranks of the formal career or, on the other hand, in the parallel career, with no promotion prospects.

Next, we will analyse whether the professional categories held by academics are in line with their qualifications (PhD, master's or bachelor's degrees). This analysis takes into account the institutions of both sectors (public and private) and subsystems (university and polytechnic). Therefore, it is relevant to analyse this variable in order to understand whether the duration of contracts and the professional categories held by academics are in line with academics' qualifications (PhD, master's or bachelor's degrees). This analysis takes into account the institutions of both sectors (public and private) and subsystems (university and polytechnic).

5.1.1. Educational attainment

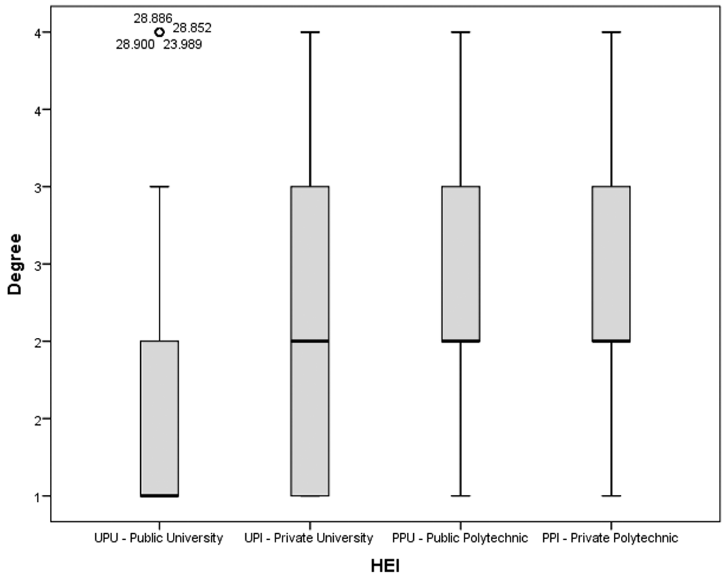
The analysis of academics' qualifications according to the type of institution allows for the conclusion that almost half (45 %) of the academics working in the Portuguese HE system hold a PhD. These academics are highly concentrated in universities and, among these, especially in public ones (68.5 % vs. 38.5 % in private universities). There is also a significant proportion of academics holding a master's degree (28.8 %). These academics tend to be in the polytechnics and, particularly, those in the public sector (45.2 %).

This unequal distribution in academics' qualifications is evidenced by Graphic 1. It is possible to see in this boxplot that the best qualified academics are largely concentrated in public universities. A significant proportion of these academics are located between PhD (1) and master's degree (2). In turn, academics in polytechnics (both public and private) are mainly located between master's and bachelor's degrees (3). Other (4) qualifications have almost no expression. This unequal distribution may be explained by the fact that, as previously mentioned, the two institutions have different careers based on their different missions, with universities being more research-orientated and polytechnics more vocationally-orientated. Private universities are those presenting a greater dispersion in terms of academics' qualifications.

Therefore, our findings seem to suggest that polytechnics (both public and private) and private universities are less capable of attracting better qualified academic staff, this capacity predominantly being held by public universities. Specifically in the case of polytechnics, this can be explained by the fact that, for a long time, access to the bottom positions of a polytechnic career required only a bachelor's degree.

Based on previous findings, one might assume that public universities have more tenured staff because they also have more academics with better qualifications. It seems, therefore, that the tenured position is related to academics' educational attainment. In order to verify this assumption, academics' qualifications will be further characterized by examining the way in which these relate to the professional category occupied, first for the university career and then for the polytechnic one. This is valid even for private institutions, since although they do not have the possibility of tenure, they assume the same professional categories used in public institutions.

Figure 1. Academics' distribution by educational attainment (degree) and type of institution



Legend: 1 = PhD; 2 = Master's; 3 = Bachelor's; 4 = Others

In public universities, almost all academics in a tenured position — full and associated professors — have the necessary qualifications to be at the academic rank they currently occupy, i.e., a PhD (98.9 % and 98.5 % respectively) (Table 3). The same is valid, on the tenure track, for auxiliary professors (98.5 %). This may mean that, despite having the qualifications allowing them to have a tenure position, some of these academics are in an insecure contractual situation, with a fixed-term contract or even an open-ended contract.

However, assistants and trainee assistants still do not hold the current minimum requirement to enter the academic profession, namely a PhD. Indeed, while the master's is the most frequently held degree among assistants (67.2 %), among trainee assistants this corresponds to the bachelor's (80.8 %).

A high proportion of the invited staff on the non-tenure track (full, associated and auxiliary professors) have the required qualifications (e.g., a PhD) to be on a tenure track (76.2 %, 57.4 % and 60.2 % respectively). It would be interesting to find out if these academics have an invited position because they develop other professional activities outside public universities or, rather, as a result of institutional financial constraints.

Further, it is possible to see that 5.7 % of the invited assistants do indeed have the needed qualifications, not only to be on a tenure track but also to be in a higher position (as auxiliary professors). This may be due to the fact that these academics were in the career (as assistants) but did not finish their PhDs within the required time. However, once again, this can also reflect the constraints that public universities have had to face over the last five years regarding the recruitment of new permanent staff.

Even more striking is the fact that some assistants (7.7 %) on the tenure track have qualifications higher than those needed for the category. As this situation is not allowed by law, it may be explained by the incorrect identification by academics of their professional category, namely that of invited professor. The same may be true for academics in the full, associated and auxiliary professor categories who do not have a PhD (1.2 %, 1.4 % and 1.4 %, respectively) as this has been the legally required qualification for these positions since 1979.

The tendency for private universities to have academics with lower qualifications than those in the public sector is confirmed when analysing academics' qualifications within the professional categories of the formal career (Table 3).

Even if, as previously seen, the proportion of academics with a PhD in private universities is lower in comparison with public universities, they are mainly concentrated in the higher academic ranks (96.8 % of full professors, 97.2 % of associated professors and 92.4 % of auxiliary professors). In turn, the high percentage of academics without a PhD and occupying the same categories in the parallel career (invited full, associated and auxiliary professors) may explain why these academics are not integrated in the formal career. Nevertheless, a high percentage of invited academics have the qualifications to be in this career (72.6 % of invited full, 60.3 of invited associated and 46 % of invited auxiliary professors).

Table 3. Academics distribution by academic rank and educational attainment in universities

		Public University					Private University				
		PhD	Master	Bachelor	Other	Total	PhD	Master	Bachelor	Other	Total
Full Professor	N	1119	3	10	0	1132	240	1	7	0	248
	%	98.9	0.3	0.9	0	100	96.8	0.4	2.8	0	100
Associated Professor	N	1890	6	22	0	1918	485	5	9	0	499
	%	98.5	0.3	1.1	0	100	97.2	1	1.8	0	100
Auxiliary Professor	N	5267	38	40	0	5345	1053	46	37	4	1140
	%	98.5	0.7	0.7	0	100	92.4	4	3.2	0.4	100
Assistant	N	89	781	293	0	1163	51	1170	477	9	1707
	%	7.7	67.2	25.2	0	100	3	68.5	27.9	0.5	100
Trainee Assistant	N	0	5	21	0	26	5	53	421	2	481
	%	0	19.2	80.8	0	100	1	11	87.5	0.4	100
Invited Full Professor	N	93	7	21	1	122	82	7	24	0	113
	%	76.2	5.7	17.2	0.8	100	72.6	6.2	21.2	0	100
Invited Associated Professor	N	147	11	98	0	256	94	22	40	0	156
	%	57.4	4.3	38.3	0	100	60.3	14.1	25.6	0	100
Invited Auxiliary Professor	N	539	117	236	3	895	402	236	231	4	873
	%	60.2	13.1	26.4	0.3	100	46	27	26.5	0.5	100
Invited Assistant	N	130	753	1408	2	2293	28	488	520	11	1047
	%	5.7	32.8	61.4	0.1	100	2.7	46.6	49.7	1.1	100
Invited Trainee Assistant	N	0	0	0	0	0	0	0	11	1	12
	%	0	0	0	0	0	0	0	91.7	8.3	100
Other	N	425	280	366	5	1076	23	38	35	2	98
	%	39.5	26	34	0.5	100	23.5	38.8	35.7	2	100
Total	N	9699	2001	2515	11	14226	2463	2066	1812	33	6374
	%	68.2	14.1	17.7	0.1	100	38.6	32.4	28,4	0.5	100

In summary, our findings lead to the conclusion that academics' educational attainment is not the only variable that explains the differences in terms of contracts in both public and private universities. These differences may instead be explained by the external constraints framed by the influence of NPM/managerialism. Such constraints may be one of the main reasons for the relevant prevalence of fixed-term contracts reflected in the importance assumed by the parallel career.

Table 4 presents the relation between academics' positions in academic rank and educational attainment in public and private polytechnics.

As previously mentioned, for a long time the only requirement for access to the first ranks of a polytechnic career was a bachelor's degree. This partially explains the tendency for academics (both in public and private polytechnics) to have a master's or a bachelor's degree, and for the lower proportion of those holding a PhD. However, differences can be found between these institutions with academics of public polytechnics presenting slightly higher qualifications than those of private polytechnics. While in public polytechnics the master's is the most common degree (45.4 %), in private polytechnics the master's and the bachelors are both prevalent, presenting similar proportions (39.1 % and 39.9 %). Nonetheless, when looking at the professional categories, one can see that in both sectors (public and private) academics holding the same position in their careers tend to have similar qualifications.

When analysing public polytechnics, one can conclude that academics in a tenured position actually have the required qualifications: 90.9 % of principal coordinator professors and 70.6 % of coordinator professors have a PhD. Furthermore, the non-tenured staff on the tenure track (adjunct professors and assistants 1st and 2nd triennium) and on the non-tenure track (equivalent coordinator professors, equivalent adjunct professors and equivalent assistants 1st and 2nd triennium) present very similar qualifications. In private polytechnics, the qualifications of academics in the parallel career (equivalent professors) are not greatly different from the qualifications of their colleagues in the formal career.

These findings seem to confirm once again that educational attainment is not the main variable explaining the more precarious working conditions of academic staff. For instance, although residual, the PhD is relevant among adjunct professors, which indicates that these academics could occupy a higher professional category. Specifically, in this case the non-correspondence between qualifications and position occupied might mean that, although able to get the necessary degree for a promotion, these academics, due to the aforementioned constraints, moved from the formal to the parallel career. They

Table 4. Academics distribution by academic rank and educational attainment in polytechnics

		Public Polytechnic					Private Polytechnic				
		PhD	Master	Bachelor	Other	Total	PhD	Master	Bachelor	Other	Total
Principal Coordinator Professor	N	30	2	1	0	33	15	0	0	0	15
	%	90.9	6.1	3	0	100	100	0	0	0	100
Coordinator Professor	N	451	144	44	0	639	337	22	13	2	374
	%	70.6	22.5	6.9	0	100	90.1	5.9	3.5	0.5	100
Adjunct Professor	N	791	1305	252	6	2354	202	815	75	6	1098
	%	33.6	55.4	10.7	0.3	100	18.4	74.2	6.8	0.5	100
Assistant (1st and 2nd triennium)	N	123	1090	1058	22	2293	29	367	1010	17	1423
	%	5.4	47.5	46.1	1	100	2	25.8	71	1.2	100
Equivalent to coordinator professor	N	35	5	10	0	50	71	17	9	0	97
	%	70	10	20	0	100	73.2	17.5	9.3	0	100
Equivalent Adjunct Professor	N	451	765	374	15	1605	43	125	72	2	242
	%	28.1	47.7	23.3	0.9	100	17.8	51.7	29.8	0.8	100
Equivalent Assistant	N	117	782	992	11	1902	5	49	228	11	293
	%	6.2	41.1	52.2	0.6	100	1.7	16.7	77.8	3.8	100
Other (Especially hired, Specialists, Other)	N	55	119	200	29	403	16	22	37	4	79
	%	13.6	29.5	49.6	7.2	100	20.3	27.8	46.8	5	100
Total	N	2053	4212	2931	83	9279	718	1417	1444	42	3621
	%	22.1	45.4	31.6	0.9	100	19.8	39.1	39.9	1.2	100

may have started as assistants but, since they did not manage placement as adjunct professors, they moved to the position of equivalent adjunct professor. Assuming this more precarious position, these academics also become more dependent on the senior and more secure staff (the small elite) that holds the power to decide upon academics recruitment (Musselin, 2013). As equivalent professors, academics are not recruited through competition but chosen by senior academics.

In brief, one can argue that polytechnics have worse working conditions than universities. The majority of academics are in a non-tenured position, the proportion of permanent staff is lower, and there is a higher resort to the recruitment for the parallel career. These findings may be explained not only by the lower qualifications of academics but also by the distinct mission of these institutions and their social prestige within the HE system. As previously stressed, polytechnics have a more professional or vocational orientation and, therefore, resort more to academic staff developing professional activities outside HE. At the same time, compared with universities (and mainly those in the public sector), polytechnics are a more recent part of the system and, thus, hold lower symbolic capital. As a consequence, they have fewer students and also less support from the ministry, not only in respect of financial issues but also regarding the willingness to open new vacancies to allow for career progression. This is particularly relevant at a time of serious financial and economic constraints, as currently faced by Portugal.

Having analysed contract duration and its relation to the educational attainment of academics in order to understand how they influence these professionals' working conditions, another important variable is now examined with the aim of deepening that understanding: the time regime.

5.2. Time regime

Another important variable in the analysis of academics' working conditions is the time regime (i.e., the working hours defined by their contracts). Academics can have a FT contract, with or without exclusivity, or a PT contract. Data analysis using cross tabulation with the chi-square test reveals that there is a significant relationship between the time regime and the type of institution (chi-square value = 6.185,487, df = 9, $p<.000$).

From the analysis of the table (Table 5), a relevant feature emerges: that HEIs resort substantially to the PT regime (38.3 %). This regime is especially high if one considers its prevalence within the working population. Within an employed population of 4,634,700, only 14.3 % (664,100) are in a PT regime

(Pordata, 2013). Academics within the PT regime are highly concentrated in private institutions (68.2 % polytechnics; 59.6 % universities). One can argue, therefore, that academic staff's casualization assumes a higher expression in private universities than in public HEIs. This high concentration is mainly related to the historical process of the emergence of these institutions.

Table 5. Academics' distribution by time regime in HEIs

		Higher Education Institutions				Total
		Universities		Polytechnics		
		Public	Private	Public	Private	
FTE	N	6276	253	3925	140	10594
	%	42.4	3.9	41	3.7	30.6
FT	N	4813	2359	2527	1069	10768
	%	32.5	36.5	26.4	28.1	31.1
PT	N	3712	3856	3132	2592	13292
	%	25.1	59.6	32.6	68.2	38.3
Total	N	14801	6468	9584	3801	34654
	%	100	100	100	100	100

Chi-square value = 6.185,487, df = 9, $p < .000$

Private HEIs — both universities and polytechnics — emerged in Portugal in the mid–1980s with the underlying aim of geographically expanding HE and to offer more diverse programmes and be more responsive to labour market needs. However, its "geographical and disciplinary distribution, the balance between teaching and research and the quality of the degrees provided, have been quite different from political expectations, and this has provoked severe tensions within the system" (Teixeira & Amaral, 2001: 368). Indeed private HEIs (mostly consisting of polytechnic institutions) are predominantly located in the "wealthiest and most populated" regions of the country, offer low-cost and popular programmes (in the social sciences, for instance), have a lower capacity to attract students (mainly due to expensive fees), and share their academic staff with public HEIs (Teixeira & Amaral, 2001). These academic staff mainly comprise academics in the parallel career, who are usually labelled 'turbo-professors' (Carvalho, 2012). The high percentage of the PT regime among the academic staff of private institutions seems to indicate that a significant proportion of them may also pursue other economic activities, including teaching at public institutions.

The proportion of academics in a FTE regime is insignificant for private institutions (universities = 3.9 %; polytechnics = 3.7 %), while they are almost equally distributed in public ones (universities = 42.4 %; polytechnics = 41 %).

This is not surprising since, as mentioned previously, in private universities the academic career is not regulated by the state. These institutions and their staff comply with the general labour law. Academics can have a permanent contract only after completing three probation contracts. However, they do not have the opportunity to celebrate a FTE contract since private universities (as well as private polytechnics) do not have this regime. Furthermore, academics in the FT regime have to complete 40 working hours *per* week (including all academic tasks).

The data concerning FT regimes are somewhat surprising. Being the second more predominant regime (31.1 %), academics in FT are mainly concentrated in universities, both public (32.5 %) and private (36.5 %), rather than in polytechnics. Even more relevant and surprising is the fact that private polytechnics (26.4 %) have a slightly lower proportion of academics in FT than the public (28.1 %).

These findings seem to confirm the previously identified tendency for academics working in public polytechnics to have worse working conditions than expected when compared with those at public universities. Moreover, the analysis of the time regime seems to reveal that in this matter public polytechnics seem to have even worse working conditions than their counterparts in private institutions, since they have a slightly higher percentage of academics in a FT regime.

As in other countries, it seems that Portuguese public polytechnics are increasingly becoming more flexible regarding staff working conditions. The predominant model seems to be one of a core permanent staff and a periphery constituted by a contingent workforce of casual and temporary employees (Altbach, 2000; Enders, 2000).

Even if it is true that private institutions have a higher proportion of PT workers, the relevance of the PT regime in public institutions suggests that academics are not a professional group with privileged working conditions when compared with the broad working population. Actually, our findings help in deconstructing the idea that academics are an elite profession, since they seem to show that these professionals have a higher probability than professionals working in any other activity of signing a PT contract with their institutions.

In trying to deepen this analysis, it seems pertinent to examine the relationship between the time regime and the professional category occupied by academics (academic rank), both in universities (Table 6) and polytechnics (Table 7).

Table 6. Academics' distribution by time regime and academic rank in universities

		Public Universities				Private Universities			
		Time Regime			Total	Time Regime			Total
		FTE	FT	PT		FTE	FT	PT	
Full Professor	N	636	436	46	1118	12	145	91	248
	%	57	39	4	100	5	58	37	100
Associated Professor	N	1060	788	60	1908	48	317	133	498
	%	56	41	3	100	10	64	26	100
Auxiliary Professor	N	3235	1948	148	5331	96	638	403	1137
	%	61	37	2	100	8	56	36	100
Assistant	N	509	465	184	1158	68	758	884	1710
	%	44	4	16	100	4	44	51	100
Trainee Assistant	N	4	18	4	26	4	100	378	482
	%	15	69	16	100	1	21	78	100
Invited Full Professor	N	12	18	81	111	1	19	92	112
	%	11	16	73	100	1	17	82	100
Invited Associated Professor	N	10	22	221	253	2	31	121	154
	%	4	9	87	100	1	20	79	100
Invited Auxiliary Professor	N	90	145	658	893	11	177	689	877
	%	10	16	74	100	1	20	79	100
Invited Assistant	N	129	249	1906	2284	4	132	914	1050
	%	6	11	83	100	0	13	87	100
Invited Trainee Assistant	N	0	0	0	0	0	0	12	12
	%	0	0	0	0	0	0	100	100
Other	N	205	511	357	1073	2	17	82	101
	%	19	48	34	100	2	17	81	100
Total	N	5890	4600	3665	14155	248	2334	3799	6381
	%	42	32	26	100	4	37	59	100

In public universities, it is possible to see that academics holding a tenured position or a category on the tenure track are mainly in a FTE or a FT regime. In fact, the majority of full and associated professors (57 % and 56 %) are in the FTE regime, as are the majority of auxiliary professors and assistants (61 % and 44 %), while for the most part trainee assistants enjoy a FT regime (69 %). The PT regime is residual among these academics.

In the parallel or informal career (non-tenure track), one finds the opposite situation. The most expressive time regime is the PT, with the majority of the invited professors (full professor 73 %, associated professor 87 %,

Table 7. Academics' distribution by time regime and academic rank in polytechnics

		Public Polytechnic				Private Polytechnic			
		Time Regime			Total	Time Regime			Total
		FTE	FT	PT		FTE	FT	PT	
Principal Coordinator Professor	N	19	12	2	33	1	5	9	15
	%	57.6	36.4	6.1	100	6.7	33.3	60	100
Coordinator Professor	N	440	173	28	641	21	178	174	373
	%	68.6	27	4.4	100	5.6	47.7	46.6	100
Adjunct Professor	N	1418	717	223	2358	68	425	608	1101
	%	60.1	30.4	9.5	100	6.2	38.6	55.2	100
Assistant (1st and 2nd triennium)	N	770	585	938	2293	20	300	1106	1426
	%	33.6	25.5	40.9	100	1.4	21	77.6	100
Equivalent Coordinator Professor	N	13	9	28	50	5	31	61	97
	%	26	18	56	100	5.2	32	62.9	100
Equivalent Adjunct Professor	N	689	422	494	1605	7	26	211	244
	%	42.9	26.3	30.8	100	2.9	10.7	86.5	100
Equivalent Assistant	N	481	433	972	1886	4	33	259	296
	%	25.5	23	51.5	100	1.4	11.1	87.5	100
Other (Specialists, Especially Hired, Others)	N	14	91	296	401	0	36	45	81
	%	3.5	22.7	73.8	100	0	44.4	55.6	100
Total	N	3844	2442	2981	9267	126	1034	2473	3633
	%	41.5	26.4	32.2	100	3.5	28.5	68.1	100

auxiliary professor 74 %, and assistant 83 %) in this situation. Even if this corresponds to a condition of more precarious employment, the fact is that most of these academics can mitigate it by working in more than one institution, either public or private.

However, this situation is even more evident among private universities. The majority of full, associated and auxiliary professors are in the FT regime (58 %, 64 % and 56 %), while among assistants and trainee assistants the most common regime is the PT (51 % and 78 %).

The same is valid for all the invited professors, with the great majority of them in the PT regime (full professor 82 %, associated professor 79 %, auxiliary professor 79 %, and assistant 87 %). The high prevalence of the PT regime among these academic staff seems to suggest that they develop other economic activities, including teaching in public institutions. Taking into account that, as mentioned previously, in Portugal PT labour has no relevant expression among the working population, this might signify the existence of worse working conditions among the academic staff of private universities.

This analysis allows for the conclusion that private universities resort increasingly to PT contracts rather than public ones. Nonetheless, it also reveals that PT regimes — both in public and private universities — are used more for those in the first ranks of a career and with working contracts for a shorter length of time.

Looking now to academics' distribution according to academic rank and time regime in polytechnics (Table 7), one can see that, as in public universities (and partially in private ones), in public polytechnics, academics in the top positions of the career tend to benefit from a more comfortable situation in terms of work regime. Indeed, the FTE regime is especially prevalent among tenured staff (57.6 % principal coordinator professors and 68.6 % coordinator professors). The FTE regime is also the most expressive with adjunct professors (60.1 %), while in the category of assistant (1st and 2nd triennium) the FTE and — at the opposite end — the PT tend to have a very similar prevalence (33.6 % and 40.9 %).

In private polytechnics, however, the reality is quite different. The PT regime is the most prevalent for the great majority of academics regardless of their professional category (68.1 %). The sole exception to this is constituted by the coordinator professor category where the FT and the PT regimes present a similar proportion (47.7 % and 46.6 %). Therefore, in these institutions the whole of the academic staff seems to be affected by fragile working conditions which in the other institutions (public and private universities and public polytechnics) affect mainly the staff on the non-tenure track.

Indeed, the tendency verified in universities (public and private) for those on the non-tenure track to present the worst working conditions is maintained in the public polytechnics, with the exception of the equivalent adjunct professors. The PT regime is very significant among equivalent coordinator professors and equivalent assistants (56 % and 51.5 % respectively). Nevertheless, it is important to stress that the equivalent coordinator professors have a distinct employment situation when compared with the equivalent assistants. While the former may be in a PT position owing to the fact that they have other professional activities (like teaching in other institutions or working in companies), the latter might not be able to progress in their career owing to the previously mentioned financial restrictions. These limitations also justified the distribution of the equivalent adjunct professors by time regime. These are the only ones (within the parallel career) enjoying a FTE regime (42.9 %).

Polytechnics — and especially private polytechnics — resort more than public universities to academic casualization, as evidenced by the high proportion of PT academics. This may be due to polytechnics' distinct mission. Since they are more vocational, they also tend to recruit, in a more flexible way, professors who are also working in other economic sectors (Santiago & Carvalho, 2008). However, in the specific case of private polytechnics, it can also be explained by the less favourable position these institutions hold within the HE system, their more limited training on offer, and their greater financial difficulties.

Academic casualization among polytechnics reflects, however, a trend common to many European countries. As argued by Musselin (2013), academics are increasingly perceived by HEIs as a labour force specifically and occasionally recruited to 'produce' teaching and research.

Furthermore there is a clear gap in HEIs in Portugal between academics at the top and those at the bottom of their careers. This "gap of insecurity" (Oliver, 2012) can be generational — that is, it can be explained by the fact that senior academics tend to occupy better positions than junior academics. Furthermore, there is a minority of academics with a tenure position and FTE employment, which coexists with a considerable number of academics with a non-tenure position and with PT employment. Academics subject to these last conditions are part of the parallel career, constituting what Altbach (2000) has called the 'reserve army'. These academics experience a double insecurity since they not only have precarious contracts but also heavier teaching workloads, implying a maximum of 12 teaching hours per week. This 'reserve army' reflects the casualization of the Portuguese academic workforce (contracts depending on HEIs' casual needs).

6. Conclusions

In recent years, driven by increasing pressure for efficiency and effectiveness under the influence of NPM/managerialism, the academic career has been submitted to major transformations in most developed countries. These have usually been translated into a devaluation of their working conditions.

In Portugal, the influence of NPM/managerialism has been noticed since the 1990s. As a result, changes were introduced in the regulation of public academic careers (both university and polytechnic) with the creation of new legal frameworks. Even if these legal frameworks had as their underlying purposes enabling more secure professional positions, the 'real picture' is quite different, as marked by insecure and precarious academic working conditions. Nevertheless, the consequences of this deterioration are not homogeneous. Differences are noticed not only among different HEIs but also among different groups of academics within the same institution.

Public universities not only have the highest percentage of academics in the system (due to the fact that they also have more students), but they also offer more secure employment conditions with more academics in a tenured position and FTE regime. However, academics within these institutions are also those with higher qualifications. Notwithstanding, when analysing the academic rank and educational attainment in public universities, some of those in the initial career ranks have qualifications for a higher rank.

Contrary to what was expected, public polytechnics present the worse working conditions. The parallel career assumes a special relevance among public polytechnics where there are a considerable number of academics holding higher qualifications than those required for the ranks they occupy.

Private universities and polytechnic institutions form the group that has more academics with non-tenured positions and in a PT regime. This is a striking finding, especially if one considers the mission and recent institutionalization of the private sector, and that in general the public sector presents better working conditions.

Among all HEIs, it is possible to identify a clear difference between the working conditions of junior and senior staff. Senior academic staff constitute a small elite within the academic professional group, with secure working conditions. This small elite — usually benefiting from tenure, exclusivity and holding the best qualifications — seems to still profit from the traditional protection provided by the state. Therefore, one can argue that Portuguese academics tend to stand in 'circles', with a minority constituting the central professionals while the majority are in the periphery.

Compared with the elite, junior academic staff have been experiencing a deterioration in their working conditions. These academics are mainly non-tenured staff on a non-tenure track and, in general, have embarked upon what could be called a 'parallel career'. In fact, academics in this career have less secure working conditions. At the same time, their contracts imply heavier workloads, since they have on average four more teaching hours *per* week than their colleagues. This contributes to inhibiting academics' career progression, since this progression is mainly dependent on research productivity. Furthermore, they do not benefit from institutional support for this progression, namely sabbatical leave.

A great number of academics in the parallel career have a PT contract expressing the casualization of the academic workforce. This reflects the tendency for the deprofessionalization of academics, since they are considered by institutions as mere employees who recruit them to develop occasional (and mainly teaching) tasks. Therefore, deterioration and precariousness become definitive as academics experience difficulties in improving both their qualifications and research outputs, and in renegotiating their contracts with the institutions. On the other hand, as their future recruitment is dependent on the choice of 'elite' academics, invited staff are less autonomous and thus hold a lower degree of academic freedom.

References

Abbott, A. (1988). *The system of professions. An essay on the division of expert labour*. Chicago, IL — London, UK: The University of Chicago Press.

Altbach, P. (Ed.) (2000). *The changing academic workplace: Comparative perspectives*. Boston, MA: Centre for International Higher Education.

Amaral, A., Ferreira, J, Machado, M. & Santiago, R. (2006). *Modelos de governação e gestão dos institutos politécnicos portugueses em contexto Europeu*. Castelo Branco: Edição Politécnica.

Bell, D. (1976). *Vers la société post-Industrielle*. Paris: Laffont.

Bureau, V., Henriksson, L. & Wrede, S. (2004). Comparing professional groups in health care: Toward a context sensitive analysis. *Knowledge, Work & Society*, 2 (2), 49–68.

Carvalho, T. (2012). Shaping the 'new' academic profession. Tensions and contradictions in the professionalisation of academics. In: G. Neave & A. Amaral (Eds.), *Higher education in Portugal 1974–2009. A nation, a generation* (pp. 329–352). Dordrecht: Springer.

Carvalho, T. & Bruckman, S. (2014). Reforming Portuguese public sector: A route from health to higher education. In: C. Musselin & P. Teixeira (Eds.), *Reforming higher education: Public policy design and implementation*. Dordrecht: Springer.

Carvalho, T. & Santiago, R. (2010). Still academics after all. *Higher Education Policy*, 23 (3), 397–411.

Castells, M. (1996). *The rise of the network society. The information age: Economy, society and culture Vol. I*. Cambridge, MA — Oxford, UK: Blackwell.

Clark, B. (1983). *The higher education system: Academic organization in cross-national perspective*. Berkeley, CA: University of California Press.

DGEEC (2013). Direção Geral de Estatísticas da Educação e Ciência (Directorate General Statistics of Education and Science. Inscritos no 1º ano pela 1ª vez (Enrolled in Higher Education in the first year for the first time) Statistical Document. http://www.dgeec.mec.pt/np4/84/. Accessed 15 October 2013.

Drucker, P. (1969). *The age of discontinuity. Guidelines to our changing society*. New York, NY: Harper and Row.

Enders, J. (1999). Crisis? What crisis? The academic profession in 'knowledge' society. *Higher Education*, 38 (1), 71–81.

Enders, J. (2000). Academic staff in Europe: Changing employment and working conditions. *International Perspectives on Higher Education Research*, 1, 7–32.

Enders, J. (2001). Between state control and academic capitalism: A comparative perspective on academic staff in Europe. In: J. Enders (Ed.), *Academic staff in Europe. Changing contexts and conditions* (pp. 1–24). Westport: Greenwood Press.

Evetts, J. (2003). The sociological analysis of professionalism. *International Sociology*, 18 (2), 395–415.

Exworthy, M. & Halford, S. (1999). Professionals and managers in a changing public sector: Conflict, compromise and collaboration. In: M. Exworthy & S. Halford (Eds.), *Professionals and the new managerialism in the public sector* (pp. 1–17). Philadelphia: Open University Press.

Farnham, D. & Horton, S. (1996). *Managing people in the public services*. London, UK: MacMillan.

FCT (2012). PhD studentships and post-doctoral fellowships 2012 Statistics. http://alfa.fct.mctes.pt/estatisticas/bolsas/index.phtml.pt.

Ferlie, E., Ashburner, L., Fitzgerald, L. & Pettigrew, A. (1996). *The new public management in action*. Oxford, UK: Oxford University Press.

Fournier, V. (1999). The appeal to "professionalism" as a disciplinary mechanism. *Sociological Review,* 47 (2), 280–307.

Fournier, V. (2000). Boundary work and the (un)making of the profession. In: M. Malin (Ed.), *Professionalism, boundaries and the workplace* (pp. 67–86). London, UK: Routledge.

Freidson, E. (1988). *Profession of Medicine* (2 ed.). Chicago, IL: The University of Chicago Press.

Freidson, E. (1994). *Professionalism reborn*. Cambridge, UK: Polity Press.

GPEARI (2011) Doutoramentos realizados ou reconhecidos por universidades Portuguesas de 1970 a 2010 (PhD made or recognised by Portuguese universities from 1970 to 2010). http://www.dgeec.mec.pt/np4/91/.

Johnson, T. (1972). *Professions and power*. London, UK: Macmillan.

Kirkpatrick, I. & Ackroyd, S. (2003). Archetype theory and the changing professional organization: A critique and alternative. *Organization*, 10 (4), 731–750.

Kirkpatrick, I., Ackroyd, S. & Walker, R. (2005). *The new managerialism and public service professions*. London, UK: Palgrave-MacMillan.

Larson, M. (1977). *The rise of professionalism. A sociological analysis*. Berkeley, CA: University of California Press.

MacDonald, K. (1995). *The sociology of the professions*. London, UK: Sage.

Musselin, C. (2004). Towards a European labour market? Some lessons drawn from empirical studies on academic mobility. *Higher Education*, 48 (1), 55–78.

Musselin, C. (2008). Towards a sociology of academic work. In: A. Amaral, C. Musselin & I. Bleikie (Eds.), *From governance to identity. A festschrift for Mary Henkel* (pp. 47–56). Dordrecht: Springer.

Musselin, C. (2013). Redefinition of the relationship between academics and their university. *Higher Education*, 65, 25–37.

Navarro, V. (1976). Medicine under capitalism. New York, NY: Prodist.

Neave, G. & Rhoades, G. (1987). The academic estate in Western Europe. In: B. Clark (Ed.)), *The academic profession: national, disciplinary, and institutional settings* (pp. 211–270). Los Angeles, CA: University of California Press.

OCES (2003). *Programa De Formação Avançada Recursos Humanos Em C&T (1990–1993)*. Lisboa MSTHE.

Oliver, E. (2012). Living flexibly? How Europe's science researchers manage mobility, fixed-term employment and life outside work. *The International Journal of Human Resources Management*, 23 (8), 3856–3871.

Perkin, H. (1987). The academic profession in the United Kingdom. In: B. Clark (Ed.), *The academic profession. National, disciplinary & institutional settings* (pp. 13–59). London, UK: University of California Press.

Pordata (2013). Estatisticas do emprego. (Employment Statistics). http://www.pordata.pt/Portugal/Ambiente+de+Consulta/Tabela.

Reed, M. (2002). New managerialism, professional power and organisational governance in UK universities: A review and assessment. In: A. Amaral, G. Jones & B. Karseth (Eds.), *Governing higher education: National perspectives on institutional governance* (pp. 163–185). Netherlands: Kluwer.

Salter B. (1999). Change in the governance of medicine and the politics of self-regulation. *Policy & Politics*, 27 (2), 143–158.

Santiago, R. & Carvalho, T. (2008). Academics in a new work environment: The impact of new public management on work conditions. *Higher Education Quarterly*, 62 (3), 204–223.

Sen, A. (1999). *Development as freedom*. Oxford, UK: Oxford University Press.

Teixeira, P. & Amaral, A. (2001). Private higher education and diversity: An exploratory survey. *Higher Education Quarterly,* 55 (4), 359–395.

Torstendahl, R. & Burrage, M. (1990). *The formation of professions. Knowledge, state and strategy*. London, UK: Sage.

Zola, I. (1972). Medicine as an institution of social control. *Sociological Review*, 20 (4), 487–504.

Legislation

Decree-Law 185/81
Decree-Law 205/2009
Decree-Law 207/2009
Decree-Law 448/79

Work and career aspects of 'ghetto laboratories'[1]

Izabela Wagner

This chapter analyses the impact of scientists' culture of origin on their work and careers. The particular focus here is on the phenomenon called by insiders 'the ghetto lab'. These are scientific teams composed of scientists of similar origin who work mainly in important American institutions of research. Using data gathered from ethnographic studies conducted in life science research laboratories in France, Poland and the US, the author shows that the creation of these nearly mono-cultural research-teams constitutes a spontaneous adaptation to the dynamics of the researcher's world, a way to participate in the process of internationalization, and the participants' response to the dynamic expectations of their professional environment. From the perspective of the sociology of labour, this process of bringing together people educated in similar geographic (cultural) areas renders their work easier and more efficient in terms of the organizational structure and the relationships among team-members. The author shows how those adjustments are implemented as well as the beneficial and negative influences that they have on the work of researchers.

1. Introduction

1.1. Mobility of scientists — internationalization in the world of research activity

The term 'mobility' in scientific environments no longer signifies upward professional mobility in the sense of proceeding from PhD student to professor to laboratory chief, and, for a few, leadership of an institute. Mobility is understood primarily in the sense of the geographical mobility

[1] I would like to thank the Polish-American Kościuszko Foundation for a fellowship that supported my visiting scholar position at Harvard University in the Department of the History of Science; the Polish Foundation of Science for their contract of research on the Polish scientific elite. All my research work would have been impossible without the strong involvement of my participants, to whom I am deeply grateful. I would also like to thank Yanning Huang and Aren LaBianca for their careful reading and remarks. At the final stage of the writing process, Arthur Allen helped me with his knowledge, performing language revision — for that work I am deeply grateful. Finally, I would wish to thank the editors of this book as well as the anonymous reviewers, whose discerning remarks and helpful comments improved this chapter. As always, all responsibility for any faults is mine.

of scientists and faculty.[2] In the early 21st century, geographical mobility among researchers has become an important topic in the social sciences, especially in the EU but also in US universities and research institutes. According to a Science survey in 2009, only 34 % of postdocs in the US were born there.[3]

US institutions welcome more foreign students[4] and hire more foreign researchers than those of any other country. Among advanced scholars, the foreign-born outnumber scientists born and educated in the US in many fields. In the biological and medical sciences, by 2002 foreign postdoctoral students outnumbered US postdocs by 23 % (16,890 to 13,787). Most of these foreign postdocs had earned doctorates in other countries before coming to the US to work (Garrison et.al., 2006:193). European scientists working in the US have been heard to illustrate this situation with the remark, *in the American labs, there are no Americans — except the secretary and her boss. Everyone else is a foreigner*.

Life science laboratory groups may be composed of people from various parts of the world, or dominated by individuals originating from the same country or region. I observed during my research[5] that in laboratories led by a person of Chinese origin, the majority of team members will be Chinese, while a Russian principal investigator (PI) will attract a lot of Russian scientists, an Italian draw other Italians, etc. The proportions of people of the same origin vary, but it is not unusual for half of a lab to come from a single country. Such phenomena are rare in European institutions, where the proportion of scientists from the host country of a given institution is always much greater than that of the foreigners.[6] This paper focuses mainly American research institutions. I consider European countries here principally as 'exporters' of scientists, who create their own 'ghetto laboratories' in the US.

[2] Here, I use the term mobility in reference to geographical mobility only. In my book, I analysed the process of interaction between both types of mobility, showing strict interdependence between geographical professional migration/mobility and career advancement. I call this relationship 'transmobility' (Wagner, 2011).

[3] http://www.the-scientist.com/?articles.view/articleNo/27149/title/Best-Places-to-Work---Postdocs–2009/flagPost/44720/

[4] See, for example, an article in the Chronicle of Higher Education: http://chronicle.com/article/China-Continues-to-Drive/135700/?cid=gn&utm_source=gn&utm_medium=en

[5] I have no statistics available for documenting this fact — in the institutions at which I conducted my research, it was said that such data were not recorded.

[6] Another factor that differentiates US and EU laboratories (with the exception of those in the UK and Ireland) is the language used. National languages predominate in EU labs, sometimes leading to feelings of isolation and even discrimination among foreign researchers. Language is an important factor in scholars' choice of location for postdocs (Wagner, 2011).

1.2. Literature on multicultural laboratories — an ignored issue?

Few scientific papers have dealt with the specific aspects arising from the presence of these foreign scientific cultures within US labs. While publications have described the international careers of scientists who become what I term 'transnational' professionals,[7] (Wagner, 2011; Bento, Cota & Arraujo, 2009), I am unaware of only a single study devoted to the work within the international lab team. Surprisingly, social scientists who have investigated scientific interactions and communication (Knorr Cetina, 1981, 1999), collaborations (Rabinow, 1997), the research process (Latour & Woolgar, 1979) and scientific management (Owen-Smith, 2001) have ignored this crucial influence on scientists' work. There is a small literature concerning the collaboration of teams from different countries on common projects, such as an article (de Bony, 2010) on Dutch-French projects and a book (Rabinow, 2008) analysing the French-American DNA project. However, no works appear to have been published on the relationships inside international and/or multinational research teams.

A rich sociological literature has examined other types of multicultural workplaces, especially in the field of management. Under the label of 'international management', authors have dealt with such topics as cultural differences and their impact on the work and relationships among people of different cultures[8] engaged in common projects (Schneider & de Meyer, 1991). In these publications, authors usually analyse the meeting of two cultures, typically the model in which 'northern' managers meet 'southern' workers (Hofstede, 2001, 2010). Yet the sociological differences observed in business have yet to be studied in research laboratories. Perhaps this topic has been ignored because social scientists believe that the work culture of laboratories remains unaffected by the influences described in the business area. According to one common perception, the scientific environment is cosmopolitan — that is, one in which national differences do not exist. On this reading, scientific laboratories are free of cultural or national discrimination, or even national stereotypes in the minds of co-workers.[9]

[7] 'Transnational professional' refers to those people whose careers are conducted in several countries and who are divided between the work cultures of their domestic science community and that which prevails in the country of adoption, and who therefore possess a hybrid professional culture (Wagner, 2009).

[8] For precision — in a later section, I will explain the term 'culture'.

[9] Sociologist and historian of science Steven Shapin, in his suggestively titled book Never Pure: Historical Studies of Science as if It Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority (2010), explains the origin of such perceptions of the scientific community. In the fourth chapter of his book, Shapin analyses the problem of prejudice concerning scientists and their work.

Perhaps the lack of literature on cultural differences among research teams is related to the mythical endowment of the scientist with the ability to rise above petty prejudices. Furthermore, there may be a political taboo against investigating such difficult issues in our own professional world. Finally, the appropriate method for studying cultural differences in a research team — participant observation — may have posed too large an obstacle to many social scientists. Before starting to respond to these questions, it will be necessary to define our terms.

1.3. Concepts (theory and field) — objective and subjective perceptions

For the interactionist, 'culture' is a tricky and imprecise term, a non-dynamic phenomenon with fixed boundaries and, as Serge Grudzinski (1999) has underlined, a big box into which everything is put and out of which nothing clear emerges. I will divide the term into two, the first aspect referring to the professional culture present in each workplace. Here, I am following the theoretical perspective of Sapir, who said that professional culture is constantly created through the interactions of people who participate in the everyday activities of their world (Sapir, 1949). The term 'culture' will be used in a second sense in reference to national or ethnic phenomena; here, I use the term in accordance with the understanding of my participants. When they speak about the characteristics of people originating from a given country, these participants refer to what a sociologist might define as a 'national culture'. However, the participants replace 'national' — which has a slightly pejorative overtone — with the term 'different'. This semantic modification seeks to depict their attitudes as more open and as offering a positive evaluation of cultural differences. However, when examined in detail, their accounts of this 'different' culture match the stereotypical vision of 'the stranger'. The adjective 'national' emerges frequently in longer discussions. References to national culture are related to the origin of a person (state of birth and education) and the cultural characteristics of people from that area. This is most often a country, although in some cases participants have erroneous information about what is generally seen as the original country of the 'culture' in question (for example, the assumption that 'Spanish' culture is unique, which ignores the existence of several different identities Catalan, Basques, etc.)

The next term that needs to be explored is 'stereotype', understood here as the result of a social process resulting in the production of a homogenous image of a given group (Kozek, 1992; Kania, 1992; LaViolette & Silvert, 1951). In the scientific world, individuals are presumed not to employ stereotypical visions of ‘the other’ because such perceptions are not based on proof and do not acknowledge specificity or the individual distribution of features. Participants rarely used the term ‘national’ except after conflict resolution, whereby they point out the stereotype as a source of misunderstanding.

The last term requiring definition is ‘ghetto’, which is highly charged in its historical significance and differently employed in different cultural areas (in the US, it has mostly been used to describe poor areas with African American inhabitants, while in Europe it reflects the history of WWII and Jewish ghettos in Nazi-occupied countries). In this article, I will employ the term as it was used by the first sociologist working on the topic. Louis Wirth published in 1928 his book titled *The Ghetto*, in which he presents the phenomenon of ‘social isolation’ based on Jewish communities in Europe and in the US (mainly Chicago). Wirth shows the positive and negative aspects of social organization, which separates people from different cultures and distant lands in distinct spaces of life, work and social activity. In this article, I show how this system of social separation operates in contemporary scientific laboratories. I will provide data from laboratory ethnography showing the elements that contribute to what participants have called ‘ghetto laboratories’.

2. Methodology

2.1. Ethnography and research questions

My research is mainly based on qualitative methods, conducted according to the Chicago School tradition (Glaser & Strauss, 1968; Hughes, 1971) with active observation (Peretz, 1998), including periods of observation[10] in four laboratories. I conducted around 400 formal, semi-open interviews concentrating on the biographies of my respondents.[11] The main questions were related to participants' careers, especial their international aspects. My research began in 2003 and was carried out mainly in three countries — France, Poland and the US — with additional observation and interviews in Germany, Canada and China.

This article mainly concerns itself with American laboratories. The majority of data used for this paper come from observation of two research laboratories. In one of them (during five months in 2010–11), my observation post

[10] I played following roles: a researcher/sociologist, a volunteer/sociologist, a translator, a guide for people taking part in scientific conferences, and close friend to a few scientists.

[11] I did not use computer programs to analyse the data.

was a small cafe room in an important research institution, in which several hundred scientists are employed. There, researchers gathered for breaks or to prepare their lunches and to talk to other researchers — or to me. I conducted most of my formal interviews in the coffee room (the lab rooms were too cramped for interviews, since many scientists typically worked in a small space, each focused on his or her own experiments). I asked the following questions to people who worked in multicultural research teams: How does the presence of different cultures in the laboratory influence their daily routine? In what ways do cultural differences (in the sense of national or ethnic cultures)[12] affect interactions among team members? How does this cultural diversity impact researchers' work? While observing people at work, I focus on how researchers adjust their practices and career strategies within highly internationalized work environments. Finally, I wanted to know how cultures of origin shape researchers' careers.

2.2. The world of laboratories: between multi-culture teams and the ghetto laboratory

Life science laboratories in the US generally can be defined according to two types, in terms of their international character. In what might be called 'multicultural' laboratories, the 7–15 members of the lab are a patchwork of nationalities. These might include, say, an American primary investigator, a postdoc from Germany, another from France, a third from India and a fourth from Italy, and PhD students from China, Portugal, Indonesia, the US and Spain. In the second 'type' of lab, most if not all the workers originate from the same country or geographic area. For example, the workers in a Russian PI's lab might come mostly from Russia, with a few individuals from other Slavic-language countries. The latter is discussed in the following field notes:

> *Today we have this phenomenon of ghetto laboratories. It is easy to see this kind of effect: when the PI is from a given country, most of his researchers and PhD students will also originate there. If not all, then at least the majority. This is specifically true for people from China, Russia, Korea... and Poland, too! So you have, for example, a Chinese lab inside an American institute of research in an American city. The PI is Chinese and almost all*

[12] The informants in this study use the adjective 'national' to name their country of origin. The sociological term corresponding to this phenomenon would be 'national culture'. I maintained the double adjective in order to be as close as possible to the expression and meaning given by participants to this issue.

> *the people working there are from China. And people call that an ‘international team’.*
>
> (Informal discussion with a retired American scientist, member of grant panels and research committees. US, 2010).

If scientists in a typical multicultural laboratory are from France, Portugal and Germany, for example, they will frequently place themselves in the category of Europeans, differentiating themselves from Americans and Asians. The core element of such categorization will be constituted by the university system and similar education systems. According to some interviews, the Erasmus programme and other exchanges among researchers inside the EU have played an important role in the construction of such identity perceptions.

3. Data analysis

My data analysis begins with the language issue. There are several aspects of language capacities among researchers that can hinder the achievement of fluency in conversation: pronunciation, vocabulary, cultural understandings and emotional emphasis of the words (Wierzbicka, 1994). I will discuss the tensions among observed scientists in daily situations (for example, when they discuss politics) and the different patterns of conflict solution. I will also present the different perceptions of gender roles and various perceptions of hierarchy. Finally, I will focus on ‘science talk’ and its cultural aspects. The section closes with a discussion of the rationalization processes of scientists in relation to national stereotypes.

3.1. Language: beyond pidgin laboratory English

Researchers usually come to the US with good technical skills in scientific English. If they come from non-English-speaking countries, however, frequently they will have difficulty communicating outside of the scientific setting. My informants often said this problem was most acute among Asian scientists, since most European languages were closer to English than were Japanese, Korean or Chinese:

> We are in the main office (there is a coffee machine and a nice couch — people come here to take a break, eat lunch, chat between experiments).

> Hans speaks about his high school in East Germany and a classmate who one day tried to make a joke by menacing his teacher with a fake weapon. The teacher was scared to death, though his students knew it was a joke, and laughed. Kim, a Korean-origin scientist and Hans' girlfriend, didn't find the story funny. Said Hans, *So what's wrong? Should I tell the story again or this is cultural issue?* In former Soviet countries, nobody had contact with guns; this had to be a joke. But for Kim, raised in the US, this would have been a horrible situation, especially since there have been shootings on American campuses in recent years. After telling his story, Hans wondered whether it was vocabulary, pronunciation or cultural misunderstanding that caused Kim's alienation. It was interesting that he immediately took into consideration not one but three different origins of the problem.

Failure to understand colleagues poses an obstacle to work and especially the achievement of highly intensive exchanges between collaborators, a necessary aspect of experimental research (Wagner, 2006). The difficulties in conversation could pose a huge barrier to the creation of good relationships, which form the basis for the passage of knowledge and the effective training of young scientists.

3.1.1. When the clarity of pronunciation is an obstacle

The ability to understand pronunciations that stray from traditional American and British English, and to modify one's own voice to account for differences in understanding, is an important skill. But for some researchers this is very difficult. They lose their patience and tend to avoid working with people originating from certain countries. If they are a PI, they tend to hire team members from other places:

> In the lab's common room at lunchtime, I'm eating a salad and speaking with a PI (European, non-native English speaker, has lived in the US for nearly 20 years) when a Chinese postdoc comes over and asks, *Can we talk this afternoon*? The PI responds, *Perhaps tomorrow morning?* The postdoc puts his lunch into the microwave and leaves the office for a while. The PI says to me: *You know, this is a very difficult situation for me. I have no prejudices against Asians at all, but I have huge trouble understanding what they say to me. The literal words. I have to ask several additional questions to be sure we are understanding each other.* The postdoc returns 10 minutes later to retrieve his lunch from the microwave. He sits at the table (the

> room contains a single large conference table) and eats his lunch silently. If the postdoc were from another country — in South America, Israel or Sweden, for example — the PI would have started talking with him about the research problem at hand. It wouldn't have been necessary to make an appointment for the next day. The problem could be resolved in a simple conversation over lunch.

3.1.2. The important role of vocabulary

A rich vocabulary consists of a repertoire of words that give a person the option to communicate in different areas, not only those related to work. The language of the laboratory is rudimentary — I call it 'pidgin laboratory language' — and the following anecdote (which I heard from one of my respondents) illustrates the quality of this local professional tongue:

> An Australian scientist goes home to visit his family after two years of work in a German institute. His frustrated relatives say to him, *Do you think you could manage to use more than 200 words when you're speaking?*

Because of the high proportion of foreigners in laboratories, the language employed tends to be as simple as possible. But communication is not easy when people are trying to build collaborations. The collaborators, especially those who share long-term projects and whose careers are interdependent (Wagner, 2006), may have strong professional relationships that require interactions in private life as well as in the lab.

The ties among people working in the laboratories are multiple. For nearly all foreigners working in US labs, the lab constitutes their whole life and their whole life is in the lab. For the majority of postdocs, this period after the achievement of the PhD is devoted almost exclusively to work. All energy is focused on publishing 'the big paper' that they hope will open up their futures. If they have friends, almost all of them are scientists too. Only a small number have families (partners; rarely children). Conversations in the lab, where postdocs spend seven days a week, using their homes only for sleeping, thus extend beyond work to other matters. The lab becomes a substitute for a 'social life'. Experimental biology work requires a lot of precise manual manipulation, but conversation is not only possible, but somehow inevitable during breaks between different tasks, while waiting for the machines to process samples, or in the 15–30 minutes between manipulations. In other words, the organization of the work favours chatting. In order not to be excluded from all this 'small talk', the postdoc requires language skills beyond the '200 words'.

Moreover, language is important for the work itself, especially when it comes to writing scientific papers and grant applications. This limitation plays a crucial part in the selection of foreign scientists during the competitions for the PI positions or tenure track at American universities. This aspect was underlined in an informal conversation with a former American scientist, *The most important obstacle to foreigners who want to become PIs is their poor English. Freelance editing is very expensive, and these postdocs can't cover the editing fees with their salaries*. Although one scientist (Indian origin, retired, editor of a scientific journal) told me that the rule he imposed is, *First accept the paper, then the English*, in the highly competitive world of science, language plays an important role as a selection criteria.

3.1.3. Cultural understanding of word meanings

Certainly one of the best illustrations of this problem comprises the very common misunderstandings of the word 'no':

> In a restaurant on a Saturday night, I speak with Michal (Polish researcher) and Wattana (an Asian researcher who had lived in the US for eight years). Wattana explains, *In my country, as in the rest of Asia, it is very impolite to say no. So we say it with other words: "I will see if it is possible," or '"Let me think about it," or "We'll have to consider that." The person to whom this is said understands immediately that the answer is no. I've been in the US so long but I still haven't learned how to say 'no.' This is impossible... it's too hard for me*. Michal thanked Wattana for the information. A week later, members of the lab were going to a concert and someone proposed having dinner together afterward. Michal asked Wattana if he wanted to come, and Wattana responded that he would think about it. After the concert he was asked again and said *I think that it would be difficult*. So Michal, to confirm, asked, *So you are not coming?* And Wattana replied, *I am not sure*. Michal laughed. *That was an excellent example of an Asian yes for no*, he said.

The same kind of misunderstanding in working environments can constitute a huge problem. Testimony from Western scientists who had worked with Asian people in the US, EU countries or Asia, realized after some days or months that their communication had gone culturally astray. One of them lost two months of experimental work because he believed it when his colleagues said they would follow his advice. In fact, they did not understand the core issue, were being polite, and their experiments were done incorrectly and failed. When my interlocutor, a European scientist, started to ask specific questions to find out where the error had occurred, he realized that his teammates had not understood part of the protocol but weren't able to say they did not understand it. Knowing the culture, European researchers would perhaps be able to detect a subtly negative response, so different from the Western tendency to say 'no', or 'I don't understand'. My interviews, as well as my own observations in the lab, provided a number of similar stories and suggest this is critical point for further study.

3.1.4. Words and their feelings: cultural scripts

The last important component to be discussed here comprises the different emotions that speakers of various backgrounds associate with words. As linguistic sociologist Anna Wierzbicka has shown, an important cultural influence can be traced in the reception of words charged with emotions (she called this phenomenon 'cultural scripts'; Wierzbicka, 1994). These differences occur even among English-speaking countries — the UK, US and Australia — where the same word may be perceived in various ways. Foreigners may fail to grasp the emotional nuance of English words, and this can become a source of misunderstanding. This is easy to observe in situations of conflict, when communication becomes difficult to manage for people who have different models of conflict solution:

> Dorotea (Polish master's student) tells me the story of her boss, a Japanese woman (postdoc): *After several weeks of crazy work, Akira and I left a very tense meeting with the PI. Akira had three times tried to refuse his version of a paper. I could see from her face that she was tired, and I asked, "Are you angry?"* She responded, calmly, *"I am simply furious." You could not see the reaction on her face, but now I know Akira and I am sure she was on fire inside. If I were in her place, it would not be like that; but she is Asian, and people in this culture react differently to a situation like this.*

Dorotea knew that Akira maintained great self-control as the result of her education in an Asian culture. However, the expression *I am simply furious*, said calmly and quietly, surprised her because there was no corresponding tone, body language or visible emotion, as would normally accompany this expression when used by a Westerner. People from different cultures respond with different expressions of emotion in conflicts, and these variations can lead to misunderstanding. According to Wierzbicka (1994), feelings and emotions are normally taught during the education of children along with vocabulary, a transmission that's part of one's cultural immersion and background.

3.2. Culture: between tolerance and stereotypes

Regardless of any communication problems, most of my interviewees said that the sensitivity to cultural differences in the laboratory inspired the workers there to handle conflicts with heightened consideration. One interviewee said:

> *In my previous place, where everyone was from the same country, I would get upset and scream at someone for messing up my work. Here it's different. I ask at least one more time to be sure I understand what happened. When something difficult occurs, there is always more tolerance and distance, an effort not to jump to conclusions. It's certainly a more tolerant attitude.*

This opinion was expressed by numerous scientists. My observations confirmed that tolerance and the careful analysis of misunderstandings and other difficult situations made work inside of multicultural laboratories easier.

3.2.1. International politics in the research lab

Politics can be tricky in any team. The following anecdote presents the most difficult situation — when scientists come from enemy countries. Sometimes, the results are unexpected:

> A European PI told me: *Last year we had a situation that worried me for days. We have two labs that work together practically as a single team, and Andrea (the other PI) invited a new postdoc for two years, and I invited another one, for several months. Just before they got here, we had a discussion and realized that they were both from Israel: one was a Palestinian, the other a Jew. We were scared! We thought we'd have another Middle Eastern war in our lab. So they came — first Isaac, the son of a Zionist from Eastern Europe, and some days later, Ali. They were both very smart guys, brilliant scientists with a great sense of humour. And they worked together wonderfully. Actually, Isaac told us that the best students in Israel today were Palestinians, that they had the same hunger for science as the first generation of Israeli colonists. They became best friends. Really! We were happy, especially since it could have really troubled the atmosphere in the lab. We had three Christmas parties with them: Hanukkah, Ramadan and Noel!*

In other situations, cultural differences are of no help in resolving the political conflicts that arise. In one place where I conducted participant observation, the PI imposed a rule forbidding his workers from speaking about politics:

> The PI said clearly: *No politics in my lab!* So one day, lunch as usual — some people were coming to the main room in the lab and this was the day when the Nobel Prize was announced. Jan (Polish postdoc) said: *The Chinese dissident [Liu Xiaobo] got it.* The PI entered the room at that moment and asked his young PhD from China: *Does that make you happy? Not at all,* she responds, *This is very bad news and not at all a good choice.* The PI said: *OK,* and changed the subject.

This is a classic example of how politics can spring up in the lab. Everyone tries to respect the prohibition and each other’s feelings. Everyone cares about the wellbeing of other members of the group. However, in some situations (a prize distribution, a sports game, as well as a scientific discovery or a good or bad decision about publication, or simply the stress of pressure) people forget to censure themselves. The most important thing, however, is to maintain a good ambiance in the lab.[13] The work environment and the quality of interactions among team members (Mayo, 1949) was just as important to lab work as it was in the context of a factory.

3.2.2. Cultural paths for conflict resolution

The conflict between people from the different cultures is a delicate phenomenon which should be carefully managed when it occurs inside of a research team:

> *It is not easy to work under pressure. I've spent several years now preparing this one publication. It should appear in Nature — first class. Before coming here, I published every year, but since I got here — four years without anything! At first, I had problems with my experiments. Nothing worked as it should... I was crushed... and I had some disagreements with my PI, and you know, I am French, and one day I was so upset that I started to argue with him. I'm “sang chaud” you know — “hot-blooded” — and I screamed at him. And he is not a Mediterranean guy at all. He's more under control and, you know, he was surprised, even shocked. For several days after that we didn't have a normal conversation. For me, it passed fast. You know how French tempers are: short-fused; but then it passes and everything's OK. But for him, it was too much. I think he believes I am unstable... I am not... in France, anyone would blow a fuse under the circumstances. Afterwards we*

[13] Another example is sensitivity concerning the issue of WWII and the Holocaust. Polish researchers say frequently that when they have German-origin researchers in the lab, they are careful never to use the adjective ‘German’ when referring to atrocities from the era, instead saying ‘Nazi’ in order not to hurt their colleagues' feelings.

> *have dinner and a glass of wine, and everything is back to normal. Here it was not like this — there was distance between us for a long time. But that was in the past — now it is OK.*

Bourdieu (1972), in his work on Kabyle culture, showed how the culture of conflict is important, with different patterns respected by people of different traditions. When emotions provoke a loss of self-control, those patterns of behaviour are models for people to follow. In such situations, it is important to take into consideration the culture of the other. The long days of distance which followed the situation described were the consequence of cultural differences. If the fight had occurred between two French scientists, everything would probably have been forgotten the next day, with no impact on the relationship since both would recognize similar patterns of behaviour. We might add here that conflicts in the context of a hierarchical relationship involving people from different cultures impose particular stresses.

3.2.3. Hierarchy role and cultural patterns

Anna is a young woman who went through her early education in France, then assimilated to the American model. For her, the distance between teacher and student, and later between herself and her boss, was wide. To ask for help was an act that seemed to violate the hierarchical distance. Only after long negotiations and explanations was she able to abandon her notion of the proper relationship between PI and technician. The price of her cultural misstep was a one year delay in her training:

> Anna was an MA working as a technician for two years. She had been in the US for eight years and wanted to start her PhD programme. At the time, she was writing her personal statement. The previous year, she hadn't been able to find a place — her candidature had been rejected. I asked if she had shown the personal statement to her boss. She said, *Not at all! I don't dare take his time and bother him with it. He's so busy!* I was surprised, because she had been working in the lab for two years, and it is always a part of the PI's job to check personal statements and other professional papers from people he manages. In the afternoon, I asked the PI if he could correct Anna's personal statement. He said: *I've been waiting to since last year. She did not ask me to last time, and this is why she was not accepted. Obviously I'd do it, with pleasure, but I won't ask her. It is up to her to ask me for help*. As a participant-observer, I returned to Anna and told her she should ask her PI to check her statement. She hesitated for some days, finally asked for his help, and he quickly corrected it. She then

sent the statement to two labs and was accepted by both. *Without your advice*, she said in thanking me, *I would have never asked him for the help*.

3.2.4. Gender roles and their cultural origin

The cultural origin of gender roles can be illustrated with a quote from an interview with a PI (a European woman):

> *The fact that I'm a woman was a huge problem for my Egyptian postdoc. He was technically good, but we had misunderstandings... cultural problems. I would explain something and he always said he understood: "Yes. OK." Then, days later, I would realize that he had not understood, because the experiment was improperly prepared. Talking with him again and asking supplementary questions, I would confirm he had not understood and still did not. It was like this on several occasions — he never said 'no'. Finally, I understood that in his culture it was impossible to let a woman think she knew something you did not know, because you cannot be 'below' her. This would be a compromised situation, like being dominated.*

Meanwhile, in Asia and as we have seen in the previous section, it is very impolite to say 'no' because it is perceived as a mark of a lack of respect. For this postdoc from the Middle East, saying 'no' in a way that showed professional ignorance was to put oneself in a subservient position. In Arab culture, at least as experienced by the postdoc, the dominant position was reserved for men.

The last example might confirm the stereotype of women being forced into inferior roles in science, and indeed there are several publications that describe gender factors as affecting the career achievement of female scientists. However, male/female power relationships in the laboratory can be complex and vary across cultures. The following example comes from a laboratory in the EU:

> When a Mediterranean researcher came to work in Poland, he was surprised to see so many women behaving like men. He was not comfortable when, in the absence of the 'big boss', his female colleagues — who held similar or even lower positions in the laboratory structure, ordered him to do things (beginning with tasks like preparing a buffer for the whole team).

In the example described above, the researcher reacted negatively, considering his female colleagues to be "haughty." Polish men are less perturbed by this kind of relationship because, in Polish culture, it is acceptable for women to give the orders, especially when it is a question of daily tasks, although as feminist sociologists point out, this is not exactly the same as 'proof' of female domination in Polish culture (Giza-Poleszczuk, 2000). Learning about such cultural points can only result from cultural immersion, which requires a long stay in a given country, and also at least some familiarity with the local language.[14]

3.2.5. Inter-professional communication

The culture of communication is very important, especially in scientific communication and particularly in writing publications and grant proposals:

> A person who helped foreign postdocs pursue careers in the US said: *Jobs in academia are hard to get now. The science, or being good in science, is only a part of the skills you need. The foreigners lack skills in the culture of speaking and network chitchatting in the American way, and this is very important. For them, the only choice is to be hired after their postdoc by industry. That's why they don't apply for the money (grants), which today are the basis for getting a position in academia. They don't publish the papers, because of English and the specific style of writing. When I advise people to write or present something, I stress that it's necessary to describe the topic, talk about it, and at the end repeat what it's all about. This is necessary for an American audience.*

It is clearly not only English language skills that count, but cultural knowledge as well. Asians and Europeans have their own models of work in academic and research institutes. The rules in the US are different from European expectations; in France, for example, sophistication is highly valued in presentations, while in Poland, an individual presentation of original ideas is what matters most. Other values and models of expression (written and oral) become another important criterion during the selection. Those who know the rules will obtain a job after their postdoc. Others will have to look for another postdoc contract.

3.2.6. Scientific understanding

In the 1930s, Polish biologist and sociologist of science Ludwik Fleck coined the concept of 'thought style', denoting a pattern of thinking influenced by a given culture (Fleck, 1935 [2009]). Fleck's idea was then developed by

[14] This is not always possible — if we consider that for each research contract this is about 2–3 years, the learning of a new language is, for a lot of mobile scientists, impossible.

Kuhn (1962) and the issue of cultural influences in the sciences started to be observed in various disciplines. In mathematics (which is an example of hard science), since the beginning of the century, there has been a discussion over a controversy about cultural influence in mathematics. It is by now widely agreed that culture is an important component of science, including even the practice of mathematics (Wilder, 1981). The tendency of individual scientists to consult with non-specialist compatriots has a parallel at the group level: the creation of what participants call the ‘ghetto laboratory’:

> *At a researcher's housewarming part, people from many labs were there. An American postdoc speaks with another postdoc from a different institution: I am furious. I do not know how to manage this situation, I have never seen this. When she [a PhD student working under her] doesn’t understand something, and that happens often when you work on a project like this, she goes up to the next floor and meets her friend, a Russian guy, and asks him to explain everything. This is crazy — I am her supervisor, this is my project, this guy is not really a specialist and she is not asking me. How can I advance quickly with someone who is not collaborating with me at all? I have no contact with her.*

This phenomenon is common. I came across similar examples almost every day:

> *This afternoon in my lab, when everyone was working, Xiu (a young PhD, fresh from China) came in with a pipette in his hand and asked a research question. There were two other postdocs in the room, but no one understood. She kept asking, again and again — no improvement in understanding. Then, the senior scientist (a Chinese woman) came, and Xiu asked the same question in Mandarin. They exchanged few remarks in their language, and finally Xiu went back to the lab space to continue her work. In our lab, only English is permitted. This restriction is respected and imposed by the PI, but in this situation he was not present.*

In the corridors and in my ‘office’, researchers of the same national origin frequently met to help each other in their scientific work. I asked several times why they would ask their compatriots for solutions or explanations, even when the latter were not experts in the field in question. Why not ask someone from the lab who works on the same project instead? Some responded that, because of the precision of explanation required, they were more likely to understand a conversation in their mother tongue. Others said they were ashamed not to know something, so they did not want to ask their lab superiors.

Finally, and most interestingly, sometimes the interviewees pointed to the cultural differences in their 'way of thinking' about science. This explanation surprises most Western scientists, who believe that — especially in biology — each scientist has the same background based on publications in the scientific literature. This is partially true, for basic knowledge is acquired during the first few years of school. Yet even if we follow the popular conviction that there is no culture in mathematics (2 + 2 = 4 is an accepted fact all over the world), scientists still point out cultural aspects of science and knowledge.

3.2.7. Rationalizing stereotypes

The materials analysed above show how participants perceive national/cultural differences. Scientists in the laboratory have to negotiate and explain the meaning of their words and acts. If they have a stereotyped vision of another person, they will resort to a rationalized justification. For example, they will say that Germans are 'well organized', which is why they do things in a particular way. They will say that Poles are 'rude and outspoken' (not out of boorishness, but rather because 'that's the culture' in Poland) and that the French are choleric, not because of mental deficiency but rather because of a culture that encourages expressive emoting.

Such rationalizations make stereotypes seem less harmful and more logical, and ease incorporation into the multicultural life of the lab. Researchers fill these stereotypes with proofs and explanations; consequently, the main characteristic of the stereotype (which is not based on fact) is neutralized. Just as humour plays an important role in easing pressure and aiding in the cohesion of a laboratory group, national stereotypes can serve as an excellent basis for jokes. The following example came during a long interview with my principal informer (Junker, 1960):

> *I came as a PI to my new lab in France, and people were curious about me, but they didn't say much. It was not a warm welcome. They were reserved. In order to change that, I decided to perform the stereotype of a perfect Brit. I bought the worst instant coffee I could find and some cheap instant milk, and when they came in for the first meeting I asked — "Coffee?" They were scared you could see them asking themselves, "He wouldn't really do that, would he?" So I said, "OK, well I'll have some," and I filled my cup with some cold water from the sink, mixed it instant coffee and milk and put it in the microwave. Their faces were full of disgust. I had to drink it--which was awful for me — and then I left the room. The walls are not thick and I could hear them scream-*

ing when I left the room: “I knew it! Typically British!” The atmosphere was better afterwards. I was the Brit who drank crap coffee. When they realized several days later that it had been a joke, they laughed a lot.

Playing with stereotypes in this way reveals that scientists are not free of these kinds of opinions about ‘the other’. However, work within a multicultural team provides the opportunity to have a prolonged relationship with members of various groups and individuals, which tend to destroy stereotypical attitudes. The ‘other’ is no longer just a Pole, Russian or Chinese, but becomes Maciej, Sacha or Jin.

4. Conclusions: the ghetto lab — a miracle solution

In the preceding paragraphs I have listed the many consequences of multicultural coexistence in the observed research teams. There are several factors that can trigger conflicts, cause work delays, collapse experimental work or even lead to the abandonment of a project or collaboration. The enumeration of these features provides an idea of the limiting experience of extreme cultural diversity inside a research team. Yet the wish to avoid such difficulties is only one of the reasons underlying the creation of ghetto laboratories. In this section, I focus on the specific problems relating to foreigner-scientists and on networking as a crucial part of job research for career coupling.

People of foreign origin encounter various mundane issues that locally born researchers do not need to deal with, or to which they are accustomed: visas, ID cards, setting up bank accounts and arranging medical insurance. It's crucial for them to understand their environments in order to avoid unpleasant situations and wasted time. Some countries require particular vaccinations and blood tests for entry which, for example, forced one researcher to go into quarantine because he was alleged to be spreading tuberculosis (because his vaccination against the disease resulted in a positive skin test). Such situations are sources of stress and anxiety. But when a researcher comes to the US and is immediately surrounded by people from his or her native country, these compatriots can explain everything that needs to be done and the experience becomes more digestible. Introducing a new person to the reality of a new world is easier when there's a common comparison with the country of reference (country of origin). I observed many people grouping themselves according to national origin and passing along precious information and help in the domains of private life, institutional behaviour and — obviously — the research work.

It is the PI who chooses his or her researchers, and thus the PI who creates the ghetto laboratory. When a PI originating from a given country chooses more than half of his or her lab members from the homeland, other people working in the lab's institution will view it as a 'ghetto lab'. When I asked them to explain why they had chosen so many of their compatriots, many attributed it to their country's *excellent theoretical training*. Often, though, their responses were not related to scientific skills but to culture. They responded that they chose someone because of his or her '*habits* or because they were *used to having Russians in their lab* or *liked listening to the language — it's a sort of nostalgia*.

With other postdocs I attended a seminar by Peter Frisk, an American specialist in scientific careers. We all had the impression that the speech was prepared for American researchers (who were a minority in the conference room). 'Networking, networking, networking' — that was the conclusion. *If you want to find a job after your postdoc, you should mobilize all your ties — university mates, university mentors and professors, baseball teams' members, friends from childhood, people with whom you did your MA study, your PhD study, and those whom you're working with now*. That was great advice for the hundreds of foreigners who came to this particular seminar — many of them couldn't even understand the speech. It was a nice show, but the speaker's advice did not fit their lives that well. What kind of networking links people from a university in India, an MA advisor from Bucharest, a PhD mentor from St. Petersburg, friends and family from Islamabad, and baseball team members from Madagascar?

The employment situation for foreign scientists in the US is quite different to how it was during the period 1940–1970. In those days, physics was the queen of the sciences, and state research funding and financial support were enormous because of WWII and then Cold War scientific competition. This enabled the creation of thousands of scientific jobs (Pestre & Dahan, 2004). The life sciences and medical research advanced after 1970, and today these are the top priorities of US scientific activity. But the context is very different from places like Los Alamos, where 'the cream of the cream' of researchers worked comfortably and in secret on the elaboration of the atomic bomb.

Today, the postdoc is the core of the laboratory, the workforce of a modern research. When they come to the US to work at famous research institutes, the postdocs know that this is the most important period of their professional lives. They face huge challenges in terms of making a discovery and publishing a paper about it. The situation is precarious and the future uncertain. The prospects of finding a good job in the US are slim. They are not on an equal footing with their American colleagues, a fact they know well. They are constantly aware of the years left on their J1 visas, counting down with anxiety the time left until the visa expires and there is no further possibility of extending it.

Only a rare few researchers succeed and can compete with native US scientists and create their own networks that will support them at the crucial moment of job selection. When they get this position and become PIs themselves, they remember the rules of the game and feel responsible towards their compatriots. They remember the sensation of isolation and the mechanism ‘pay it forward’ comes to their mind almost automatically. Some adopt specific proportions (say, no more than 30 % from the same country of origin) while others scorn such rules. They hire the people they want in their labs and heed only the efficiency of their work. Nevertheless, given the importance of fruitful collaborations and good relationships among team members for scientific achievement, it is not surprising to observe an over-representation of the PI's compatriots in a given lab. Only the most exceptional PI really pays no attention to the nationality of his or her lab members, according to my research. One PI told me he did nothing special for his former countrymen, yet over 70 % of his researchers had received their PhDs in Russia.

Despite the negative overtones of its name, the ghetto lab organization has many benefits. If the working atmosphere is good, the workers can create a rare dynamic, producing more and better results, since people feel more involved in their tasks and invest all their time in them. Working among people sharing one’s own origin allows them to spare time otherwise invested in the creation of trusting relationships.[15] If patterns of behaviour are clear and there is no place for cultural misunderstanding, the evaluation of other people takes less time.

To diminish or eliminate the risk of failure in matching close collaborators and team members, some PIs carry out a pre-selection. Their former collaborator, who is back in her/his homeland, sends the next generation of scientists to a ‘friendly lab’. The first pre-selection takes place in the country of origin, where the PI's collaborator tests potential candidates by working with them for a certain period of time. The second phase is the classic postdoc interview, which is frequently no more than confirmation of the partner's decision made in the home country. The master chooses the best students and sends them to his/her master in the US. And so, the next generation of well-trained scientists is ensured.

[15] As research on creativity shows, successful collaboration is based on trust and a willingness to cooperate (Sawyer, 2001; Henry, 2004; Moran & John-Steiner, 2004 in Khodyakov, 2007).

According to my studies of the career paths of violin virtuosi and life scientists, people are more successful when engaged in strong collaborations with a mentor or a research partner. I call this specific process of intense professional relationship 'career coupling' (Wagner, 2006). The process involves an intense involvement in a given project that over time brings outstanding results (Wagner, 2006). In the virtuoso field, I looked for the influence of national culture on the quality of the career coupling process. I discovered an important relationship between career coupling partners of the same origin and their career development (Wagner, 2012). In other words, mutual inspiration and understanding in non-verbal activities and work dynamic seems to be better when people are from similar cultures.

Such dependence seems to occur in a similar way in laboratories. Most of my respondents claimed to have easier understandings with lab members raised in the same culture. Trust-based relationships develop faster because each individual recognizes cultural signs faster. There is less of a feeling of isolation when working with similar people (who share similar values, jokes, senses of humour, cultural background, movies, books, etc.), especially when the work is time-consuming, as is always the case with postdocs. The mechanisms of career coupling processes based on the pre-selection conducted in 'the old country' build stronger collaboration with the team on the other side of the Atlantic or Pacific. The 'sister-labs' can share projects, exchange people and thus accelerate research.[16] These relationships can include out-sourcing, which makes research cheaper (a popular solution with the use of human resources in China, Poland and India).

All the phenomena mentioned above perfectly match the golden rule of our postdoc career specialist, Peter Frisk: networking, networking, networking. Each person does what she/he can. Americans use their connections: the guy from the Stanford baseball team, the roommate from the undergrad years at UCLA and the PhD colleague from Harvard. Foreign scientists work other connections — their 'home-based connections'. The foreign and American researchers are engaged in similar processes. I believe that ghetto laboratories are not a pathological phenomenon but rather an adaptation to certain expectations of a given environment. The ghetto laboratory is a parallel professional society in the space of American/internationalized science.

Many of these units are Indian, Chinese, Polish and Russian. Why is this? These countries have maintained strong public education systems, espe-

[16] However, such collaborations can be abused, for example, when several groups are working in the 'mother country', but the publication lists only the names from the US lab. I collected several examples of this.

cially in science. Children in their public schools usually start learning biology with evolutionary theory, and math and physics are taught at a high level from the earliest years. These societies attach positive values to science and research, which seems enough to awaken a passion for science that prepares young people for lab work.[17] In these countries, young researchers dream of complementing their training with a US postdoc. Except for China, the conditions of scientific work are poor in these countries. Their home environments cannot accept all the people trained, which is why geographic mobility is a necessity at this stage in their careers. The following question arises: is the contemporary scientist a transnational professional or a *Gastarbeiter*?

Geographical mobility is the main subject of discussion in sociological analyses of scientific careers in the 21st century. Mobility is presented as a unique way to achieve excellence and master knowledge. For rich countries, mobility is tool for attracting the best research minds from poorer countries. A huge amount of US research requires foreign heads and hands, although the training of those heads is paid for by the taxes that sustain high public education levels in the countries where it occurred — in the EU or in poor societies.

The ideology of research mobility and scientific flexibility (as an example of the world citizen) conceals the precarious situation of postdocs and the saturated market of tenured contracts. The rare positions held by senior scientists require ‘soft money’ (as scientists call the grant system) — short research contracts that may disappear if the next grant does. The transnational professional — affiliated with multiple institutions in two or more countries (Wagner, 2011) and constantly travelling and working in international teams — is held up as an ideal. But the ecology of the scientific world imposes rude selection, and only a few scientists will achieve this exalted status. Others will fulfil several postdoc contracts, each time changing institutions and cities, until visa limits push them out of the country where they spent the best years of their scientific life, when they were young and passionate about research, when they worked every day for years with no break for summer travel, years without seeing family, far from aging parents, focused only on the research results, publications and the next contract.

In effect, their lives constitute a modern version of the *Gastarbeiter* — the term used for immigrant workers who spent the early years of their lives in German factories, without their families or any rights to citizenship, on short-term visas. When the factory contract ended, Germany needed the

[17] The ethos of science present in Eastern Europe is completely different from that described by Rabinow, who believes that the passionate and disinterested (in the Mertonian sense) scientist is a mere myth today.

Gastarbeiter no longer and sent him home (although, in effect, many managed to remain).

The multi-culture labs and ghetto labs are full of such *Gastarbeiters* who, when they go back to their home country, will rarely be able to maintain the pace and high-level intensity of their work. They were in the Mecca of science — the best place to be in the world. Now, for the majority, the dream is over. A post-postdoc depression starts almost immediately after the joy of reuniting with their families has ended (Wagner, 2011).[18] They have expended years of tremendous effort and sacrificed themselves on the altar of science, in exchange for the destiny of the *Gastarbeiter*. For such scientists, without a doubt, cultural origin is important.

References

Bento, S., Cota, D. & Arraujo, E. (2009). Mobility and research institutes in Portugal — Conceptualizing knowledge circulation — paper presented at the Second International Conference on Academic Mobility, Tallinn University, 24th September 2009.

Bony de, J. (2010). Project management and national culture: A Dutch–French case study. *International Journal of Project Management,* 28, 173–82.

Bourdieu, P. (1972). *Esquisse d'une theorie de la pratique precede de Trois etudes d'ethnologie kabyle*. Paris: Editions du Seuil.

Fleck, L. (1979 [1935]). *The Genesis and development of a scientific fact*. Chicago, IL: University of Chicago Press.

Garrison, H.H., Stith A.L. & Gerbi, S.A. (2006). Foreign postdocs: the changing face of biomedical science in the U.S. Resource document: FASEB Journal 20, 193–196.

http://www.fasebj.org/content/19/14/1938.full. Accessed: the 25th March 2013

Giza-Poleszczuk, A. (2000). Byc kobieta, byc mezczyzna — czyli o przemianach tozsamosci zwiazanej z plcia we wspolczesnej Polsce. In: M. Marody (Ed.), *Miedzy rynkiem a etatem. Spoleczne negocjowanie rzeczywistosci* (pp. 44–74). Warszawa: Wydawnictwo Naukowe Scholar.

Glaser, B. & Strauss, A.L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine.

Grudzinski, S. (1999). *La Pensée métisse*, Paris: Fayard.

Hofstede. G. (1980). *Culture's consequences, international differences in work related values*. Newbury Park, CA: Sage.

Hofstede. G. (2001) *Culture's consequences: comparing values, behaviors, institutions and organizations across nations*. Thousand Oaks, CA: Sage Publications.

[18] I devoted one chapter of my book entitled *Becoming transnational professionals: Mobility and career of Polish elite of science* to the analysis of this phenomenon of post-postdoc depression.

Hofstede, G., Hofstede G. Jan. & Minkov, M. (2010). *Cultures and organizations: Software of the mind*. 3rd Edition, McGraw-Hill USA.

Hughes, C. (1971). *The Sociological eye: Selected papers*. Chicago, IL: Aldine.

Jasinska-Kania, A. (Ed.) (1992). *Bliscy i dalecy. Studia nad postawami wobec różnych narodow, ras i grup etnicznych*. Warszawa: Wyd. IS. UW.

Khodyakov, D.M. (2007). The complexity of trust-control relationships in creative organizations: Insights from a qualitative analysis of a conductorless orchestra, *Social Forces*, 86 (1), 1–22.

Knorr-Cetina, K. (1981). *The manufacture of knowledge — An essay on the constructivist and contextual nature of science*. Oxford, UK: Pergamon Press.

Knorr-Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Cambridge, MA: Harvard University Press.

Kozek. W. (1992). Doświadczenie a stereotypy etniczne. Niemcy w opinii Polaków pracujących na obszarze państw niemieckich w latach osiemdziesiątych. In: A. Jasińska-Kania (Ed.) *Bliscy i dalecy*. Volume II (pp. 25–62). Warszawa: Instytut Socjologii.

Kuhn, T.S. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.

Latour B. & Woolgar, S. (1979). *Laboratory life: The construction of scientific facts*. Ewing, NJ: Princeton University Press.

LaViolette F. & Silvert K.H. (1951). A theory of stereotypes. *Social Forces*, 29 (39), 257–262.

Mayo, E. (1949). *Hawthorne and the Western Electric Company. The social problems of an industrial civilisation*. London, UK: Routledge.

Merton, R. K. (1973). *The sociology of science*. Chicago, IL: University of Chicago Press.

Owen-Smith, J. (2001). Managing laboratory work through skepticism: processes of evaluation and control. *American Sociological Review*, 66 (3), 427–452.

Pestre, D. & Dahan, A. (Eds.) (2004). *Les Sciences pour la guerre, 1940–1960*. Paris: Presses de l’EHESS.

Rabinow, P. (1996). *Essays on the anthropology of reason*. Princeton, NJ: Princeton University Press.

Rabinow, P. (1997). *Making PCR. A story of biotechnology*. Chicago, IL: University of Chicago Press.

Rabinow, P. (2008). *French DNA: Trouble in purgatory*. Chicago, IL: University of Chicago Press.

Sapir, E. (1949). *Selected writings in language, culture, and personality*. Berkeley; Los Angeles: California University Press.

Schneider, S. C. & Meyer de, A. (1991). Interpreting and responding to strategic issues: The impact of national culture. *Strategic Management Journal*, 12, 307–320.

Shapin, S. (2008). *The scientific life: A moral history of a late modern vocation*. Chicago, IL: The University of Chicago Press

Shapin, S. (2010). *Never pure: Historical studies of science as if it was produced by people with bodies, situated in time, space, culture, and society, and struggling for credibility and authority*. Baltimore, MD: The John Hopkins University Press.

Wagner, I. (2006). Career coupling: career making in the elite world of musicians and scientists. *Qualitative Sociology Review,* 2, 78–98.

http://www.qualitativesociologyreview.org/ENG/archive_eng.php, Last accessed February 2010.

Wagner, I. (2009). Transnarodowy Profesjonalista i jego profesjonalna kultura. In: L. Krzyzowski & S. Urbanska (Eds.), *Mozaiki przestrzeni międzynarodowych. Teorie, metody, zjawiska* (pp. 155–171). Krakow: Nomos.

Wagner, I. (2011). *Becoming transnational professional. Mobilność i kariery polskich elit naukowych*. Warszawa: Wyd. Scholar Wydawnictwo Naukowe.

Wierzbicka, A. (1994). 'Cultural scripts': a semantic approach to cultural analysis and cross-cultural communication. In: L. Bouton and Y. Kachru (Eds.,) *Pragmatics & Language Learning* (Monograph Series), 5. (pp. 1–24). Urbana-Champain: University of Illinois.

Wilder, R.L. (1981). *Mathematics as a cultural system*. Oxford, UK — New York, NY: Pergamon Press.

Wirth, L. (1928). *The ghetto*. Chicago, IL: Chicago University Press.

Research career development in Russia: the role of international mobility[1]

Nadia Asheulova and Svetlana Dushina

The chapter presents the Russian institutional context of the academic career, analyses how the scientific space is structured in Russia. It studies the role played by international scientific mobility in the intellectual biography of Russian scholars and their academic careers. The findings of an empirical study of Russian scientists' international mobility and the Chinese experience of science policy encouraging mobility are provided. The conclusion highlights that mobility is of great importance in boosting academic careers and can solve some problems of science organization. The 'international mobility' of scholars proves to be a significant new instrument for reproducing the scientific elite.

1. Introduction

The issue of an academic career goes hand in hand with constructing one's life: which 'points in the corridor' must one pass in order to achieve a certain status in the scientific community? Which targets must be set in one's professional activity and where should one's efforts be directed to later gain symbolic/economic capital?

An academic career includes practices produced by social agents as well as institutionally determined activities, caused by subjective choices and personal aspirations, at the same time structured by the layout of one's academic field(s). A scientist's professional progress has its own specific features in national academic markets, which changes together with broader systemic transformations.

The free movement of scholars is an essential feature for one's professional career. Working in advanced, well-equipped research centres is a common desire of each person choosing an academic path. International mobility has always played a prominent role in Russian science and in shaping of the scientific elite. Since the fall of the 'iron curtain', Russian scholars in circumstances of social transformation had an option which they did

[1] The paper is prepared within the framework of the Programme of Fundamental Research of the Presidium of RAS 'Traditions and innovations in the history and culture' and the project 'International mobility of Russian scientists' (on the basis of science-studies researches).

not have before: the freedom to establish international professional contacts and to travel abroad. In this connection, it is important to understand the role played by international scientific mobility in the intellectual biography of Russian scholars and their academic careers.

This chapter presents the Russian institutional context of an academic career, analyses how scientific space is structured in Russia. It studies the motives of researchers for the international mobility and effects that have on future career progression.

We use the findings of an empirical study of Russian scientists' international mobility and also provide data on the Chinese experience of science policy, which encourages mobility. Our conclusions highlight that mobility plays a very important role in boosting individual academic careers and that it can help to solve some of the problems of scientific institutional organization. A study of the 'international mobility' of scholars has proven to be a significant new theme in understanding the scientific elite that various nations are producing. In this chapter, we focus on the post-Soviet Russian example, but our conclusions reach beyond the limits of any single country.

2. Academic careers in Russia: institutional context

To explore the organization of academic science, Pierre Bourdieu's concept of the 'field'; will be used as a relatively autonomous space where knowledge is produced with specific rules, but which is indirectly connected with society. It is not that science is isolated from external impositions and prescriptions, but that external constraints are translated into a scientific language that is integrated into developmental logic. Scientists are connected to society through many links: orders from various organizations, including government, set the priority directions defined by 'expert' circles. Such outside influence are translated into the language and codes of scientific knowledge, redistributed and transformed into effective research and development. Bourdieu calls this ability of a field to resist *refraction*: the more autonomous the field, the higher the level of refraction. Heteronomous fields are expressed as being *not very competent — from the point of view of a field's specific norms — people are able to interfere in it acting on behalf of heteronomous principles instead of being immediately disqualified* (Bourdieu, 1997).

The field structure is formed by distributing academic capital between various agents (individuals, institutions). Bourdieu clarifies that academic capital is a specific type of symbolic capital, and that it is a recognition (or trust) which is granted by a group of peer-rivals within the academic field.

Authority (the recognition of merits) in the scientific community depends on the 'size' of symbolic capital and its owners take part in defining the 'rules of the game'; they become experts in their disciplines, forming judgments of validity regarding what should be published in prestigious journals and what should not, about who can be recruited for academic positions and whose applications should be turned down. In other words, scholar agents establish an appropriate field structure in proportion to 'weight' that depends on other agents. At the same time, each 'academic capitalist' is subjected to structural pressures whose strength shows an inverse proportion to the relative 'weight' of academic capital, which denotes the status of scholarship that has considerable symbolic capital and which can be converted into economic capital.

Academic careers are thus advanced by the aspirations of social agents (individual scholars and collectives) to occupy a strategic position in scientific space that is made up of academic merits: advantageous topics, research grants, academic degrees, publications in journals with high impact factors, participation in conferences and seminars, etc.

The more autonomous the academic field and transparent the rules (set and shared by the scientific community) of the game are, the clearer it is how one should build a career and where one's talent should be invested in order to achieve a certain recognition. It is evident that there are no perfect academic systems, though there are systems where academic merits are closely connected with academic progress, with the holding of an influential disposition in the academic field. In the process, these merits are determined, first of all, by relevant circumstances, but there are systems where these links are weak, and the rules of the game are vague. It is from this perspective that we will look at the Russian case of an academic career.

The organization of Russian science is connected to the Soviet way of doing science. Under the circumstances of party-and-government control of science, the issue of an academic field's autonomy should be addressed differentially: it exists in some disciplines, for example, in physics and mathematics. But in the social sciences and humanities, the principle functioning of autonomous thought was slight.

A postgraduate course was the best way of training young talent for future scientific work. Young people studied at the postgraduate school of the USSR Academy of Sciences, worked in the same sector during their studies, obtained a PhD and moved up the scientific career ladder. The promotion mechanism involved the status of leading specialists and the heads of research units (section, laboratory or department). Afterwards, he or she became famous, received distinctions and was elected as a member of the USSR

Academy of Sciences as a corresponding member or academician, which was accompanied by high scientific status. That was the way the Academy system of generating continuity worked.

A scientist's career presumed a passage through points in the 'academic corridor' as a leading specialist, head of an organizational unit (sector or laboratory, up to an institution's directorship) and/or membership in the USSR Academy of Sciences. Not infrequently, the scholar's professional life began and ended inside a single academic/research establishment; a long, uninterrupted service at one and the same institution was an advantage and considered a great academic merit. Working in elite institutes that obtained orders from the military-industrial complex was especially prestigious, because they concentrated significant resources in conducting R&D and they provided good opportunities for achieving one's personal goals.

One structural feature of Soviet science organization should thus be highlighted: the low occupational mobility that it promoted due to its closed character. This drawback has remained in post-Soviet Russian science.

The transformations of the macro-system have ultimately had an effect on the academic field, whatever degree of autonomy scientists possessed. As Bauman put it, the period of 'interregnum' came, a situation of insecurity and uncertainty, when the old rights were no longer binding and when there were no new ones (Bauman, 2011). Russian science was subjected to pressure from political and economic circumstances and academic capitalists, enticed by economic interest and material advantage, lowering the refraction of the academic space. A devaluation of the academic symbols that once constituted academic capital took place; an institutional erosion began which had different manifestations: from election to the Presidium of the Russian Academy of Sciences (RAS) to simple *turnkey defences of scholar dissertations (one form of corruption is 'giving out' scientific qualifications)* (Yurevich, 2010: 161).

Now, we will outline the key positions that characterize the academic field today and its social agents. Higher education in Russia nowadays is characterized by mass enrolment. The number of postgraduates grows each year, but approximately one-third of all those who have completed the course are able to defend a dissertation (Table 1).

Today's postgraduates regard obtaining a degree as an 'entrance ticket' to the academic field; a postgraduate course is a 'point in the corridor' that one must pass. Each year, however, we see the number of researchers dropping. This is determined by a number of factors: inadequate funding for research and academic institutions by the government, a mass exodus of scientists

Table 1. Postgraduate courses (person) in Russia

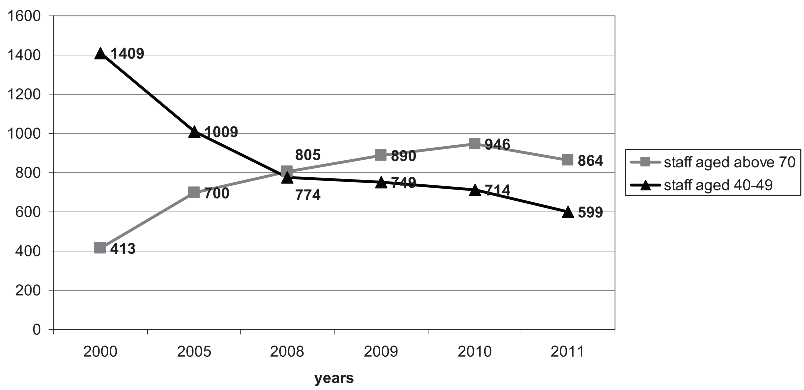
Year	2007	2008	2009	2010
Enrolment (total)	147719	147674	154470	157437
Entrants	51633	49638	55540	54558
Graduates	35747	33670	34235	33763
Graduates with defended dissertations	10940	8831	10740	9611

Source: Table 1.2. Postgraduate and doctoral courses // Science, Technology and Innovation in Russia: brief data book, 2007–2011 (2012) Ed. Mindeli, L., Moscow: ISS RAS.

abroad in the 1990s, or movement to other types of work due to low pay and the lower social prestige of academic professions. This suggests that Russia's science and education has become uncompetitive compared with business and finance. It is as professor Rafael Yusupov (2012: 133) said in an interview: *These days it is more prestigious for a young man [sic] to say 'I work for Google' than 'I work for the RAS'*.

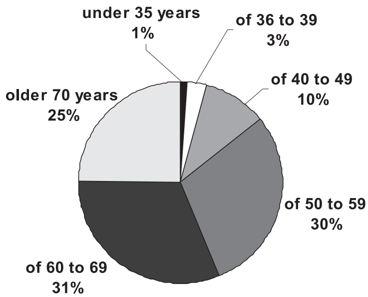
Another feature of Russia's national academic market can be singled out, namely the overall ageing of scientists in charge of science and education, especially in the RAS institutions, which hinders the inflow of young specialists into science (Figure 1).

Figure 1. The dynamics of staff in institutions of the St. Petersburg Centre of the Russian Academy of Sciences (by year and age group)



From 2000 (7 %) to 2011 (19 %), the number of researchers in academic institutions over 70 years old almost tripled. This was due to a decrease of scientists aged 40 to 49 years. At the same time, the proportion of young scientist-managers in St. Petersburg has been negligible (Figure 2).

Figure 2. Proportion of laboratory leaders in research institutions of the St. Petersburg Centre of the Russian Academy of Sciences by age



It is possible that this is not peculiar to Russia: *We are told that younger scientists are being denied research opportunities, as an increasing number of prestigious research grants are going to older scientists. This trend is alleged to foreshadow doom for the future of science. Today's young scientists will be retiring before their careers have really begun* (Arbesman & Wray, 2013: 282).

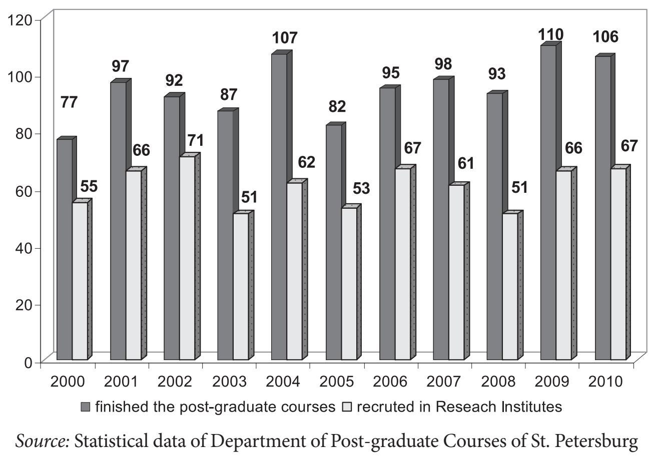
Administrative positions in Russian academic fields are powerful enough: the administration controls material resources, makes decisions regarding employment and prolonging contracts (legally, there is no permanent salary; all employees, including those on the staff, are subjected each year to competition). The administration's work, however, is not transparent; the 'rules of the game' are vague for agents in the field and it is not always clear which criteria are decisive in the recruitment process, in assigning bonuses, or in decisions as to whether to pay money to staff for business trips or not. The heteronomous (in relation to the academic field) factors are not rejected as irrelevant, but can sometimes become priorities, which indicates a 'low moral density' in the scientific community as well as weak autonomy in the field.

These facts highlight another issue of a career progress in Russia: equality/inequality of opportunities. The term 'equality' has many meanings, as Alfred Schütz noted, and to avoid a semantic confusion, he links it to the concept of 'relevance'. All objects (facts, features, persons) assigned to one and the same type or field of relevance are called 'homogenous' (Schütz, 1957). The parts related to various areas he called 'heterogeneous'. Equality and inequality in this sense are correlated with different degrees of perfection and achievements that belong to one relevant area. The secondary and principal merits accumulate symbolic capital (earning an academic degree, working on a research project, the status of a Skolkovo resident, an administrative job, taking part in a trainee programme abroad, etc.) and it is agents in the field who make the decisions. They also structure the ranking of achievements and advantages. To put it differently, the status of *homo academicus* must be determined only on the basis of academic merits related to homogeneity in the academic field. Schütz points out in this connection that it is only within each of these relevance zones that the degrees of merits and excellence can be identified; what can be correlated in the system of one area cannot be correlated in other systems, such that applying criteria unrelated to one and the same zone of relevance leads to logical and axiological (moral) contradictions.

Building up scientific space on phenomena such as friend/foe, nepotism, conspiracy, and pursuit of one's own financial interests is so common in administrative circles. Being heterogeneous to the academic field, all these facts do not add to the attractiveness of Russia's academic market.

It now happens that young talented researchers are unable to find jobs at Russian institutions. Academician Georgy Georgiev gives an example of this at the Institute of Gene Biology of the RAS, where all departments conduct research at the world level and are more or less supported with grants. Upon receiving their PhD, young, gifted scientists seek to go on working at the institute and to not leave the country. However, there are not enough vacancies for young people (Georgiev, 2009). According to the statistical data of the Department of Post-graduate Courses of the St. Petersburg Scientific Centre, only 63.2 % of PhD students recruited at research institutes from the St. Petersburg Scientific Centre in 2010, such that 36.8 % of students finishing post-graduate studies are forced to seek employment elsewhere (Figure 3).

Figure 3. Recruitment of graduates of research institutes at the St. Petersburg Centre of the Russian Academy of Sciences (2000–10) (in numbers)



Source: Statistical data of Department of Post-graduate Courses of St. Petersburg Scientific Centre, Russian Academy of Sciences, 2010 (Fokichev Yu.)

Particular features of the Russian academic market, with its opaque rules of the game and the scientific community's general lack of consensus on significant academic symbols (academic degree, discoveries, grants, administrative position, recognition abroad), hamper the strategic planning of professional biographies, which are 'modelled' on academic life and form a rather situational approach (Frantsouz, 2004: 44). Choosing a field and place for one's professional self-realization depends on a combination of incentives: cognitive, social and economic. When considering social and economic determinants, a young specialist has few arguments in favour of choosing a teacher's or researcher's job in Russia. The prestige of teaching or doing research in Russian higher education is not high, and the pay is much lower than the average in the domestic economy.

3. Mobility of Russian scholars in the past

Russia is a country whose history has seen all types of international mobility: free movement of scientists in the 18th to 19th centuries, forced emigration in the 1920s, limited mobility in Soviet times, mass emigration in the post-Soviet years, and a return to brain circulation and the use of international mobility as a mechanism of integrating Russia into the global scientific community in the 21st century.

Russian science emerged and has benefited greatly from the international movement of scientists. The RAS was established thanks to a famous fact: a number of talented young scientists came to Russia, resulting in the creation of the Academy and the foundation of science itself. Both emigration and immigration have been common in the world scientific community. The European Enlightenment saw a sort of competition between monarchs to attract famous scientists. Catherine II managed to attract Leonhard Euler to St. Petersburg, one of the leading mathematicians of the time, a member of the Berlin Academy of Sciences, and under the sponsorship of Friedrich the Great (Kolchinsky, 2003).

It is also well-known that during the 18th and early 19th centuries, many German scientists came to Russia and that a lot of them became professors and adjuncts in the St. Petersburg Academy of Sciences and in Russian universities. To be educated in a leading European — especially German — university or higher technical school meant a lot for the successful professional career of Russian scientists in the 19th and early 20th centuries.

In the Soviet era, and in contrast to the Russian Empire, international scientific exchanges were of course limited. But even a cursory 'retrospective view' does not provide a uniform picture. Emigration and the tragic expulsion of Russian intellectuals abroad in 1922 led to the impoverishment of culture and the various fields of the humanities. However, at this time the new government created a new scientific infrastructure. In 1918, there were only 22 research institutes but by 1933 their number had increased to 658. Thus, in September 1918, the State Institute of X-ray and Radiology (GRRI), with the Physical-Technical Department, was organized, headed by Abram Ioffe, which became an independent institute in 1921. The Ioffe Physical and Technical Institute is one of Russia's largest institutions for research in physics and technology, with a wide variety of operating projects. So, it is quite natural that the Institute bears the name of this outstanding scholar and science organizer. Until 1950, Ioffe remained the Director of the Institute — the 'cradle of Soviet physics'.

In 1918, the State Optical Institute was founded on initiative of Dmitry Rozhdestvensky. Between 1917 and 1922, the Radium Institute was created at the initiative and under the direction of the academician Vladimir Vernadskiy, which consolidated all of the radiological institutions available in Petrograd at that time. New research institutions and laboratories were formed in Moscow, Nizhny Novgorod and Tver, and we can therefore suggest that during this period a network of research institutions was built.

In the 1920s, albeit briefly, Soviet scientists established contacts with the international scientific community. After the revolution (i.e., the Bolshevik seizure of power), the academic community repeatedly appealed to the new government, demanding the restoral of international contacts with Russian scientists. Thus, in July 1918, the Permanent Secretary of the Academy of Sciences Sergey Oldenburg, wrote a letter to the People's Commissariat for Education[2], indicating the need to develop Russian scientific institutes abroad, especially in Paris. He observed: *The Academy stands with the same point of view about the need and vital importance of international relations between scientific people in institutions of all countries* (Ostrovitjanov, 1968: 369–370).

On November 22, 1920, the Academy of Sciences addressed the Council of People's Commissars[3] and demanded the restoration of scientific

[2] People's Commissariat for Education (commonly called Narkompros) was the Soviet agency founded by the State Commission on Education and charged with the administration of public education and most of other issues related to culture.

[3] The Council of People's Commissars of the Russian Soviet Federative Socialist Republic (RSFSR) was government cabinet of the RSFSR from 1917 through 1946, when it was renamed the Council of Ministers of the RSFSR

communication between Russia and the West *through systematic and not random, as currently, trips by Russian scientists abroad.* Scientists also demanded the restoration of the *delivery of scientific books and materials from abroad and from Russia abroad.* They wrote: *Without these measures, the work of Russian scientists is to a large extent meaningless because, when working on their research, they do not know what has already been done abroad. They cannot see the connection between the research results of different scholars. But due to the internationality of science, this connection is crucial. Additionally, Russian scientists are unable to receive serious and thorough criticism of their work from foreign experts* (Ostrovitjanov, 1968: 376).

In August 1919, the Scientific and Technical Department of the Supreme Soviet of the National Economy was created, which was the key state institution for managing the economy of the RSFSR and later of the Soviet Union. There were two institutions with this name, at different times (1917–1932 and 1963–1965), which were entrusted to promote contact between Russian and foreign scientific and technical institutions. In 1921, on the orders of Lenin, a Committee for Foreign Literature was organized. The state scientific policy of the Soviet government in the field of international scientific cooperation was highly centralized and contacts were limited. Nominations for foreign scientific visits were essentially determined by the government, which sanctioned trips and the visits of foreign scientists in the RSFSR.

In a memorandum to the State Institute of X-ray and Radiology in the research department of the People's Commissariat, justification for the trip abroad by Mikhail Nemenov and Abram Ioffe was given. Of particular interest is the following argument: *Further work without direct communication with Western Europe, without first obtaining the latest instruments and apparatus, and without foreign literature and magazines is almost unthinkable* (Ostrovitjanov, 1968: 372). This note completed a request to equip scientists with a *sufficient amount of foreign currency for the purchase of instruments, apparatus, reagents and literature*. The Scientific and Technical Department offered to send abroad two persons from each branch of science and technology (one with a bias towards pure science and the other for practical applications). The priority missions were invited to take place depending on their importance to the national economy at the time or another branch of scientific discipline. Of course, mass mobility was impossible, but in these circumstances the state supported outstanding scientists and sometimes good managers for foreign trips, which saw positive results for both Russian science and career scientists. Mikhail Nemenov, in a letter from Berlin on October 15, 1920, reported: *It is particularly interesting to note that the Germans now give us an example,* *the fact that the government provides the universities very little money. Many provincial universities must sell their radium and platinum to maintain their existence* (Ostrovitjanov, 1968: 375).

Ioffe recalls receiving orders from Lenin in 1921. Along with Rozhdestvensky and Krylov, he went abroad to re-establish scientific communication. Of great assistance in this case was Ehrenfest, who at the time headed the department of theoretical physics at the University of Leiden and had extensive contacts among scientists, especially physicists (he invited to his seminars Einstein, Bohr, Pauli and Dirac). Thanks to Ehrenfest, many Soviet scientists worked in the Leiden laboratories: Obreimov, Shubnikov,and others(Ioffe, 1962: 42). In 1926, Shubnikov was sent to the Leiden laboratory — on the recommendation of Ioffe — to Wander Johannes de Haas. On his return from Leiden in 1931, Shubnikov headed a cryogenics lab in the newly created Physico-Technical Institute in Kharkov. As early as 1931, liquid hydrogen was created in that cryogenics lab; in 1933, liquid helium. In 1934, the Physico-Technical Institute created another cryogenic centre, which was the fourth largest in the world. This success was made possible thanks to the help of managers from Leiden's laboratory — de Haas and Willem Keesom — who transferred to Kharkov the necessary materials and equipment (which did not exist in the USSR).

In 1926 and 1927, Ioffe was invited by the Department of Physics at Massachusetts Institute of Technology in Boston, to visit the US. Ioffe worked as a consultant in the electro-technical laboratory in Boston and received a lot of money. In the summer of 1928, he arranged for 20 young Soviet physicists to visit leading foreign research centres (Ioffe, 1962: 42). On the purpose of his trip to the US Ioffe (1962: 42) wrote: *[I was] familiarizing [myself] with scientific and technical laboratories and ways of introducing scientific and technical results.* Famous physicists Ehrenfest, Langevin and Dirac had repeatedly visited the USSR, meeting with Soviet scientists and working in the physics centres of Moscow, Leningrad and Kharkov.

International mobility in a closed state with strong centralization filled with outstanding scientists, unfortunately, could not be scaled-up, and trips abroad were rare. Oldenburg repeatedly raised the issue with the new government regarding the inadequacy of this situation. In particular, on June 17, 1929, he wrote from France: *in our absence from a large part of scientific books, overseas trips for Soviet scientists were the only way to keep up with science. Trips abroad should be given exclusive attention, because without them we will fall behind everyone. Therefore, what is needed is to send our graduates to universities abroad to get acquainted with the local execution of work and* *to develop qualified specialists. We could also invite several young foreigners to work with our outstanding specialists* (Bolshakov, 1974: 384).

At the same time, since the mid–1930s, foreign cooperation was limited. During the post-war years, international contacts were extremely limited. However, it should be born in mind that Soviet science cooperated with German experts who were exported from Germany in 1945. During Khrushchev's thaw, if someone was to be sent on a scientific mission to a capitalist country, it was usually the scientists themselves, or the heads of academic groups or institutions. This exchange of information was much more intense (intelligence work), yet did not coincide with the higher mobility of scientific personnel. In the USSR, scientific and educational cooperation was associated primarily with other socialist countries (East Germany, Poland, Czechoslovakia, etc.), in large universities, with students from 'friendly countries', such that for a few decades international mobility in Soviet science did not play a significant role.

4. Empirical study of Russian scientists' international mobility

This chapter presents some results from an empirical sociological study on the international mobility of Russian scientists funded by the programme of Fundamental Research of the RAS Presidium 'Traditions and innovations in culture and history'. The research was conducted by the Centre for Sociology of Science and Science Studies, St. Petersburg Branch of the S.I. Vavilov Institute for the History of Science and Technology, RAS in 2011–2013.

4.1. Research methodology and respondents profile

The main research topics of our study are listed below:

- General working conditions of researchers;
- Motives for international mobility;
- Major barriers in scientific fields;
- International mobility rates, destinations, periods and frequency;
- Forms and effects of international mobility;
- Main effects of international mobility.

In order to obtain reliable data about the problems considered above as a base for further analyses, as well as conclusions and recommendations for future actions, we conducted a sociological survey. A questionnaire was prepared, directed to a specified target group — respondents who had experienced international mobility, namely: for study or an internship; for a joint project/programme or an international conference, seminar or different scientific event; for a postdoctoral research programme; to deliver a lecture or engage in scientific work with an international organization.

In the study, both quantitative and qualitative approaches were used. The inquiry was based on purposive sampling and consisted of various open-ended questions, focused on selecting information-rich cases to yield insights and an in-depth understanding of the selected problems, rather than collecting empirical generalizations. With a purposive sample, the opinions of the target respondents could be gathered and examined. The purposive sampling technique was used such that the questionnaires were directed only to relevant respondents. The questionnaires were disseminated among researchers in paper form or else electronically. In total, 133 researchers responded to our survey, out of which only 53 respondents had experienced international mobility.

The statistical results show that the majority of the survey respondents (out of 53) were 22 to 30 years old (73 %), 20 % were within the range of 31–35 years old, while the remaining 7 % were above 35 years old. Regarding gender, 63 % were male and 37 % were female. The study indicates that most of the respondents (70 %) have a PhD degree. The share of PhD students taking part in the survey was 30 %. Regarding their scientific field, about 38 % of the respondents were in the area of the natural sciences, followed by researchers in the field 'engineering and technology' (23 %). Other fields (social sciences, medical sciences, humanities, etc.) were represented by 39 % of all respondents. About 60 % of the respondents were married and 40 % were not married, and 49 % had children.

The primary sociological data gathered were processed statistically obtaining percentage distributions, ratings, etc. For the purposes of the analyses, some additional research methods were applied: generalizing, classifying, data comparison, etc.

4.2. Results

Based on the characteristics of the institutional academic environment, we formulated the hypothesis:

- Young researchers intend to work abroad;
- The main motive for mobility is improving their standard of living;
- International mobility contributes to professional development (access to new equipment, development of new methods, etc.);
- International mobility promotes scientific visibility (growth in publication activity: joint international publications, citation index increases).

Our hypotheses rest on the classical *push/pull* theory. Typically, there is a combination of 'pull' and 'push' factors regarding the international mobility of researchers (Ciumaasu, 2010).

Considering the importance of the research environment for Russian researchers, several questions were posed concerning this field in the questionnaire. Thus, the respondents were asked to assess the problems of national science (Table 2).

Table 2. Which problems of domestic science you consider the most important?

Various Answers	Respondents	%
Level of pay for scientific work	50	94.3
Level of material-technical conditions for scientific activities	43	81.1
Quality of scientific research and development	41	77.4
Lack of use-value for domestic consumers	37	69.8
Prestige of scientific career in Russia	36	67.9
Professional level of scientific colleagues	30	56.6
Underdeveloped system of Russian research funding	27	50.9
Emigration outflow of scientific colleagues	26	49.1
Low publication activity of Russian scientists abroad	24	45.3
Insignificant participation of Russian scholars in international projects, conferences, etc.	21	39.6
Age structure of scientific personnel	20	37.7
Legislation in the field of intellectual property rights	15	28.3
Weak participation of PhDs and Doctors in training scientific personnel	11	20.8
Other	5	9.4

Total >100 %, because it was possible to answer several categories

In summary, Russian researchers are not satisfied with the conditions of funding and/or salaries (94.3 % of respondents). We found out about the low level of material-technical conditions for scientific activities (81.1 % of respondents). At the same time, 69.8 % of respondents noted that Russian business is not active in supporting science, that the quality of R&D is low (77.4 %), and that the prestige of scientific careers has declined in Russia (67.9 %).

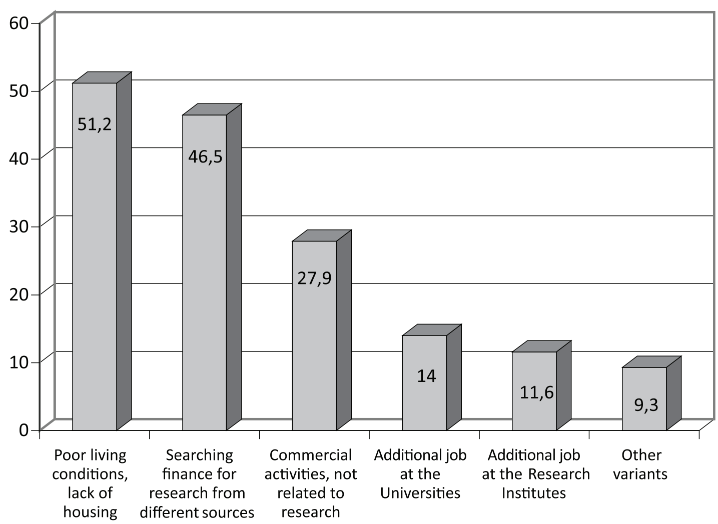
According to the poll's data, Russian youth goes into scientific fields, first of all, in response to their cognitive needs, to have intimate knowledge. At the same time, academic professions in Russia do not provide the assurance of financial stability. The study identified factors that are attractive for the academic profession: a creative team environment, an ability for self-realization, a convenient working schedule (Table 3).

Table 3. What does the most hold you in the position at the scientific institute?

Various answers	Respondents	%
Possibility of self-realization	28	58.3
Interesting creative environment	28	58.3
Convenient schedule	27	56.3
Prospect of creating a private research group	15	31.3
Possibility of career growth	14	29.2
Possibility of additional earnings	10	20.8
Difficulties in finding other jobs	9	18.8
Confidence that soon the situation in science (in my institute) will change for the better	8	16.7
Work prestige	7	14.6
Reluctance to change	6	12.5
Decent salary	5	10.4
Other	5	10.4
Trips abroad/internships	3	6.3
Nothing maintains me	1	2.1

The most distracting factors: the impossibility of leasing and purchasing a flat/house and searching for research funding (Figure 4).

Figure 4. What is it that most distracts you from scientific work?



Total >100 %, because it was possible to answer several categories

It is interesting to clarify the motives of Russian scholars for living abroad (Table 4).

Table 4. What preferences do you have for the country of your scientific career?

Various answers	Respondents	%
Work with contemporary (modern) equipment	18	72
Number of funds and grants that can be obtained	11	44
Transparency of academic career	10	40
Possibility of publishing in highly-ranked journals	10	40
Possibilities for career development	9	36
Possibilities of periodic changes in scientific organization, centre and quality of work circumstances	7	28
Academic freedom	4	16
Diversity of professional contacts	4	16
High standard and quality of life	4	16
Entry into world-class research	4	16
Possibilities for business and commerce	3	12
Other	1	4

Total >100 %, because it was possible to answer several categories

An interesting finding, confirming the suggestion made in the analytical framework section, is that a small number of the respondents paid significant attention to the higher standard of living abroad. Business or commercialization opportunities were not among the strongest motives for the international mobility of researchers.

It should also be noted that in the surveys of previous years, conducted by our Centre, the situation was the opposite. The key motive for international mobility was improving the standard of living. In more developed countries, the main motives for occupational mobility are the reputation of host organizations, future career development and better working conditions in host organizations.

A question was posed about the forms of international mobility used by respondents. The survey results reveal that the researchers participated in international conferences, seminars and other scientific events abroad (90 %), studying and fellowship programmes (30 %), publications in foreign journals (25 %), participation in joint projects and programmes (15), and working at a foreign scientific centre (10 %).

Table 5. What kinds of international cooperation have you participated in during the past five years?

Various answers	Respondents	%
Participation at international conference, seminar, or different scientific event	36	90.0
Travel abroad for study or internship	12	30.0
Publication in international work	10	25.0
Participation in joint project or program	6	15.0
Scientific work with international organization	4	10.0
Postdoctoral research program	2	5.0
Travel abroad to deliver a lecture	1	2.5
Other	1	2.5

Total >100 %, because it was possible to answer several categories

The study showed the most significant effects of international mobility (Table 6).

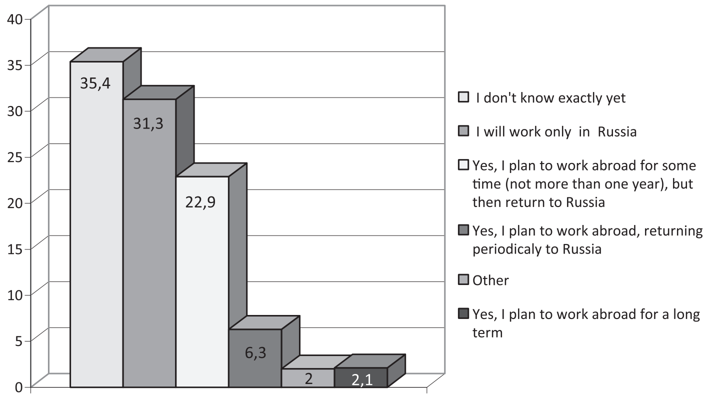
Table 6. How did the international cooperation increase your career possibilities?

Various answers	Respondents	%
Gaining experience and skills, professional qualifications	18	40.9
Acquiring and maintaining contacts with foreign scholars	16	36.4
Access to new scientific literature, information databases and archives	15	34.1
Joint publications	13	29.5
Access to contemporary (modern) scientific equipment	10	22.7
Boosting academic career	9	20.5
Publishing results of research in leading scientific works	7	15.9
Difficult to answer	6	13.6
Wage increase	5	11.4
Position promotion	3	6.8
No effect	3	6.8
Possibility to prepare/defend dissertation	2	4.5
Other	1	2.3

Total >100 %, because it was possible to answer several categories

The majority of respondents in our study would like to have the experience of working abroad in the future: short-term visits of up to two years were preferred by 63 % of respondents, and emigration by 2 %. However, a significant number of researchers expressed the desire to work exclusively in Russia (30.6 %) while 4.4 % did not know (Figure 5).

Figure 5. Do you consider the possibility of working abroad with the goal of a professional career in science and higher education?



These results suggest that not all of the hypotheses were confirmed. One of the main hypotheses, regarding the main motive for mobility being the search for higher living standards, was not justified despite the fact that the vast majority of respondents are concerned about the low wages and poor living conditions (a lack of housing, in particular) in Russia. As seen from the respondents' answers, the most important reasons were strictly related to professional activities, access to equipment and recent literature, etc. The survey results confirmed the first hypothesis. Many of the respondents pointed to a direct link between work or internships abroad and increasing publication activity; thus, the one of the hypothesis (about scientific visibility) was also empirically verified. In general, it is important to note that this study showed that the mobility of scientists is determined solely by cognitive factors arising from research activities.

The cognitive incentives of work are related to realizing one's own cognitive abilities and the conditions of academic work that would enable solving research problems: well-equipped laboratories, cohesive teams and access to the latest achievements. Russia has recently seen its government take an interest in science, which is supported through funding and new labs being founded in national research universities, as well as foundations that facilitate commercial development. However, these measures are obviously not enough to change the current situation. This leads to the idea that transmigration to world-class scientific centres could be a necessary episode in the intellectual biography of scholars aiming for higher scientific productivity. The new generation of Russian scientists perceives recognition in the global scientific community, along with 'network capital', as an important academic merit and as a means to help attract extra financial and other resources in solving research tasks.

In Soviet Russia, the functioning of science, the formation of the scientific community and the reproduction of scientific elites were inseparable from the important element of self-organization in the scientific community of 'scientific schools'. Scientific schools played a very significant role in Soviet science. Yet this idea has been devalued in the eyes of the new generation of scientists (including middle-aged, forty-year-old researchers). Their professional development declined in the 1990s with institutional instability and the intense outflow of highly-qualified specialists who represented some of the established scientific schools. In the circumstances, the 'personal characteristics' of a young scientist, including his or her ability and talent, not only for research work but also for management, became the dominant factor in reproducing the intellectual elite in Russia. Young scientists had to become accustomed to the new rules of the game: nowadays their professional viability depends not so much on government support as on the ability to obtain the means of implementing research and development with the help of additional sources.

At this point, Russian scientists' connections with the international scientific community — which were minimized during Soviet times — have acquired a new quality. We are speaking about programmes for the international mobility of scientists, research grants given by international foundations, internships, academic exchanges between different institutes, etc. For local researchers, these represent new ways of entering into international research networks which are actually transnational and open. It seems that today the international scientific network plays an important role in the process of scientific functioning and reproducing the scientific community; its significance is comparable to the role played by Russian research schools in the past.

Nowadays, mobility (both virtual, i.e., using information and communication technologies, and real) is a way of shaping a 'new generation' of scholars, who will constantly have to prove their worth to their colleagues, to experts when applying for grants, to managers and, ultimately, to a public that wants to know how tax money is being spent and what the practical benefits of research and development are. This is why modern scientists are public figures: they must be able to present themselves, to expound clearly on their achievements, to be actively involved in scientific networks and, of course, they should be mobile.

5. Mobility as a measure for boosting academic careers: the experience of China

It is clear that Russian researchers have an idealized perception of other national academic systems. However, there is no doubt that mobility is encouraged in the European, Chinese and American academic markets. From this point of view, the experience of other vigorously developing transition economy countries — especially China — seems interesting.

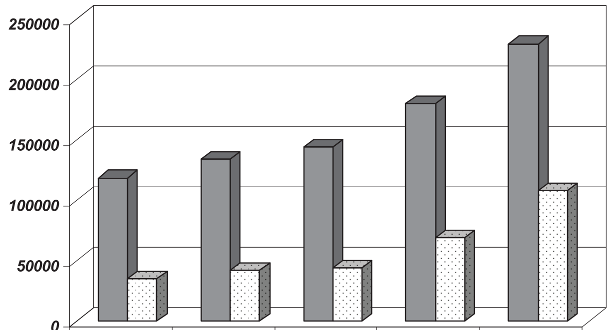
'The case of China' should be considered for two reasons: first, the Chinese science of the 1950s was created on the Soviet model and, secondly, after the Chinese Cultural Revolution, the scientific research organization has relied on mobility. Unlike in Russia, the Chinese government's science policy in the field of mobility was flexible and varied. The mobility of Chinese scholars and students is currently rather high: for example, according to 2009 data, since at least 2002 Chinese scientists have constituted a majority of doctoral students studying in Germany (2,019 people). With these numbers, China has left other countries (India — 1,037 people, and Russia — 789) far behind (DAAD, HIS, 2012). In 2009, 47 % of students, studying natural sciences and engineering in the US were from China and India (National Science Foundation, 2011).

According to the data of the National Bureau of Statistics of the Chinese Ministry of Science and Technology, the number of students and postgraduates studying abroad was 229,300 in 2009, and the number returning in the same year was 108,300. The flow of student migration is steadily increasing (Figure 6).

Science policy in China is designed to attract expatriates for research work in their motherland, which seems to be extremely effective. China does not begrudge money for science: its annual outlay for research work has increased by 18 % per year. There are many repatriates in Chinese research and education centres:[4] as a rule, they have undergone extensive training in the US, Germany and elsewhere. More than half the heads of Chinese research institutions have already worked abroad.

[4] The UNESCO Science Report (2010) has noted that despite the large amount of materials on migration it is almost impossible to make a systematic quantitative picture of long-term migration of highly-skilled specialists all over the world. The case of China is not so different. The number of repatriates in China is assessed very differently: it varies between 100 people (which seems to be incorrect and understated) and 200,000 people (which is probably an overestimation). It is well-known that 81 % of those who have studied and worked abroad have returned to the Chinese Academy of Sciences; it will be 54 % for the Chinese Academy of Engineering. In 2009, the Chinese government approved a programme aimed at attracting about 1,500 leading scientists to China over the course of five years who had achieved remarkable progress in various fields of science (Astvatsaturyan, 2009).

Figure 6. Number of Postgraduates and Students Studying Abroad



	2005	2006	2007	2008	2009
Number of Postgraduates and Students Studying Abroad	118515	134000	144000	179800	229300
Number of Returned Postgraduates and Students	34987	42000	44000	69300	108300

Source: Table 20–10. Number of Postgraduates and Students Studying Abroad // Chinese statistical yearbook on science and technology 2010 [Electronic resource] //National Bureau of Statistics of the Chinese Ministry of Science and Technology. China Statistics Press, 2010 URL: http://www.stats.gov.cn/tjsj/ndsj/2010/indexeh.htm

Two models for modernizing academic science in China have appeared: the Shanghai Institute of Life Sciences is an example of the first kind. It combines several academic institutions and research centres. One of these institutions is headed by Gang Pei, a young scientist who returned from the US. Favourable conditions are offered to scientists who decide to return to China. The 'guest' laboratories established on the grounds of mutually beneficial international cooperation can be considered an example of the second model. For example, the guest laboratory of the German Max Planck Society works as a part of the Chinese Institute of Cell Biology. The Chinese Academy of Sciences pays the salaries and overhead expenses of the scientists, while the Max Planck Society provides the laboratory with all the necessary scientific equipment.

On the basis of this model, a *100 Talents Programme* was developed, which seeks to invite the most productive expatriate scientists that have worked in the USA, Japan and Australia. These scientists have to organize research laboratories, to recover losses or to create new scientific schools for training young specialists. From 1998 to 2004, 778 specialists under the age of 45 went through this programme (Sterligov, 2008). It is important to note that this programme assumes the possibility of scientists maintaining their position in foreign scientific institutions. Repatriates' salaries are twice as much as the average salary of Australian scientists and almost equal to that of American scientists. In addition, significant extra fees are paid to stimulate the publication of articles in scientific journals or to elaborate lecture courses. Apropos the duration of contracts, foreign scientists (or expatriates) have been contracted for various periods of time, from two to three weeks to three to five years. In this respect, conditions of cooperation have been quite flexible.

Currently, China funds research and educational work not only at home but also abroad. The country partially pays the salaries of those foreign scientists who participate in Chinese projects (i.e., teaching Chinese students). From 2007, students studying abroad at the expense of the state are required, following their internship, to work at home for at least two years; only afterwards can they continue their studies as postgraduates, otherwise they would have to pay a considerable penalty. Such a restrictive measure seems rigorous but effective: the vast majority of students prefer to return home. It is obvious that the Chinese experience of work with expatriates should be considered in Russia.

In Russia, mobility programmes focused first on cooperating with expatriate scientists of Russian origin and training young specialists. In 2010, in accordance with the Government Decree 'Measures to Attract Leading Scientists to Russian Educational Institutions', the Ministry of Education and Science announced a competition for mega-grants which would support invitations for leading scientists living abroad to Russian educational institutions; scientists of all nationalities and countries of residence were eligible to apply. A visiting scholar should spend at least four months working in a Russian educational institution while having direct control over conducting research. Among the specialists who won the competition were representatives of the Russian diaspora: prominent scientists who have earned international recognition. These programmes still continue in 2013.

In projects under the guidance of scientist-colleagues, they have motivated the youth resulting in research results that are very quickly incorporated into training courses, extending the geography of scientific communications, including those online. The heads of scientific research emphasize the need to develop new areas of cooperation with the dominance of pedagogical components, whereby visiting scholars would take responsibility for lecturing, training and postgraduate students writing dissertations and monographs. In Moscow (March 4–15, 2011) under the direction of the Ministry of Education and Science of the Russian Federation, a conference was held *The Experience and Results of Research Conducted under* *the Guidance of Visiting Scientist-Colleagues*, where all aspects of international cooperation and academic mobility were discussed.[5]

It is noteworthy that the scientific potential and symbolic capital of universities and research centres has grown in Russia, and that this has had a positive effect on the training of young specialists — these laboratories have become important research platforms for young Russian scientists.

6. Conclusion

It is impossible to stop (i.e., to close the doors to) the flow of academic migration from developing countries into countries that are scientifically and technologically advanced. There are numerous bilateral and multilateral agreements between universities and laboratories encouraging the international mobility of scholars. Many developed countries are actively using various programmes to attract foreign students and scientists, and they provide subsidies for education and research. A number of non-English-speaking countries offer special programmes in English. Many programmes in Denmark, Finland, the Netherlands and Sweden are adapted in this way, to enable to attracting of foreign students, postgraduates and young researchers. More and more countries, such as the USA, Canada, Switzerland, France, Japan, Australia, New Zealand, Ireland, Germany, and so on, provide foreign graduates with jobs upon graduation and issue work visas after their student visas have expired.

Following the establishment of the RAS and the inviting of foreign academics to the Empire's capital, many decades passed before a generation of top Russian scientists was formed. The fact is that the free movement of scientists cannot easily be eliminated from Imperial science. Soviet science has often been called 'closed', but this is an over-simplification. The new state science policy of Soviet power in the 1920s and 1930s in the area of mobility was aimed at small groups of leading scientists. Travelling abroad, these scholars received financial support from the state and in return used their international experiences in the newly created research institutes in Russia. Such a public science policy in the absence of a civil society and free movement led to a definite result: new laboratories were opened that trained young researchers. The situation of social transformation in post-Soviet Russia created an enormous brain drain that depleted

[5] The transcript of the plenary session is available on the website of Russian Scientific Institute of Economy, Policy and Law (http://diaspora.riep.ru/stenogramma.php#stenogramma_001), April 18th, 2011.

entire laboratories. This often meant the termination of research in particular scientific topics or even the end of an entire scientific field.

In recent years, Russian government science policy has worked with the scientific diaspora and sought to intensify collaborative intellectual exchanges. International mobility plays an important role in boosting academic or scholarly careers. Participation in joint projects and international scientific events, the publication of research findings in prestigious journals, internships at famous scientific centres and the receipt of grants from foreign foundations lead to wider experience and higher status for young specialists, opening up new opportunities for them in their own country. International mobility integrated into scientific organization can facilitate the exchange of ideas, the development of networks with other researchers, supplement research careers, improve language competencies and increase scientific outputs.

International exchanges of researchers are based on such mechanisms as scholarships, internships and grants. These exchanges are particularly useful for young researchers carrying out experimental work elsewhere if relevant equipment (such as large research facilities) is unavailable at the home institution. Foreign work experience often has a positive correlation with publication output after returning and increasing the number of international co-publications (Jonkers, 2010). International mobility thus enhances the citation index ranking and helps scholars receive international grants and awards.

The article 'Are mobile researchers more productive and cited than non-mobile researchers? A large-scale study of Norwegian scientists', written by NIFU researchers (Aksnes et al., 2013) examines whether researchers who are mobile do better than non-mobile researchers in terms of publication rates and citation frequency.

The survey is based on more than 11,000 Norwegian university researchers. The results show that, internationally, mobile researchers have higher publication and citation levels than other, less mobile, researchers. The most significant outcomes of international mobility are the increase and diversification of research knowledge and experience, and the growth of scientific productivity indicators.

According to our sociological survey results, there are many challenges in the sphere of research policy and the practical arrangements concerning the careers and mobility of researchers in Russia. This requires dynamic efforts and efficient measures at all levels in order for a variety of problems to be resolved. A significant finding of the analysis was that researchers from Russia have a strong willingness and professional motivation to participate in international mobility programmes. The hypothesis, based on surveys from previous years, that the key motive for international mobility is improving the standard of living was not corroborated. The major motives for researchers in working abroad are working with modern equipment, attracting bigger funds — which they can receive — transparency in their academic career and the possibilities of publishing in highly ranked journals. The possibility of career growth is another substantial reason for international mobility. Moreover, most respondents acknowledge international mobility as an important factor for future career development in research. Another finding of our study is that short-term mobility programmes and schemes are preferable for respondents: most of them only have experience of such forms of international mobility.

We believe that, at present, international mobility is an important new tool that enables scholars to maintain their status in the scientific community and reproduce the scientific elite. Additionally, international mobility has become one of the most important means to integrate Russian science into the global scientific community. The participation of Russian scientists in the international division of labour allows us to solve a number of difficult problems within post-Soviet science, including the problem of a significant generational shift.

References

Arbesman, S. & Wray, K.B. (2013). Demographics and the fate of the young scientist. *Social Studies of Science,* 43 (2), 282–286.

Aksnes, D.W., Rorstad, K., Piro, F. & Sivertsen, G. (2013). Are mobile researchers more productive and cited than non-mobile researchers? A large-scale study of Norwegian scientists. *Research Evaluation.* 22 (4), 215–233.

Astvatsaturyan, M. (2009). Kitay ob"yavil o pyatiletnem plane privlecheniya v stranu bol'shogo chisla vydayushchikhsya uchenykh, rabotayushchikh za rubezhom. Resource document. Ekho Moskvy.

URL: http://echo.msk.ru/programs/granit/570158-echo/ Accessed 10 December 2012.

Bauman, Z. Tekuchaya modernost': vzglyad iz 2011 goda. Resource document. Polit.ru

URL: http://www.polit.ru/article/2011/05/06/bauman/ Accessed 10 December 2012.

Bourdieu, P. (1997). *Les usages sociaux de la science. Pour une sociologie clinique du champ scientifique.* Paris: INRA.

Bolshakov, K.G. (1974). *Organizatsiya Sovetskoy nauki v 1926–1932. Sbornik dokumentov.* Leningrad: Nauka.

DAAD, HIS (2012). *Wissenschaft weltoffen Daten und Fakten zur Internationalität von Studium und Forschung in Deutschland.* Bielefeld W. Bertelsmann Verlag GmbH & Co. KG. URL: http://www.wissenschaftweltoffen.de/publikation/wiwe_2012_mit_links.pdf. Accessed 10 December 2012.

Ma, J. et al., (Eds.) (2010). *China statistical yearbook*. National Bureau of Statistics of Ministry of Science and Technology of the People's Republic of China, Beijing: China Statistics Press.
URL: http://www.stats.gov.cn/tjsj/ndsj/2010/indexeh.htm Accessed 10 December 2012.

Ciumaasu, I. (2010). Turning brain drain into brain networking. *Science & Public Policy*, 37 (2), 135–146.

Ioffe, A.F. (1962). *Vstrechi s fizikami. Moi vospominaniya o zarubezhnykh fizikakh*. Moscow: Gosudarstvennoye izdatel'stvo fiziko-matematicheskoy literatury.

Frantsouz, Y. (2005). Akademicheskaya kar'yera v SSHA: pravila igry i motivy osushchestvleniya. *Teleskop*, 4, 39–44.
URL:http://www.teleskop-journal.spb.ru/files/dir_1/article_content-1205855713418823file.pdf Accessed 10 December 2012.

Georgiev, G. (2009). ´Vot varyag pridet. Molodim uchhenim trudno naiti mesto v rossiyskoy nauke. *Rossiyaskaya Gazeta* URL: http://www.rg.ru/2009/12/31/varyag.html Accessed 10 December 2012.

Jonkers, K. (2010). Scientific mobility and the internationalisation of social science: The case of China. *In ISSC/UNESCO World Social Science Report 2010*, Paris, UNESCO publishing.
URL: http://unesdoc.unesco.org/images/0018/001831/183180e.pdf Accessed 10 December 2012.

Kolchinsky, E.I. (2003). Nauka i emigrazia: sudbi, zifri i svershenia *Naukovedenie,* 3, 202-216.

Mindeli, L. (Ed.) (2012) *Science, Technology and Innovation in Russia: brief data book, 2007–2011* Moscow: ISS RAS.

NSF (National Science Foundation) (2010). *Science and engineering indicators* URL: http://www.nsf.gov/statistics/seind10/appendix.htm Accessed 10 December 2012.

NSF (National Science Foundation) (2011). *Foreign science and engineering students in the United States*. URL: http://www.nsf.gov/statistics/infbrief/nsf10324/?WT.mc_id=USNSF_179. Accessed 15 March 2011.

Ostrovitjanov, K.V. (Ed.), (1968). *Organizatsiya nauki v pervyye gody Sovetskoy vlasti (1917-1925). Sbornik dokumentov.* Leningrad: Nauka

Schütz, A. (1957). Equality and the meaning structure of the social world. In: L. Bryson, C.H. Faust & L. Filkenstein (Eds.). *Aspects of human equality* (pp. 33–78). New York, NY: Harper

Sterligov, I. (2008). Innovatsionnyye sistemy stran BRIK: Kitay Resource document. Ascotsiatsiya «SibAkademInnovatsiya» URL: http://www.sibai.ru/innovaczionnyie-sistemyi-stran-brik-kitaj.html. Accessed 10 December 2012.

Yurevich, A.V. (2010). Tenevaya nauka v sovremennoy Rossii. *Sociology of Science & Technology.* 1 (4), 154–170.

Yusupov, R.M. Manage the science — It means creating the conditions for its development. *Sociology of Science & Technology*, 3 (3), 128–139.

Career aspects of Slovenian researchers' collaboration practices

Blanka Groboljšek, Franc Mali, Anuška Ferligoj and
Luka Kronegger

The paper presents the characteristics and trends of scientific collaboration in Slovenia. We find the bibliometric analysis of scientific co-authorship to be one of the most useful approaches to the study of this phenomenon. We discuss the implications of scientific collaboration for professional career development. In the paper's theoretical part, general issues and strategies of scientific collaboration in connection with career paths are outlined. The focus then moves to global trends, featuring the growth of science collaboration and a micro-level analysis of the benefits of scientific collaboration. In the empirical part, the collaboration practices of selected groups of Slovenian researchers are presented by concentrating on bibliometric indicators as well as scientists' opinions of a selected group of Slovenian scientists. The analysis of the bibliographic data confirms differences in publication cultures among different scientific disciplines. Further, the analysis of the scientists' responses indicates the pragmatic nature of scientific collaboration, particularly in terms of better access to skills, techniques and equipment. Scientific collaboration appears to be one of the most important factors in increasing publication productivity, which is crucial to the development of scientific careers.

1. Introduction

In our contribution, the starting assumption is that scientific collaboration plays a crucial role in ensuring that individual researchers have successful professional careers, especially where more experienced researchers collaborate as mentors with junior scientists. Of course, various factors affect the professional career paths of individual researchers. Notwithstanding this, due to its various forms and the implications arising from entire collaborative processes, the role of scientific collaboration in modern science appears to be one of the key factors in increasing publication productivity, which is critical for developing scientific careers in the academic world. In recent decades, the characteristics of publication activities have been changing intensively. Single authorship of scientific publications is becoming less common. It seems that research collaboration has become practically the norm in all fields of scientific research. Accordingly, the growing number of co-authorship publications all around the world can be seen as an aspect of the strategies of individual scientists in creating more successful career paths. In these circumstances, scientific collaborations are, as Barry Bozeman and Elizabeth Corley put it, *about much more than just 'getting the work' out the door* (Bozeman & Corley, 2004: 601).

Recently, we have been able to observe and explore various dimensions and levels of scientific collaboration as well as the implications and structural changes within the scientific system that initiated the expansion of collaborative work practices. However, systematic and detailed studies of scientific collaboration as a key social phenomenon in modern science did not emerge before the 1960s. Since then, different research methods have been applied to investigate these phenomena, including bibliometrics, interviews, observations, controlled experiments, surveys, simulations, self-reflection, social network analysis and specific types of qualitative approaches (see Shrum et al., 1988; Shrum et al., 2007). Among various quantitative and qualitative approaches to understanding recent trends in scientific collaboration, one of the most useful approaches is the bibliometric analysis of scientific co-authorship.[1] This approach has several advantages, such as: (1) the data on co-authorship can be easily and accurately extracted from publication databases (Pike, 2010: 431); (2) co-authorship data are generally considered one of the most *tangible and formal ways of analysing collaboration* and, consequently, also as *the most frequently used information* when exploring collaboration patterns among researchers (De Stefano et al., 2011: 1092); and (3) co-authorship as part of scientific publication plays a crucial role in the development of science in general as well as in *the reward structure for academics in particular* (Acedo et al., 2006: 958). Despite these advantages, among which is also the public availability of bibliometric data as well as their international comparability, this approach has certain drawbacks. For example, research collaboration does not necessarily lead to co-authored scientific publication and a co-authored paper is not always a result of mutual collaboration (Wong in Singh, 2013). A similar assertion was made by Laudel (2002: 3) arguing that *co-authorships do not depict all collaborative relations but only certain fractions*. Nevertheless, co-authorship analysis is still the most useful and efficient way of measuring collaboration and it is recommended largely because it is the most reliable way of observing collaborative practice (Jeong et al., 2011: 970).

[1] In contemporary research, data on co-authorship are often presented and analysed in the form of co-authorship networks consisting of researchers and the relationships among them, which are defined by common authorship of a single scientific publication.

In this chapter, our main objective is, first, to offer more general critical comments on the enhanced role of scientific collaboration in scientific career paths and, second, to identify some characteristics of scientific collaboration in Slovenia. Concerning the case of Slovenia, we use two levels of analysis: (1) a bibliometric analysis of recent trends of co-authorship publications in Slovenia; and (2) a qualitative insight into the contextual factors (including Slovenian researchers' motivations to engage in collaboration because of their career track) which are relevant to scientific collaboration at large. The qualitative insights are based on semi-structured interviews of a selected group of scientists in Slovenia. With such opinions of scientists about the gains or losses of their scientific co-operation as well as their incentives and barriers to scientific co-operation, it is possible to reconstruct their general strategies concerning their professional careers in the context of modern collectivized science. Our main research question is, therefore, concerned with the career aspects of scientific collaboration as well as with identifying collaboration practices within a specific national context. Answering the questions of how to explain the differences in collaborative work among disciplines and which are the key factors affecting collaborative practices in Slovenian context should enable us to also shed some light into the career implications of scientific collaboration.

The chapter is organized as follows: in Section 2, we present some general issues of the dynamics and strategies of scientific collaboration through co-authorship publications in connection with the professional career paths of both senior and junior scientists. In Section 3, the focus shifts from the macro to the micro level. Some advantages and disadvantages of scientific collaboration are outlined. In Section 4, the collaboration practices of selected groups of Slovenian researchers are presented by focusing on bibliometric indicators as well as scientists' opinions gained via semi-structured interviews of a randomly selected group of Slovenian scientists. Section 5 outlines a few general conclusions based on our empirical investigation.

2. The importance of scientific collaboration to ensure more successful professional careers for scientists

The traditional model of an academic scientific career usually presented as a linear, standardized and mobile professional path of individual researchers is no longer in line with recent scientific practice. Even in the middle of the second half of the 20th century it was still possible to think about the professional career of a scientist as being quite a secure, well-respected position where an individual researcher explores the objective world and honestly pursues the truth. However, with the start of the 21st century, a kind of *patchwork [of] scientific careers* (Felt, 2009: 179) can be seen, reflecting those types of researchers' professional career paths that are disrupted, broken, fragmented or even dispersed across different institutions and roles. The various theoretical and empirical findings in the fields of the sociology of science and the sociology of professions suggest that in recent times various factors are hindering the development of the traditionally linear professional career paths of researchers, such as a very competitive job market in the area of academic science, constraints in the funding of science, the scientific profession's lost reputation in society, frequent institutional/organizational restructuring of R&D systems and the introduction of 'new public management' in the academic science sector,[2] etc. The steady state conditions of modern science are leading to greater variety but less security of employment among academics (Ziman, 1994: 11). Individual career trajectories or paths in modern science are often playing out in very specific contextual circumstances. They are less demarcated and riskier (see, for example: Delamont et al., 2004; Campbell, 2003). An individual researcher's stable planning of their professional career over the whole course of life is no longer possible. The destabilization of secure scientific careers has many negative consequences. Yet it is also true that scientific research activity as a closed professional path with poor promotion prospects is not always accepted by young and talented people. Namely, science has always been an intensively competitive job. Researchers have always competed with each other, often quite openly, for academic positions and public reputation. The core assumption of all (traditional) sociological studies in the scientific community is that the reward system in science, which confers recognition on the most excellent and productive scientists, is based on the principle of competition. For example, the exchange-recognition model of the scientific community elaborated by classical sociologists of science, such as W. Hagstrom (1965), N. Storer (1966), R. Merton (1973) and R. Whitley (1984), is built on the thesis that there is fierce competition among researchers for esteem (symbolic capital) inside and outside the scientific community.

The professional careers of individual scientists depend on many factors, such as disciplinarity, the organization of national R&D human resource policies, R&D evaluation systems, etc. Actual practices and the related expectations concerning professional careers vary across specific disciplinary contexts. As

[2] In the last 15 years, the governance of academic life in many European countries has substantially changed in the direction of new structures associated with the catch phrase 'new public management' (for more, see Enders and De Weert, 2009).

found in some studies, career structures — especially in their early stages — are more demarcated and less ambiguous in hard sciences than in soft sciences (Felt, 2009). Some analyses also argue that women are positioned in particularly problematic ways by the creation and reproduction of a stable science career (Prpić et al., 2009). The smallness of a scientific community can also play a role. It is often expected that researchers from small countries care more intensively about international mobility (Mali, 2010). Last, but not least, there are also differences with regard to national R&D human resource policies. Some (national) R&D human resource policies are more inclined to a system of early recruitment to secure lifelong employment (in these cases, the tradition of academic tenure is practically institutionally entrenched in the functioning of the scientific community), while other (national) R&D human resource policies are more inclined to increase competition among personnel for research work throughout the entire professional career. In the last case, an academic career based on secure lifelong employment and academic tenure is seen as a major barrier to managerial initiative and personal upward mobility.

Scientists competing for reputation at their academic institution and in the scientific community use various strategies to improve their positions. When these are not successful, their career paths are aggravated or even disrupted. Recently, the professional careers of academic researchers have mainly depended on their ability to publish and their ability to establish and maintain strong epistemic and interpersonal connections with their professional colleagues. Creating a good network of open publication possibilities is becoming an important part of researchers' career planning already in the earlier stages of their working lives (Matelič et al., 2007; Yoshikane et al., 2009). As a result it, is also very important for young researchers to establish research collaborations and networking opportunities. The results of some empirical analyses indicate that over 60 % of postdocs have managed to establish collaboration and hence it is more likely for them to have a higher level of research output than those without such collaboration (for more, see Scaffidi & Berman, 2011: 692). As indicated by various empirical studies, when researchers early on in their career co-author publications with their mentors, this might also help them form networks with academic colleagues and contribute to their academic institution's research outputs and provide themselves with professional development opportunities (for more, see Zutshi et al., 2012; Andrade et al., 2009; Lee & Bozeman, 2005). As stated by Rijnsoever and Hessels (2011: 464) *conducting the right type of research and engaging in the right type of collaboration with mentor contribute this success*.

For the early-career path of a scientist it is crucial to collaborate with highly productive scholars since this may improve their personal productivity (Bankart, 2011: 34). Dean Keith Simonton (1997) and Harriet Zuckerman (1967) found that eminent scientists tended to have mentors who were themselves eminent scientists. Nobel laureate economist Paul Samuelson summarized his view on the importance of mentors in the creative development of young researchers in the following way: *I can tell you how to get a Nobel Prize… to have great teachers* (Samuelson, 1972: 155).

A more detailed and systematic qualitative and quantitative analysis of the benefits of collaborative work will be presented in the next section. But before that, and so as not to refer too much to evidence based on anecdotal descriptions of the importance of scientific collaboration for academic scientists' professional careers, let us briefly overview the increased trends of scientific collaboration in recent science supported by statistical data.

The latest trends especially indicate the growth of scientific collaboration through co-authored publications. Bibliometric analyses highlight two types of processes: first, growth in the number of co-authored papers and, second, growth in the number of authors within collaborative papers.[3] This does not mean that scientific co-authorships have always been a priority of scientific activity. For example, during the first half of the 20th century, scientific research was generally carried out by individual scientists; consequently, papers written by more than one author were relatively rare (Acedo et al., 2006: 957).[4] The results obtained through different research perspectives also suggest that collaboration has, since the beginning of modern science, been more common in the natural sciences and less so in the social sciences. A continuous rise in the number of co-authored papers in practically all scientific disciplines as well as across different countries has primarily been seen in the last three decades. These trends are revealed in the findings of many bibliometric studies. For example, based on an analysis of all research

[3] The data showing an increased average number of collaborators per paper might indicate that researchers are more interested in working with other people; however, and in contrast, it might also mean that researchers have to address and solve scientific problems that require the combined efforts of multiple scientists (Uddin et al., 2012: 694–695). Using the number of co-authors as a measure of collaboration has particular advantages since this measure is: (a) invariant; (b) easily and inexpensively ascertainable; (c) quantifiable; and (d) non-reactive (i.e., the process of ascertaining collaboration does not affect the process of collaboration itself) (Katz & Martin, 1997: 3).

[4] Although from the beginning of modern sciences in the 18th century scientific research in physics and chemistry was the result of the collective work of various people with different knowledge and skills, at the end the research work was not necessarily considered to be the result of all the collaborators. The authorship of articles (although a result of collective work) belonged to those scientists who took overall responsibility for the published results (see Wray, 2002).

articles indexed in 1980, 1990 and 2000 in the Science Citation Index, Glänzel and Schubert (2004) established that the proportion of single-authored papers in all research fields had continuously decreased. While in 1980 still around one-quarter of all papers (24.8 %) had one single author, this share dropped to roughly 15 % 10 years later and reached the level of 10 % in 2000.

When studying collaborative practices within particular disciplines, research based on data from Web of Science and conducted by Wray (2002: 152) has indicated that 62 % of articles published in 1998 in leading journals in physics were co-authored. In a sample of 365 articles drawn from articles published in 1998 in the most important journals in genetics, 82 % of the articles were multi-authored. Wray suggests that collaborative research not only persists but is becoming more popular in both the natural and social sciences. To support this idea, he presented the results of the analysis by Zuckerman and Merton (in Wray, 2002: 159) indicating that whereas only 25 % of papers published between 1900 and 1909 in the natural sciences were multi-authored, the share had risen to 83 % in the 1950s. A similar trend was found in the social sciences, although collaborative research is still less common there than in the natural sciences. Whereas only 6 % of papers published in the social sciences in the 1920s were multi-authored, the share went up to 32 % in the 1950s (Wray, 2002: 159). As mentioned earlier, these differences should be seen in perspective. A more recent survey of global scientific collaboration made by a group of scientists of the Royal Society (RS, 2011) revealed that over 35 % of articles published in international journals in 2008 were internationally collaborative, up from 25 % in 1995. Global scientific collaboration again emerges to different degrees in various scientific disciplines (De Stefano et al., 2011: 1092). For example, researchers in the natural sciences are more likely to work in large laboratory settings that yield team-based research outputs, while in the social sciences this is not a common practice because these disciplines are normally characterized by the less intensive use of quantitative methods and researchers therefore work more independently.

Collaboration among scientists and researchers is highly promoted by EU science policy as well. Since the establishment of the EU Framework Programmes (FPs), which have become an essential part of the European research funding structure, intra-European collaboration has grown considerably (RS, 2011: 66). For example, between 2007 and 2013, EUR 53.2 billion was to be spent on schemes and sub-programmes to increase the EU's competitiveness and encourage collaboration among European Member States (RS, 2011: 66).

Various explanations of the recent growth of scientific collaboration and the increasing number of co-authored publications can be found in the sociological and bibliometric literature. To mention only a few of them. Some explanations address the problem of specialization in modern science (Leahey & Reikowsky, 2008; O'Brien, 2008). Issues involving funding in modern R&D are also frequently appearing in such explanations. As Ponomariov and Boardman (2010: 618) pointed out, *the more resources and collaborators a researcher has, the more productive will that researcher become* in terms of an increased quantity of publication as well as in the number of co-authors. *In this way, establishing a research network is a prerequisite for securing research funding primarily with the aim of enhancing the research potential of the participants — researchers, self-organized into a collaborative network — through the benefits of collaboration* (Defazio et al., 2007: 293). Finally, we have to reiterate the previously mentioned factor of increased competition in modern science. Scientists compete for jobs as well for reputation (O'Brien, 2008: 10). There is growing demand to produce more scientific publications issued in the best scientific journals as such activity is required to apply for projects or certain academic positions.

3. Some advantages and disadvantages of scientific collaboration

The literature provides a very long list of possible factors contributing to scientific collaboration. The list itself is almost endless. The different analyses have generally used four sets of factors to explain the increase in scientific collaboration: economic, cognitive, political and socio-psychological (e.g., Shrum et al., 2007; Katz & Martin, 1997; Beaver & Rosen, 1978; Beaver, 2001; Glänzel & Schubert, 2004). The relative importance of these factors varies depending on the theoretical perspective of the authors who are analysing the scientific collaboration and their level of analysis.

The success of various types of scientific collaboration depends on both micro (personal) and macro (institutional) factors. Macro factors refer to economic, political and other conditions of scientific research. For example, national science policy measures can ensure the conditions for an optimal collaboration structure. Yet these measures can also hinder this trend, according to the interviewed scientists when referring to the situation in Slovenia, which will be presented in the next section. Scientific collaboration is also driven by a variety of micro factors. Micro (personal) factors represent a crucial basis for scientific collaboration. The expectations of individual scientists concerning direct or indirect benefits motivate them to collaborate. As noted in Section 1, all direct or indirect benefits strongly determine individual scientists' career paths. In this respect, the primary drivers of collaboration are scientists themselves (RS, 2011: 6).

Barry Bozeman and Elisabeth Corely (2004) listed the following expectations of scientists regarding collaboration: access to expertise, access to unavailable equipment, the encouragement of multi-disciplinary growth, the improvement of the capability to obtain funds, prestige or visibility achievement, and tacit knowledge acquisition. Wray (2002, 2006) suggested there are five important aspects for scientists in conducting collaborative research. According to him, scientists' collaboration is perceived as: (1) an important driver of higher quality research; (2) involving the types of inquiries that would otherwise not be feasible; (3) a factor that ensures that findings are less likely to be forgotten; (4) a factor that boosts publication productivity; and (5) a factor for training young scientists. Diane Sonnenwald (2007) stated that a similar approach to science, similar working styles, mutual respect, trust and an ability to get along and enjoy each other's company all play a role in scientists' decisions to engage in co-operation in public activity.

Scientists regard scientific co-operation in the form of co-authorship as valuable because it contributes to their prestige and visibility in the international scientific community. Publications with many authors tend to be relatively well-cited at the international level, so the scientists involved in co-authored publications expect to have stronger citation records than those who do not (e.g., Chinchilla-Rodriguez et al., 2010; Haslam & Laham, 2009; Sonnenwald, 2007, Wuchty et al., 2007; Persson et al., 2004; Hoekman et al., 2010). However, some scholars argue that, besides the motives connected with scientific prestige and visibility, other factors may affect decisions regarding scientific collaboration, such as the way in which the field is organized, researchers' affiliations etc. (Rubi-Barcelo, 2012: 466). Scientists are usually highly motivated to work with *the most outstanding scientists* in their field or in other fields in order to *access complementary skills and knowledge* and to stimulate new ideas (RS, 2011: 57) brought about by increasing the number of collaborators in networks, especially if this collaboration lasts for a longer time period (Defazio et al., 2007: 295).

Scientific collaboration might also involve some disadvantages and negative aspects. For example, a fundamental tension exists between the motives of national governments and the choices of individual researchers. In particular, national governments often fund scientific research to boost national prestige, stimulate economic growth and gain a competitive advantage over other nations. In contrast, *academic researchers rarely have nationalist motivations for their work*; instead, they often collaborate *to access funds, resources and data, and to ally with the most talented researchers* (RS, 2011: 46).

The phenomenon of hyper-authorship in modern science is also a kind of a mixed blessing. On the one hand, collaboration can be invaluable where the scale or scope of research is too large for a single nation, even if that nation is scientifically advanced. Scientific collaboration in big research projects at the transnational level is fostered because it is often believed that sharing knowledge among a large number of researchers at the international level brings a significant increase in research effectiveness, *just as specialization generally obtains increases in productive efficiency* (Abramo et al., 2009: 156). Big international projects, such as the Large Hadron Collider[5] and the Human Genome Project, are just two such examples. On the other hand, the radical changes in the production of knowledge in these big international projects lead to the total subversion of the traditional conception of scientific authorship. Because of the mass of research subgroups participating in a publication, issues arise as to who is responsible for the integrity of the research results, how to organize the evaluation of individual contributions to the common research result in the form of a new publication, how to organize the final publication of the research results, etc. One consequence is that scientists working in such large collaborative structures worry whether they will be adequately rewarded for their contributions to the project (see Biagioli, 1999: 274; Cronin, 2001: 561; Braun-Munzinger, 2008).

There are also some concerns among scientists working on big scientific projects that collaboration is sometimes used to *hide unethical conduct* (Sonnenwald, 2007). For example, the underlying aim of collaboration between advanced and developing countries may be to conduct unethical clinical trials, experiments or investigations involving natural resources that are prohibited in advanced countries (Sonnenwald, 2007). In other cases, scientists may collaborate with others as part of intellectual espionage. Wray (2002) discussed some additional concerns regarding the diffusion of responsibility when engaging in collaborative research. When scientists work collaboratively, it is more difficult to hold them accountable when problems arise. This diffusion of responsibility as well as credit for work has the potential to negatively impact science in the sense that scientists themselves are less sure of their contributions and entitlements in collaborative projects (Wray, 2002: 165). In addition, when discussing co-authorship, some open issues arise regarding the order of authorship, authorship with students and graduate as-

[5] The case of the Large Hadron Collider (LHC) programme at CERN, which began in 2008, includes large experimental projects such as ATLAS, with a few thousand collaborators. This large-scale collaboration clearly demonstrates the extent of the involvement of a multitude of actors when addressing certain research problems. However, there are only a few such examples (RS, 2011: 47).

sistants, 'ghost authorship', 'guest authorship' or 'honorary authorship' that raise concerns about the inclusion of authors that might have had a minimal or else made no real contribution to the paper (Zutshi et al., 2012: 34). These issues most certainly cast some negative light on collaborative processes.

It is interesting that Internet-related technologies are also presented as a double-edged sword. On the one hand, international collaboration has become much easier with the rapid development of Internet-related technologies. Whether through email, the Internet, data-sharing tools or mobile phones, these communications developments reduce the dependence on physical locations (see RS, 2011: 65; Walsh & Maloney, 2007). One consequence is that these factors motivate co-operation even in 'less expensive' scientific disciplines, such as pure mathematics and theoretical research in the social sciences (Glänzel & Schubert, 2004; RS, 2011).

On the other hand, scientific collaboration is primarily considered to be a very personal activity when scientists meet face-to-face. This aspect is particularly important for building trust, learning physical skills and sharing tacit knowledge (Choi, 2012: 28). In some views, the use of new Internet-related technologies could diminish the advantages of face-to-face communication in science. Emailing can become less effective when time-consuming written communication is involved. Further, when comparing face-to-face or even phone communication with email communication, the latter includes more possibilities for producing misunderstandings and extreme reactions, and even entail greater problems of information security (for example, most email transmissions are not secure) (Walsh & Maloney, 2007). Nevertheless, advances in Internet-related technologies and transportation technologies that have made remote collaborations easier to sustain (Walsh & Maloney, 2007; RS, 2011) have had a significant impact by changing communication patterns and increasing scientists' mobility. In the globalized world, these technologies have mostly been accepted by researchers as a positive factor for establishing new and intensive forms of scientific collaboration.

Yet there are some warnings about the possible negative effects of junior researchers' scientific collaborations on their later careers. One problem might be that a junior scientist's contribution to research conducted with a well-known senior scientist may be undervalued. Another problem occurs if junior scientists accept too many offers to collaborate. In such cases, the research may become fragmented and it may become difficult for them to develop their own research programmes (Sonnenwald, 2007).

Notwithstanding this, if we balance the advantages and disadvantages of scientific collaboration, there is no doubt that the advantages outweigh all possible negative effects. Modern academic life depends on networking and different aspects of scientific collaboration: keeping up with the research field, judging the merits of others' work and one's own, discovering the status of journals, looking for externals, finding publication outlets, hearing about conferences, jobs and gossip etc. These are all vital elements for scientists in establishing good professional careers.

4. The case of Slovenia

Slovenia is a small country with two million inhabitants and a relatively small sized scientific community. Nevertheless, as argued by some other studies, Slovenia represents a good subject for a case study on small countries (Pečlin et al., 2012: 946). In addition, the connection of two databases containing the data of all publications available in Slovenian libraries (the Co-operative Online Bibliographic System and Services — COBISS) and information on all active researchers registered at the Slovenian Research Agency (Current Research Information system SICRIS) gave as a unique opportunity to analyse the complete personal bibliographies of researchers as well as information on education, positions and employment of researchers, research groups and the institutions. This type of data with complete bibliographic data enables us to produce the most content-rich co-authorship analysis. Moreover, the issue of collaboration networks in Slovene science is also interesting from the science policy point of view, since two basic projects have already been funded to explore this topic and provide the basis for long-term R&D policymaking in Slovenia.

Despite the small size of Slovenia's scientific community,[6] it is evident that the country is following the global trend of increasing scientific collaboration. One study on collaboration within the Slovenian scientific community reveals an exponential increase in the average number of collaborators and the near-exponential growth of the network size over time (Perc, 2010: 481). Nevertheless, the dynamics of scientific collaboration and the structure of the Slovenian science system correlate with the current science evaluation system, which is currently strongly focused on encouraging scientific excellence (in terms of the quality of scientific publications) as well as international collaboration. From this perspective, this system does not work well for early-career scientists who

[6] According to the list of all employed researchers published by the National Research Agency, in March 2013 Slovenia had 14,310 active researchers (SICRIS, 2013).

face a lack of opportunities to acquire research projects after finishing their doctoral degree,[7] since at that stage most of them have not yet succeeded in having a sufficient number of publications in journals with a high impact factor.[8] Without the support of their mentors or senior colleagues, it is almost impossible for young researchers to start an academic career.[9]

In the present chapter, the dynamics of scientific collaboration are analysed on the basis of all relevant scientific publications issued over a 25-year period from 1986 to 2010. Relevant scientific contributions are defined by the Slovenian Research Agency and include original, short or review articles, published scientific conference contributions, monographs or parts of monographs, scientific or documentary films, sounds or video recordings, complete scientific databases, corpuses and patents. During this 25-year period, the Slovenian science system underwent significant changes. First, when the country attained its independence in 1991 the Slovenian science system started to adopt and implement its own science policies and, second, the new country started a process of integrating into the scientific environment of the EU (Kronegger et al., 2011). These circumstances have contributed significantly to changes in the scientific collaboration culture in Slovenia. As shown in Figure 1, these changes are clearly indicated by a break in the trend in the absolute number of published single-authored and co-authored publications.[10] The linear growth in the number of co-authored publications and the low but stable number of single-authored publications started in the early 1990s.

However, the aim of this chapter is to focus on the co-authorship networks of Slovenian scientists in four research disciplines: physics, biotechnology, mathematics and sociology. As explained in our previous publications where the collaboration patterns within these four disciplines are presented

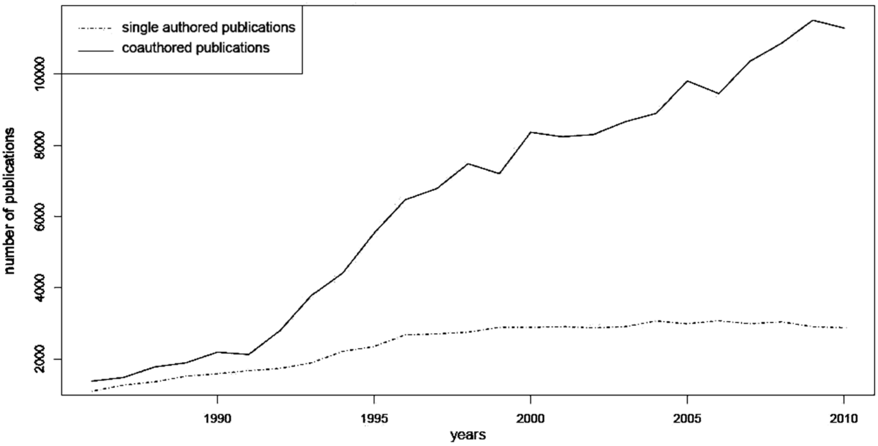
[7] As already noted in Section 1, although Slovenia has an excellent programme for training young researchers, they are mostly in a very insecure situation when they finish their programme and receive their PhD degree. This means that although the Slovenian science system provides sufficient staff recruitment, its main drawback at the moment is a lack of support for young researchers during the postdoctoral period.

[8] The current science evaluation system, which represents the basis for a research career when applying for research projects, strongly encourages scientific publication in journals with a high impact factor as a quality measure. The number of articles published in journals with an impact factor plays a crucial role in the evaluation process of R&D and research funding by the Slovenian Research Agency.

[9] The career system in Slovenia follows the academic ranking. Before finishing a PhD, a researcher can be an assistant. After a PhD, one can apply for the rank of assistant with a doctorate, followed by the rank of a research associate (or assistant professor), senior research associate (or associate professor) and, ultimately, senior research scientist (or full professor).

[10] The figure presents the dynamics of the absolute number of single-authored and co-authored publications of 17,520 Slovenian researchers active during the period 1986–2010 in all scientific disciplines. In total, there are 60,232 single-authored publications, while the number of co-authored publications is much higher (totalling 161,094).

Figure 1. The dynamics of single-authored and co-authored publications



in detail (Kronegger et al., 2011; Kronegger et al., 2012), their disciplinary cultures vary significantly:

- Physics is an old, well-established discipline; scientific processes are normally organized within research teams and laboratories;
- Biotechnology has a similar organization of work (with research teams and laboratories), but it is a young discipline still in the phase of being established;
- Mathematics is an old discipline and a so-called 'office discipline', where collaboration involves solving globally abstract scientific problems; and
- Sociology can also be considered an 'office discipline', but it is more focused on collaboration in small groups dealing with specific issues.

4.1. Methods

The basis of our empirical study is the data on complete bibliographies of all registered researchers at the Slovenian Research Agency active within the selected four scientific disciplines. The data were obtained from two reliable sources: the first is the Current Research Information System (SICRIS), which includes information about all active researchers registered with the Slovenian Research Agency, and the second is the Co-operative Online Bibliographic System and Services (COBISS), which contains data on all publications available in Slovenian libraries. These data sources represent the main official tools in evaluating scientific excellence for the distribution of funds. Combining the data from these two systems creates a unique database of complete personal bibliographies of all researchers registered in Slovenia. Following the example of previous studies dealing with bibliographical data (e.g., Newman, 2001; Perc, 2010), the collaboration between researchers was operationalized by the co-authorship of publications. First, some important general characteristics of the four scientific community networks presented in Table 1 have to be considered.

Table 1 is based on all relevant scientific publications (they are detailed at the beginning of this section) by researchers who, in the Slovenian Research Agency's database, belong to each of the selected disciplines.

Table 1. Some general network properties by scientific disciplines

	Physics	Mathematics	Biotechnology	Sociology
Number of active authors (1986–2010)	496	280	216	223
Bibliographic units per author	14.1	12.9	6.5	16.9
Single authorship (%)	15	46	9	46
Co-authorship within the discipline (%)	35	27	46	32
Co-authorship within the Slovenian Research Agency (%)	8	6	27	12
Co-authorship outside the Slovenian Research Agency (%)	42	21	18	10

The age of Slovenian researchers in general is normally distributed with a slight negative skewness (a higher number of younger researchers). There are greater differences in the gender structure according to scientific disciplines. Physics and mathematics are male-dominated disciplines, with more than three-quarters of researchers being male; in biotechnology, the structure is diametrically opposite with 74% female researchers, while in sociology the gender structure is equally distributed with a slightly higher proportion of women (54%).

The qualitative data were collected by semi-structured interviews conducted in November and December 2011 with 15 scientists[11] (nine biotechnologists and six physicists) engaged in research work within Slovenian pub-

[11] Altogether, 20 randomly selected scientists were invited to collaborate in our research. Written invitations sent to their work addresses were followed by 15 confirmations received by email or phone. The high response rate can be attributed to the fact that the respondents were also asked to respond to some questions on other topics (for example, regarding their popularisation activities, relations with the media, etc., needed for the purposes of another research study).

lic research institutions.[12] Altogether, 10 male and five female interviewees[13] answered our questions on the main advantages and disadvantages concerning the nature of collaborative work they might have experienced during their research careers. A semi-structured format was used to guide the interviews and ensure consistent coverage across participants. Key questions focused on the respondents' views on the differences between collaborative practices in the past and those that prevail today, as well as their opinions on systemic mechanisms aimed at promoting collaboration among researchers. It should be pointed out that our interest was — based on already gathered research data and outcomes — to gain a deeper understanding of these practices and to identify factors that, in their view, promote or inhibit scientific co-operation. The interviewees' discussions on scientific collaboration lasted 10 to 15 minutes each. Following the standard recommendations for the analysis of qualitative data (Mesec, 1998), the interviews were recorded and later transcribed to allow the key issues to be more easily identified. In the next phase of the analysis, the written material was summarized and labelled by the most illustrative statements.

4.2. Results

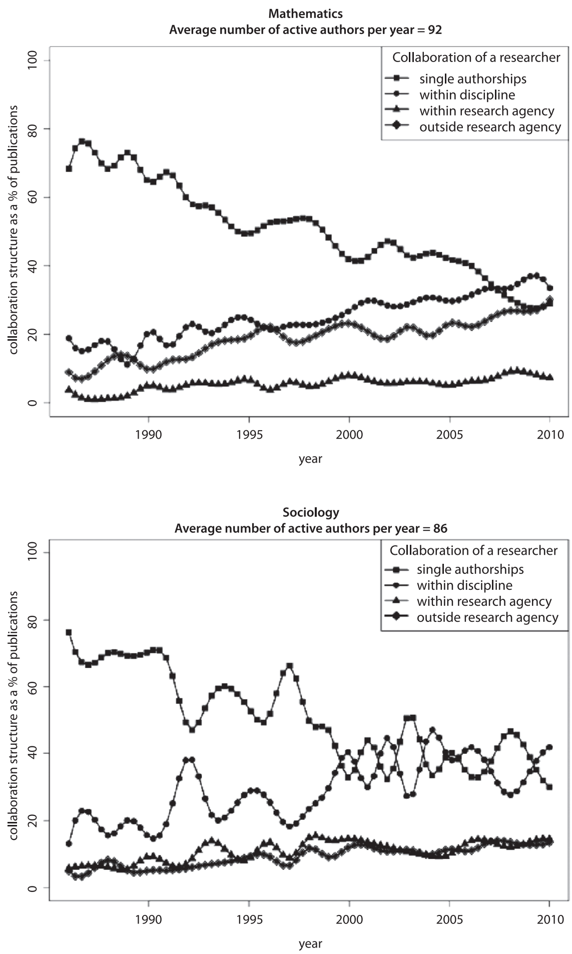
The changes over time of the collaboration structures within physics, mathematics, biotechnology and sociology are presented in Figures 2 and 3, and indicate some vital differences in disciplinary publications and collaboration cultures. For example, the proportion of single-authored publications within sociology and mathematics is relatively high; physicists recorded a very high level of collaboration within their discipline and with authors from abroad; and biotechnologists chiefly collaborate with researchers from other disciplines within the country. Although mathematicians and sociologists share similar characteristics, one of the biggest differences between them is

[12] From a methodological point of view, the group of 15 scientists included in our study seems rather small. However, some other studies on scientific collaboration that have also combined the analysis of co-authorship data and interviews have not included a significantly larger number of interviewees despite contributing significantly to the debate on scientific collaboration. For example, Melin (2000) conducted nine interviews, Beaver (2001) seven interviews, Hara et al. (2003) 14 interviews and Heidler et al. (2011) 17 interviews.

[13] The interviewed researchers belong to all three age groups (seven interviewees can be ascribed to the younger generation, five to the middle generation and three to the older generation) and, consequently, hold different academic and/or research positions: most are (full or associate) professors, while the younger ones hold an assistant professor position or are solely researchers. Either way, except for two young interviewees, most respondents pursued research as well as pedagogical work to different degrees.

that mathematicians write more publications with researchers from other countries than do sociologists. However, a dramatic drop is seen in the proportion of single-authored publications within both disciplines throughout the 25-year period. For mathematics, the share of single-authored papers fell from slightly above 60 % to below 30 % (Figure 2). In sociology, this figure was slightly below 80 % and dropped to around 30 % at the end of the period. Nevertheless, on average in sociology single-authored publications remain the most frequent form of publishing, while researchers in mathematics published more with others from their discipline and with foreign researchers in the last two decades.

Figure 2. Scientific collaboration in mathematics and sociology over time



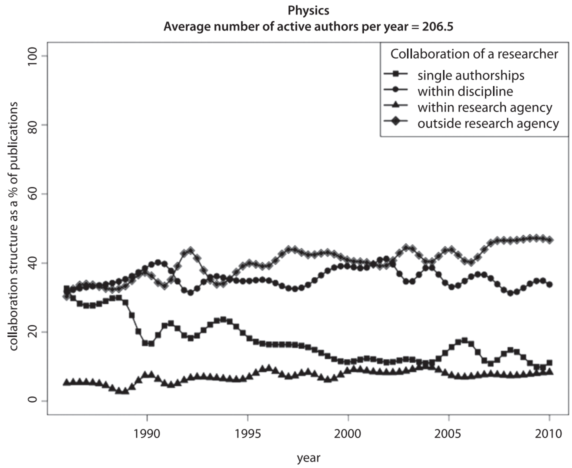
The opposite dynamics of single-authored papers can be found in the remaining two disciplines of physics and biotechnology (Figure 3). In physics, the proportion of single-authored publications remains low throughout the entire period, while in biotechnology there is an overall decline of single authorship. On the other hand, the share of collaborative papers within physics as well as outside the research agency rose over the 25 years, while the proportion of collaboration with researchers from other disciplines registered with the Slovenian Research Agency began to slowly rise at the end of the studied period. In biotechnology, the dynamics of scientific collaboration show many more fluctuations over time for all forms of collaboration: (1) the proportion of collaboration with researchers from other disciplines is the highest among the four disciplines considered; and (2) collaboration within biotechnology is very intense throughout the entire 25-year period. We should take into account that biotechnology as a 'young discipline' was, throughout the entire period, in the process of establishing itself as a discipline, as well as in the process of defining the form of its collaborative activities.

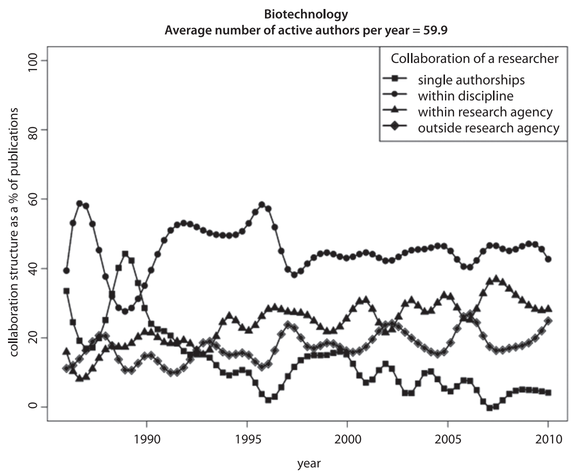
The analysis of the bibliographic data on Slovenian scientists and researchers confirms the differences in publication cultures among the four scientific disciplines or — to be more accurate — the differences among researchers who work in the natural or technical sciences, like physics and biotechnology, and those who work in the social sciences, like sociology. From this perspective, collaborative activities have not changed significantly in the last five-year period compared to the results obtained from the analysis by Kronegger et al. (2011). However, differences among the disciplines not only depend on the subject of the research but also on the nature of the work. In so-called 'lab disciplines', the collaboration of scientists in the form of co-authored papers has a much longer tradition than in disciplines where research groups and teamwork are not so crucial to scientific activity. In so-called 'office disciplines',[14] the network characteristics indicate much less intensive co-authorship activity. More importantly, although all four disciplines are following the recent trends of increasing scientific collaboration, it is clear that not all scientific fields have been responding to these changes in the same way.

The nature of scientific collaboration in the selected disciplines was further studied by the qualitative part of the study, which focused on the opinions of Slovenian biotechnologists and physicists on the positive and negative aspects

[14] The disciplines labelled as 'lab' disciplines have a built-in feature of researchers working together due to a common, often expensive, infrastructure (e.g., a laboratory) which necessitates collaborative activity. In contrast, 'office' disciplines do not have this feature and provide greater freedom for individual researchers to work on their own.

Figure 3. Scientific collaboration in physics and biotechnology over time





of collaborative work. We were interested in their experiences and views regarding scientific collaboration practices in the past in order to examine whether or not they believe they are more intensive now, and whether they consider scientific co-operation to be a bottom-up- or top-down-driven activity.

The first important factor of successful scientific collaboration that the interviewees most frequently outlined was compatibility among researchers. The majority of respondents explained how, to a large extent, the selection of collaborators follows the principle of personal compatibility as well as the compatibility of the collaborators' scope and working methods. According to our interviewees, the second important constitutive part of scientific collaboration is trust among all research partners or, as one scientist put it:

> *Collaboration is based on extreme confidence since you cannot control the work of your collaborative colleague. This is impossible. However, if one is forced to control the work of all of the colleagues, then it is better to do all the work alone. Therefore, for scientific collaboration it is necessary to establish and maintain complete trust between collaborators...*

A prerequisite for fully integrating co-operation is, as outlined by the respondents, a good interpersonal relationship. One of the biotechnologists observed:

> *...if collaborators put considerable effort into building a good relationship, then co-authored publications usually do not bring any problems. However, if one of the researchers becomes too ambitious and wants to have a larger share, then the relationship becomes problematic. After such kind[s] of negative experiences, there is a small probability of future collaborative work among these particular scientists.*

The selection of research collaborators according to personal and mutual trust involves the absence of any top-down-directed collaboration or any external determination of scientific co-operation. Most interviewees expressed the opinion that, on the individual level, selecting collaborators is a matter of free choice and derives from personal judgements. They strongly reject any determined collaboration, while at the same time they acknowledge the inevitability of some external factors affecting collaborative processes. For example, funding agencies require collaborative work when researchers apply for projects. In this respect, national and international research projects are important external and structural factors promoting scientific co-operation. As one of the younger physicists commented:

> *...the prerequisite for science collaboration is freedom of choice. However, this freedom is today difficult to obtain, since it is restricted by financial mechanisms that dictate the way of scientific work. Research projects are typically given for particular research fields; therefore, scientists often find themselves in a situation that forces them to work in a particular project group, even though some of them would prefer to work alone or to work with scientists who have proven themselves to be good collaborators in the past.*

Some of the interviewed scientists also emphasized the importance of the institutional and administrative framework of scientific co-operation, which is closely related with the criteria for obtaining research funds. On the one hand, the distribution of points among co-authors of scientific publications as practised in the Slovenian science evaluation system inhibits co-operation (single authorship brings more points within the evaluation system and, therefore, scores the scientific performance of an individual scientist much higher than a co-authored publication) while, on the other hand, most Slovenian scientists and researchers are not prepared to collaborate in research if the collaborative work does not provide a common scientific article as a result of the collective research efforts.[15] In this regard, one of the younger biotechnologists explained:

> *The Slovenian science evaluation system does not comprehend that the scoring of scientific articles and current criteria for academic titles do not encourage scientific collaboration. If there are five authors of an article, the distribution of points is shared with all five of them and the total score of an article is much lower than if a scientist works and publishes alone. From this point of view, it is better to be an individualist, to perform research alone. However, some complex problems cannot be solved by the individual-study approach.*

Some interviewees observed that in Slovenia the practice of scientific collaboration is not intensive enough, especially when it comes to sharing research equipment and facilities. Research equipment that should be considered to be the property of the entire Slovenian research community is not exploited adequately. As argued by some interviewees, this is partly a consequence of an 'outdated way of thinking'[16] among the older generation of Slovenian scientists and researchers, who are far less willing to collaborate with each other. As a result, equipment capacities are frequently duplicated within the different research institutions and extensive scientific

[15] This observation, made on the basis of the statements of some interviewees, reflects the issues that exist among scientists regarding the science evaluation system in Slovenia, according to which the scientists' performance is evaluated on the basis of total score. In the case of co-authored publication, fractural counting brings a lower score that, in some cases, discourages scientist from performing collaborative work. This seems to be a problem in those disciplines where collaboration is inevitable.

[16] This phrase was used by some of the interviewed scientists regarding the unwillingness of some older scientists to collaborate with each other as well as to share research equipment. As explained by the interviewees, this observation derives from their personal experiences with their older mentors at the beginning of their academic careers.

collaboration is entered into with foreign institutions rather than domestic institutions. This demonstrates the special feature of the Slovenian socio-cultural context which is hopefully diminishing with the new generation of scientists and researchers who are not so burdened by the past relationships among senior scientists.

Some interviewees underlined that the younger generation is much more inclined to scientific collaboration, particularly when they become self-sufficient as academics and are not so dependent on their mentors. Some interviewees believe it is only when a researcher gains an academic position that they are able to autonomously decide where and with whom they wish to collaborate. Nevertheless, most of the interviewed scientists generally perceive the practice of scientific collaboration as making a positive contribution to scientific development.

The prevailing opinion among the interviewees was that nowadays the practice of scientific collaboration is far more frequent than it used to be. Most of them mentioned the development of modern communication tools as an important factor in facilitating and intensifying partnership research and collaborative work, particularly in cases of larger geographical distances between collaborators. One interviewee, interestingly, described his vision of the situation today:

> *If you do not have colleagues around the world, if you do not have a wide-spread network of acquaintances and contacts, it is actually impossible to work within a field of science. From this point of view, it is meaningless to talk about science and scientific collaboration in Slovenia or on the national level since science has become a global activity. Today it is impossible to build a scientific career only on the national level; as a scientist you also have to prove yourself on the international level.*

To summarize, the statements of the interviewed scientists indicate the largely pragmatic nature of scientific collaboration, especially in terms of better access to skills, techniques and equipment when doing collaborative research. However, the initiative for collaboration has to come from the scientists themselves, meaning that for fruitful and successful collaboration it is crucial for scientists to decide when, where and with whom they want to collaborate. On the other hand, they largely acknowledge that the European and national funding programmes represent both a positive incentive for the collaboration of researchers working within different institutional environments as well as a certain form of external determinant of collaboration.

5. Discussion and conclusion

The aim of this chapter was to determine the basic characteristics and dynamics of scientific collaboration in Slovenia, since scientific collaboration plays a crucial role in the successful professional careers of individual researchers. The results indicated that the Slovenian research environment depends on broader social processes, and thus we have confirmed the findings from previous studies that scientific collaboration is a very complex and multifaceted issue of study. In our survey, the dynamics of scientific collaboration in four scientific disciplines — physics, mathematics, biotechnology and sociology — were studied in more detail. The analysis of the bibliographic data revealed considerable differences in publication cultures among the four scientific disciplines that can primarily be described by variations in the nature of work in specific disciplines. Despite the overall rise in co-authored publications, not all scientific fields are following this trend in the same way. Disciplinarily-driven sociological and bibliometric analysis of scientific collaboration proves to be a reasonable starting point in studying the social and cognitive structure of knowledge production. Namely, by better understanding the dynamics of collaboration we can also better understand the dynamics of the various global scientific networks and systems (RS, 2011: 57).

At the same time, it is also important to understand why researchers collaborate, what drives them to collaborate, what enables their collaboration, and what the benefits of the joint work are. Personal factors should be acknowledged much more than they have been when discussing and studying the phenomenon of increasing scientific collaboration. External incentives — such as funding mechanisms — alone do not lead to integrative collaboration among scientists, especially in the absence of scientists' internal motivation to resolve some intriguing research problems and in the absence of personal compatibility among collaborators. Micro-level studies on this issue deliver valuable information necessary for enriching our understanding of the motives that drive the individual researcher to pursue collaborative work. Several studies report different motives and benefits of scientific collaboration. Most, directly or indirectly, relate to expanding the base of knowledge and research productivity in terms of access to expertise, instruments and research equipment, access to funds, gaining visibility, etc. However, the enhancement of academic researchers' reputations and careers should not be ignored when discussing this issue. As mentioned in previous sections, several studies have demonstrated that there are connections between science collaboration and productivity as well as career development. Namely, scientific collaboration represents an important part of research as well as academic activities, especially when it results in a scientific publication. A research network can bring numerous opportunities for both the whole group as well as the individuals involved in the collaborative process. Zutshi et al. (2012: 41) pointed out that *collaboration can be a test of personalities, ideas and, more importantly, trust — the essential element connecting individuals in their roles as researchers and authors*. This statement summarizes well the findings of our interviews of Slovenian scientists.

Although this chapter primarily examines collaboration as it exists in four distinctive scientific disciplines (although some of the findings probably apply to all disciplines), we are fully aware of the fact that the phenomenon of scientific collaboration cannot be totally understood without also considering different aspects of collaboration, from personal motives and circumstances, to structural changes in science as well as in the broader social environment. At this point, our aim was to explore and understand the dynamics of scientific collaboration through an analysis of co-authored publications. In particular, the growing global trends of co-authorship also require a more detailed analysis at the national level. In this manner, Wray (2002: 166–167) wondered about the possibility of single-authored publications being totally replaced by co-authored ones in some disciplines. However, he concluded that, just as collaborative research plays an important functional role, so too do single-authored papers and, therefore, this scenario is unlikely to become a reality. In particular, single-authored papers provide young scientists with the opportunities to prove their value both to themselves and other scientists (Wray, 2002: 166).

It is reasonable to assume that the collaboration practices of individual researchers in Slovenia abide by the requirements of the science evaluation system. It is very common thinking among scientists that collaborative research should — and must — result in a co-authored paper in a high-quality (international) journal. However, since this goal is not especially easy to achieve, the result is the increasing production of scientific papers as a critical mission of academic scientists and researchers. Nevertheless, the rise in the production of papers can also be ascribed to the growing number of researchers as well as the nature of scientific work. Our study reveals the need to take the implications of disciplinary cultures into consideration when discussing the future prospects of national R&D. We argue that, although one of the most significant drivers of changes in collaborative work is science policy instruments that encourage scientific collaboration, in the long run the disciplinary context along with personal considerations are the key factors that affect the differences in the structure and dynamics of collaborative work in science.

References

Abramo, G., Ciriaco, A.D. & Di Costa, F. (2009). Research collaboration and productivity: Is there correlation? *Higher Education*, 57 (2), 155–171.

Acedo, F.J., Barroso, C., Casanueva C. & Galán, J.L. (2006). Co-authorship in management and organizational studies: An empirical and network analysis. *Journal of Management Studies,* 43 (5), 957–983.

Andrade, H., Lopez, E. & Martin, T. (2009). Dimensions of scientific collaboration and its contribution to the academic research groups' scientific quality. *Research Evaluation*, 18 (4), 301–311.

Bankart, C.A.S. (2011). The development of research networks among early-career faculty members in the science, engineering and health disciplines. Doctoral Dissertation. http://kuscholarworks.ku.edu/dspace/bitstream/1808/9997/1/Bankart_ku_0099D_11935_DATA_1.pdf. Accessed 8 March 2013.

Beaver, D. (2001). Reflections on scientific collaboration (and its study): past, present, and future. *Scientometrics,* 52 (3), 365–377.

Beaver, D. & Rosen, R. (1978). Studies in scientific collaboration: part I. The professional origins of scientific co-authorship. *Scientometrics,* 1 (1), 65–84.

Biagioli, M. (1999). Aporias of scientific authorship: credit and responsibility in contemporary biomedicine. In: M. Biagioli (Ed.), *The science studies reader* (pp. 12–31). New York, NY — London, UK: Routledge.

Bozeman, B. & Corley, E. (2004). Scientists' collaboration strategies: Implications for scientific and technical human capital. *Research Policy*, 33 (4), 599–616.

Braun-Munzinger, P. (2009). Das publikationsverhalten in grosskollaborationen [Publication behaviour in large collaborations]. In: Stefan Hornbostel et al. (Eds.), *Publikationsverhalten in unterschiedlichen wissenschaftlichen disziplinen. Beitraege zur beurteilung von forschungsleistungen* (pp. 64–71). Berlin: Alexander von Humboldt.

Campbell, R.A. (2003). Preparing the next generation of scientists: The social process of managing students. *Social Studies of Science*, 33 (6), 897–927.

Chinchilla-Rodríguez, Z., Vargas-Quesada, B., Hassan-Montero, Y., González-Molina, A. & Moya-Anegón, F. (2010). New approach to the visualization of international scientific collaboration. *Information Visualization*, 9 (4), 277–287.

Choi, S. (2012). Core-periphery, new clusters, or rising stars? International scientific collaboration among 'advanced' countries in the era of globalization. *Scientometrics,* 90 (1), 25–41.

Cronin, B. (2001). Hyperauthorship: a postmodern perversion or evidence of a structural shift in scholarly communication practices? *Journal of the American Society for Information Science & Technology*, 52 (7), 558–569.

Defazio, D., Lockett, A. & Wright, M. (2007). Funding incentives, collaborative dynamics and scientific productivity: evidence from the EU framework program. *Research Policy,* 38, 293–305.

Delamont, S., Atkinson, P. & Parry, O. (2004). *Supervising the doctorate. A guide to success*. Berkshir: Society for research into higher education & Open University press.

De Stefano, D., Giordano, G. & Prosperina Vitale, M. (2011). Issues in the analysis of co-authorship networks. *Quality & Quantity*, 45 (5), 1091–1107.

Enders, J. & De Weert, E. (Eds.) (2009). *The changing face of academic life. Analytical and comparative perspective*. Hampshire/New York, NY: Palgrave Macmillan.

Felt, U. (Ed.) (2009). *Knowing and living in academic research. Convergence and heterogeneity in research cultures in the European context*. Prague: Institute of sociology of the academy of sciences of the Czech Republic.

Glänzel, W. & Schubert, A. (2004). Analysing scientific networks through co-authorship. In: Henk F. Moed et al. (Eds.), *Handbook of quantitative science and technology research. The use of publication and patent statistics in studies of S&T systems* (pp. 257–276). Dordrecht, Boston, London, Kluwer Academic Publishers.

Hagstrom, W. (1965). *The scientific community*. New York, NY: Basic Books.

Hara, N., Solomon, P., Seung-Lye, K. & Sonnenwald, D.H. (2003). An emerging view of scientific collaboration: scientists' perspectives on collaboration and factors that impact collaboration. *Journal of the American Society for Information Science & Technology*, 54 (10), 952–965.

Haslam, N. & Laham, S. (2009). Early-career scientific achievement and patterns of authorship: the mixed blessing of publication leadership and collaboration. *Research Evaluation*, 18 (5), 405–410.

Heidler, R. (2011). Cognitive and social structure of the elite collaboration network of astrophysics: a case study on shifting network structures. *Minerva*, 49, 461–488.

Hoekman, J., Frenken, K. & Tijssen, R.J.W. (2010). Research collaboration at a distance: changing spatial patterns of scientific collaboration within Europe. *Research Policy*, 39 (5), 662–673.

Jeong, S., Young Choi, J. & Kim, J. (2011). The determinants of research collaboration modes: exploring the effects of research and researchers characteristics on co-authorship. *Scientometrics*, 89, 967–983.

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

Kronegger, L., Ferligoj, A. & Mali, F. (2011). On the dynamics of national scientific systems. *Quality & Quantity*, 45 (5), 989–1015.

Kronegger, L., Mali, F., Ferligoj, A. & Doreian, P. (2012). Collaboration structures in Slovenian scientific communities. *Scientometrics*, 90 (2), 631–647.

Laudel, G. (2002). What do we measure by co-authorship? *Research Evaluation*, 11 (1), 3–15.

Leahey, E. & Reikowsky, R.C. (2008). Research specialization and collaboration patterns in sociology. *Social Studies of Science,* 38 (3), 425–440.

Lee, S. & Bozeman, B. (2005). The impact of research collaboration on scientific productivity. *Social Studies of Science*, 35 (5), 673–702.

Mali, F. (2010). Policy issues of the international productivity and visibility of the social sciences in Central and Eastern European countries. *Sociologija i prostor,* 48 (3), 415–435.

Matelič, U., Mali, F. & Ferligoj, A. (2007). Kreativno okolje in uspešnost mladih raziskovalcev. [*Creative environment and the performance of young researchers*]. Družboslovne razprave, 55, 71–94.

Melin, G. (2000). Pragmatism and self-organization. Research collaboration on the individual level. *Research Policy*, 29, 31–40.

Merton, R. (1973). *The sociology of science*. Chicago, IL: University Press.

Mesec, B. (1998). *Uvod v kvalitativno raziskovanje v socialnem delu. [Introduction to qualitative research in social work]*. Ljubljana: Visoka šola za socialno delo.

Newman, M.E.J. (2001). From the cover: the structure of scientific collaboration networks. *PNAS*, 98: 404–409.

O'Brien, T.L. (2008). *The evolving co-authorship patterns of research scientists*. http://citation.allacademic.com/meta/p_mla_apa_research_citation/2/4/1/6/6/pages241665/p241665–10.php. Accessed 3 March 2013.

Pečlin, S., Južnič, P., Blagus, R., Čižek Sajko, M. & Stare, J. (2012). Effects of international collaboration and status of journal on impact of papers. *Scientometrics*, 93, 937–948.

Perc, M. (2010). Growth and structure of Slovenia's scientific collaboration network. *Journal of Informetrics,* 4 (4), 475–482.

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.

Pike, T.W. (2010). Collaboration networks and scientific impact among behavioural ecologists. *Behavioural Ecology*, 21 (2), 431–435.

Ponomariov, B.L. & Boardman, P.C. (2010). Influencing scientists' collaboration and productivity patterns through new institutions: university research centers and scientific and technical human capital. *Research Policy*, 39, 613–624.

Prpić, K., Oliveira, L. & Hemlin, S. (Eds.) (2009). *Women in science and technology*. Zagreb: Institute for Social Research.

Rijnsoever, F.J. & Hessels, L.K. (2011). Factors associated with disciplinary and interdisciplinary research collaboration. *Research Policy,* 40, 463–472.

RS — Royal Society (2011). Knowledge, networks and nations. Global scientific collaboration in 21st century.

http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2011/4294976134.pdf. Accessed 12 May 2012.

Rubí-Barceló, A. (2012). Core/periphery scientific collaboration networks among very similar researchers. *Theory*, 72 (4), 463–483.

Samuelson, P. 1972. Economics in a golden age: a personal memoir. In: G. Holton (Ed.), *The twentieth century science: studies in the biography of ideas* (pp. 122–35). New York, NY: Norton.

Scaffidi, A.K. & Berman, J.E. (2011). A positive postdoctoral experience is related to quality supervision and career mentoring, collaborations, networking and a nurturing research environment. *Higher Education*, 62, 685–698.

Shrum, W., Genuth, J. & Chompalov, I. (2007). *Structures of scientific collaborations.* Cambridge, MA — London, UK: The MIT Press.

Shrum, W. & Mullins, N. (1988). Network analysis in the study of science and technology. In: A. van Ran (Ed.), *Handbook of quantitative studies of science and technology* (pp. 107–133). Amsterdam: Elsevier.

SICRIS (2013). List of all employed researchers. http://www.sicris.si/search/rsr_list_all.aspx?lang=eng&SEARCH_BY=mstid&SEARCH_TERM=%25&PAGE=1&PSIZE=–1&mode=&num=14310&SID=–1&scope=public. Accessed 26 March 2013.

Simonton, K. (1997). Creative productivity: a predictive and explanatory model of career trajectories and landmarks. *Psychological Review*, 104, 66–89.

Sonnenwald, D. (2007). Scientific collaboration: a synthesis of challenges and strategies. http://philoscience.unibe.ch/documents/physics/Sonnenwald2007/Sonnenwald2007.pdf. Accessed 23 May 2012.

Storer, N. (1966). *The social system of science*. New York, NY: Reinhart and Winston Press.

Uddin, S., Liaquat, H., Abbasi, A. & Rasmussen, K. (2012). Trend and efficiency analysis of co-authorship network. *Scientometrics,* 90 (2), 687–699.

Walsh, J.P. & Maloney, N.G. (2007). Collaboration structure, communication media and problems in scientific work teams. *Journal of Computer-mediated Communication*, 12 (2). http://jcmc.indiana.edu/vol12/issue2/walsh.html. Accessed 16 May 2012.

Whitley, R. (1984). *The intellectual and social organization of science*. Oxford, UK: Oxford University press.

Wong, P.K. & Singh, A. (2013). Do co-publications with industry lead to higher levels of university technology commercialization activity? *Scientometrics. Published online.* http://link.springer.com/article/10.1007%2Fs11192-013–1029–1#page–1. Accessed 6 September 2013.

Wray, B. (2002). The epistemic significance of collaborative research. *Philosophy of Science*, 69 (1), 150–168.

Wray, B. (2006). Scientific authorship in the age of collaborative research. *Studies in History and Philosophy of Science*, 37 (3), 505–514.

Wuchty, S., Jones, B. & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, 316, 1036–1039.

Yoshikane, F., Nozawa, T., Shibui, S. & Suzuki, T. (2009). An analysis of the connection between researchers' productivity and their co-authors' past attributions, including the importance in collaboration networks. *Scientometrics*, 79 (2), 435–449.

Ziman, J. (1994). *Prometheus bound. Science in a dynamic steady state*. Cambridge, UK: Cambridge University press.

Zuckerman, H. (1967). Nobel laureates in science: patterns of productivity, collaboration, and authorship. *American Sociological Review,* 32 (3), 391–403.

Zutshi, A., McDonald, G. & Kalejs, L. (2012). Challenges in collaborative writing: addressing authorship attribution. *European Business Review*, 24 (1), 28–46.

The mentoring of young researchers in the natural and social sciences in Croatia

Marija Brajdić Vuković

The mentoring provided by a senior scientist is regarded as particularly important for young researchers' professional socialization. High-quality mentoring experiences permanently influence the careers of young researchers. Due to differences in the social organization of disciplines, the mentoring practices provided for young researchers are described as differing greatly between the social and natural sciences. However, recent global changes in nature of academic work and the practices of the academic profession, together with changes related to the production of knowledge in the social sciences, impose questions relating to the possible changes in mentoring patterns and practices in those disciplines. This qualitative study of a sample of 40 novices from the natural and social sciences has shown characteristic differences between the studied domains, but it has also found that in both the natural and social sciences, mentorship differs from — in the previous research described — characteristic disciplinary patterns and practices. The latter finding is related to the disciplinary changes in the production of knowledge, as well as global and local (Croatian) changes of science systems and policies. The study concludes with specific remarks on how to improve a 'scientific novice programme' to work more as high-quality professional socialization programme.

1. Introduction

Data gathered by international studies has proved that both formal and informal mentoring of young researchers provided by senior researchers plays a key role in ensuring their successful professional socialization. The main findings of international research in this field can be summarized as follows:

- The development of a productive mentoring relationship is associated with the successful (and faster) completion of doctoral studies, with employment satisfaction, and with career development (Lovitts, 2001;

Neuman, 2003; Nettles & Millett, 2006; Kiopa et al., 2009; Ehrenberg et al., 2010).

- Early productivity among researchers is found to be a direct result of a good mentoring relationship (Zuckerman, 1977; Matelič et al., 2007; Kamler, 2008; Polašek, 2008). Such productivity is perceived as the most important socialization outcome and a straightforward indicator of the successful training and independence of young researchers (Feist & Gorman, 1998; Prpić, 1997, 2004; Louis et al., 2007).
- The consequences of good mentoring extend beyond the time boundaries of the mentoring relationship itself, since the productivity of researchers during a doctoral candidacy is a good predictor of early postdoctoral productivity and an important predictor of later or future research productivity (Simonton, 2004; Polašek, 2008; Ehrenberg et al., 2010).
- Career development advice is found to be the most important mentoring practice provided for young researchers (Kiopa et al., 2009), proving that mentorship permanently shapes the careers of (young) researchers in many ways.

For the above reasons, the quality of a mentoring relationship during the early career stages of researchers is of the utmost importance to the development of their careers.

Previous research of doctoral-level education mainly defined mentoring as the formal supervision of young researchers by a senior researcher, thereby perceiving mentorship as a concept that is formally framed and primarily dyadic and hierarchical in nature (Kram, 1985; Mullen, 2007, 2009). However, recent research suggests that the traditional dyadic mentoring relationship is increasingly being replaced by multiple relationships that can be formal and/or informal, with one or more peers and/or experienced colleagues, and can take places not only in dyads but also in groups and cultures (Baugh & Scandura, 1999; Higgins & Kram, 2001; Lovitts, 2001; Weidman et al., 2001; Austin, 2002; Golde, 2005; Parry, 2007; Sweitzer, 2009; Mullen, 2009).

An additional finding is that formal supervision does not result in a productive mentorship by default. Instead, productive mentorship is primarily influenced by the nature of the mentoring relationship (Kiopa et al., 2009). Graduate students perceive the behaviour, functions and personal characteristics of mentors as the most important aspects of the mentoring relationship. Graduate students especially value practices such as encouragement, career support and psychosocial support, as well as being the subject of care and concern by the mentor (Eby et al., 2007; Clark et al., 2000; Johnson, 2006). Although formalizing the mentoring relationship can mark a favourable circumstance for high-quality mentorship, research shows that only around 10 % of formal supervising relationships are perceived as productive by young researchers (Kiopa et al., 2009).

Bozeman and Feeney (2007) understand mentoring as a relationship whose nature depends on the personal effort and investment of mentors beyond their formal obligations. Bozeman and Feeney's *definition in progress* thereby *liberates* mentoring from hierarchical, formal, and age boundaries and allows all relationships that are *perceived by the recipient as relevant to work, career, or professional development* to be regarded as mentoring (2007: 731). Defined in this way, the development of mentoring becomes an important empirical question.

This study focuses on the practice of mentorship as provided for young researchers in the natural and social sciences within the Croatian academic context.

The status of research in Croatia was unfavourable in the decades before social, economic and political transition in the 1990s (Prpić, 2003) and, unfortunately, did not improve during or after the transition process. According to independent estimates, the share of investment in R&D in Croatia eroded from 1.07 % in the 1990s to only 0.7–0.9 % of GDP in 2006 to 2010 (UNESCO, 2010). The effect of this reduced investment and the crises that the research system went through in the 1990s[1] (and has not yet recovered from) is most obvious in the continuous decrease in the number of researchers in Croatia.[2] The most significant problem is the unfavourable age composition of the research community, whereby the system has been shrinking mostly in the cohorts of mid-career researchers (Golub & Šuljok, 2005: 135).

The specificities related to the professional socialization of young researchers in Croatia make Bozeman's and Feeney's definition of mentorship particularly useful. From the late 1980s onwards, the socialization of young researchers in Croatia has formally taken place within the so-called 'research novice' (*znanstveni novak*) programme. All research novices are doctoral candidates and are assigned to academic research projects, funded by the government and led by a senior researcher, and they work on these projects as full-time research assistants for a contract period of six years. Novices assigned to projects led by university professors are usually also engaged as

[1] The transformation of the scientific systems of the former socialist countries in the 1990s was marked by a sharp decline in investment in science; the introduction of the new competitive system focused on the support of individual research projects (rather than institutions) and a significant reduction of research potential (Mali, 2003; Prpić, 2003).

[2] During the period 1991–2001, the number of researchers in the system dropped by 24.4 % (Prpić, 2003: 49) while during the period 2002–2008 it dropped by an additional 21.9 % (UNESCO, 2010: 189).

teaching assistants.[3] In this setting, the senior researcher/project manager is also the novices' formal supervisor and is, therefore, in charge of their professional socialization. Novices are obliged to complete their PhD theses before the expiration of the contract. As a reward for completing their theses, novices are then automatically assigned for another four years as postdoctoral researchers in the same research team.

The main problems of the research novice programme in Croatia are the length of time novices take to earn their PhDs and their low productivity. In the period 2002–2009, less than 50 % of novices earned their PhD before the expiration of their contract.[4] Also, during period from 1999 to 2005, only 37 % of all young researchers published a paper in an international scholarly journal indexed in the *ISI Web of Science* database (Polašek, 2008). An additional problem relates to the lack of effective evaluation of the quality of the programme. For example, the actual mentoring provided by formal supervisors is not monitored or evaluated in any way, and those important questions remain unresolved in the Croatian academic system.

Another characteristic of the Croatian research novice programme — although not uncommon in international comparison — is that it is implemented in the same way for all academic disciplines. Indeed, research on mentoring has recognized that socialization is an important process of the academic formation of young researchers in all academic disciplines, whether it be in the form of socialization into the academic life and system (Merton, 1973; Austin, 2002; Lindholm, 2004; Austin & McDaniels, 2006; Walker et al., 2008) or socialization into the working environment/organization (Van Maanen, 1983, 1984; Tierney & Rhoads, 1994; Tierney & Bensimon, 1996; Gardner, 2008a, 2009b, 2010). At the same time, however, socialization into a specific discipline or field (or even into a specialization or sub-specialization) is still found to be the most influential of all. Disciplinary education is, therefore, perceived as the core of professional socialization in the field of research (Biglan, 1973a; Knorr-Cetina, 1977; Whitley, 1984; Clark, 1993; Becher, 1989; Parry et al., 1994; Delamont et al., 2000; Neuman, 2003; Parry, 2007).

There are important differences between academic disciplines in the way in which work is organized at the doctoral level. These differences are

[3] Out of approximately 2,600 scientific novices in the system at present, around 73 % are affiliated with academic research projects within higher education institutions, 18 % within research institutes, and 9 % within other institutions (museums, clinics, hospitals, etc.). Approximately 33 % of novices are socialized in the disciplines of biotechnical and technical sciences, 27 % in the social sciences and humanities, 23 % in biomedicine and health, and 17 % in the natural sciences.

[4] As written in The Report on Success of Research Novice Program on the Ministry of Science website: http://public.mzos.hr/Default.aspx?art=10075&sec=2133. Accessed 3 November 2012.

most distinct in the manner in which the doctoral research subject is chosen and in the development of specific skills, but there are also differences in the approach to supervising young researchers (Whitley, 1980; Delamont & Atkinson, 2001; Lovitts, 2001; Neuman, 2003; Parry, 2007). For example, the relationship between supervisors and doctoral students in the social sciences is much closer than in the natural sciences. But the basic skills needed for carrying out independent research in the natural sciences are mostly learned through teamwork and learning is facilitated by the so-called 'pedagogic continuity' provided by the scientific research team. This pedagogic effect of teamwork is provided by a generational continuity of expertise, which relies on a significant number of postdoctoral and mid-career researchers in the team who function as a bridge between senior researchers and beginners in the field (Hacking, 1992; Delamont et al., 1997; Parry, 2007).

Despite the differences in the organization of work between academic disciplines, recent findings have shown that research is increasingly carried out in teams across nearly every field within the social sciences. According to Wuchty et al., *on average, today's social science papers are written in pairs with a continuing positive trend toward larger teams* (Wuchty et al., 2007: 1037). These trends, combined with *a broad tendency for teams to produce more highly cited work than individual authors* (Wuchty et al., 2007: 1037), mean that this new development can hardly be expected to diminish in the future.

In addition, there is evidence that group-learning contexts are also increasingly present in the social sciences (Mullen, 2009: 11) and that important structural changes in the organization of doctoral-level education in the social sciences have moved in the direction of a more natural sciences-like approach to the education of future researchers (Henkel, 2000; Neuman, 2003; Parry, 2007). These structural changes in the disciplinary socialization within the social sciences are probably affecting the patterns and sources of young researchers' mentoring relationships, making collaborative work and the pedagogic continuity of social science teams an increasingly important part of this process.

Finally, certain structural pressures at the global level in today's rapidly changing academic environment are also likely to influence national practices for mentoring young researchers. The on-going diversification and specialization process of academic activities, together with increasing forms of control that are being experienced, such as increasing pressure by the state to demonstrate the output, quality and impact of research, have made the categorization of faculty members along a continuum of teaching and research no longer possible (Musselin, 2007). Today, activities such as writing proposals, networking and being engaged in technology transfers are equally important aspects of academic work (Musselin, 2007; El Khawas, 2008; Coates & Goedegebuure, 2012). Such trends, and the additional burden that they represent, seriously reduce both the possibility and motivation of senior researchers in all disciplines to invest their time in mentoring young researchers (Silver, 2003; Macfarlane, 2005; Müller, 2013).

It can therefore be expected that the changes in disciplinary organization and practices, together with the changes of science governance (primarily the expansion of science policies with unifying effects) within the post-transitional context of the Croatian academic system, affect mentoring practices in Croatia, both in the natural and social sciences.

2. Research questions

This study is concerned with the practice of mentoring as the framework for ensuring the high-quality socialization of research novices. Starting from theoretically- and empirically-based disciplinary differences in approaches to socialization, learning and supervision in the natural and social sciences, this research is focused on the development of the mentoring relationship and the patterns and characteristics of the mentoring provided. This research paper is especially interested in identifying possible obstacles that influence a lack of provision of mentoring within a formal supervisory relationship during the socialization of young researchers. In particular, this paper is interested in whether recent changes at the global level regarding practices and academic work in the natural and social sciences, together with the specificities of the Croatian academic system, influence the practice of mentorship and, if so, in what way.

3. Methods

3.1. In-depth interview

The interest of the research was to examine mentorship practices through the testimonies of respondents regarding their experiences of socialization as young researchers. For this reason, the choice of method was qualitative research based on in-depth interviews. The researcher developed an interview protocol with questions about each important time or contextual point in the process of socialization of young researchers, including: respondents' decisions to apply for employment as a researcher, their first year as a doctoral candidate, their first research paper or conference, their relationship with their mentors, their everyday work practices, their international network, etc. Data were gathered with the aim of securing a rich and thorough description of the phenomena and contextual factors so that the research results could attain validity and, insofar as this is possible through qualitative research, modes of analytical and transfer generalization (Campbell, 1986; Polit & Tatano Beck, 2010).

3.2. Sample

The sample design was guided by the fact that significant differences exist in the cognitive and social organization of the natural and social sciences (Biglan, 1973; Whitley, 1984; Becher, 1989) as well as in the socio-political context of socialization in these disciplines. The sample consisted of 40 respondents from different fields within the natural and social sciences, from both teaching- and research-oriented institutions, with 10 respondents from each subgroup. Sampling was determined on the basis of the maximal variation technique (Patton, 2001), with the criteria being to ensure at least one respondent for each of the fields within the natural and social sciences.[5]

Within each discipline, emphasis was also placed on satisfying the sample by including respondents from theoretical, experimental and (if possible) applied fields of research, and from both genders (although not necessarily in the same proportions). The final sample consisted of 25 female and 15 male respondents, 16 from theoretical, 17 from experimental and seven from applied research fields. The age of the respondents ranged from 26 to 40 years old (mean age: 33), and 28 of the respondents had already earned their PhD, while 12 were close to finishing their doctoral dissertation.

The respondents from the natural sciences published a total of 208 journal articles, while those from the social sciences published 202 journal articles (10 articles per novice on average in both disciplines). However, differences between the disciplines in their publishing strategies and the characteristics of their publications are more obvious when comparing the *Web of Science* citations of novices. The natural sciences sample had a total of 611 citations, while novices from the social sciences had a total of 66. After excluding one obvious outlier in the natural sciences (with a personal record of 237 citations), the natural sciences had on average 20 citations per novice, while the social sciences had on average three citations per novice.

[5] In the Croatian academic system, the natural sciences as a formal category include the fields of mathematics, physics, chemistry, biology and various sub-disciplines of geology. The category 'social sciences' includes the fields of economics, sociology, psychology, education, social work, law and political science.

3.3. Ethics

Research ethics were addressed in the process of approaching the respondents, obtaining their informed consent and ensuring the researcher's responsibility towards them. Due to the sensitivity of the research subject, institutions were not involved in the selection process of respondents and were not notified of the carrying out of the research. Contact with novices was established through their colleagues and peers. Informed consent was given by the respondents before each interview and it guaranteed their right to access all research-related information, their anonymity and the researchers' ethical conduct regarding collected the data.

3.4. Procedures and analysis

The research fieldwork was conducted during the period between July 2010 and April 2011. The interviews lasted between 60 and 90 minutes (74 minutes on average) and they were all carried out by the researcher using a face-to-face method. All the interviews were audio-recorded. The respondents were assigned with unique codes and the interviews were transcribed by the researcher herself.

The analysis of the interview data was carried out with the help of *Nvivo 7* computer software. To obtain an overview, not only of the important actors engaged in the process of the socialization of young researchers but also of the nature and role of those actors in this process, the first topics to be coded related to the experiences of young researchers in being introduced to the planning and writing of research and publications. The analysis of those experiences and actors determined which mentoring tasks (if any) were provided by formal supervisors and which were provided by someone else (e.g., other experienced researchers, the research team or peers). The focus of the analysis was on those elements of mentorship (no matter the person or source) that resulted in successful socialization outcomes. Topics relating to the obstacles to (high-quality) mentoring were emergent and were coded descriptively, depending on the source and cause of the obstacle.

4. Results

The results are organized below as a summary of the findings, with occasional support from the narratives of respondents expressing some of the thoughts that the young researchers shared during the interviews.

The first topic of analysis presented in this section discusses the outcomes of the socialization process undergone by the young researchers in the Croatian research novice programme. The analysis below focuses on the novices' self-assessment of their ability to carry out research independently and on their publishing and writing practices, as well as on their attitudes to research productivity and their career plans. Outcomes are connected to the novices' assessments of the quality of the mentoring they have received during their professional socialization, both through formal supervision and from other possible sources of mentoring. The central part of the results of this research is concerned with identifying the type of mentorship experienced by those novices who assessed the outcomes of their socialization most positively, and determining the type of activities, behaviours and direct or indirect support that result in such an outcome. Obstacles to quality mentoring are discussed in the last part of the analysis.

4.1. Socialization outcomes and the responsibility of formal supervisors

There are strong differences between the levels of young researchers' self-esteem and confidence in their research skills, depending on whether they have an excellent, good or weak publishing record. These differences are consistent both in the natural and social sciences. A good or excellent publishing record has a close association with novices' self-assessment of their ability to carry out research independently, and the respondents claim it is a result of their experiences of professional socialization:

> *What I have gained is self-confidence, encouragement and knowledge of how to conduct research. I am now equipped to carry out high-quality research and to try to contribute to my field, but also to debate opinions and ideas with others.* (DZ2)

In both the natural and social sciences, publishing experience and a feeling of competence (as a result of a positive socialization experience) are characteristics that consequentially relate to narratives which show more concern for researchers' career plans and stronger attitudes regarding publishing, as well as about the research sector in general. This is much less the case for novices who are not so productive in publishing. The interviews with novices in both the natural and social sciences who had a weaker publishing record developed in a completely different direction when discussing the issues of publishing and their assessment of their own competence in the field of research.

They express a lack of confidence in their ability to work as independent researchers, even if they have already earned their PhDs. In the social sciences, the concerns of novices are related to a lack of experience in research writing and discourse, which results in feelings of unease and insecurity:

> *I can't say that I know how to write a research paper. I still don't have enough experience… and always end up lost somehow… And I always feel… as if I am showing my underwear. You know, I am somehow embarrassed.* (DZ4)

One of the consequences of the concerns about writing experience and practice is that young researchers in the social sciences adopt a pragmatic approach and submit articles to Croatian journals because they find that publishing in such journals is both easier and faster in practice, and that this approach will secure their timely promotion within the research sector.

Young researchers in the natural sciences who lack publishing experience have even more substantial issues than a lack of writing experience or publishing practice. These researchers mostly lack high-quality practical experience and can become lost with their experiments without help from their more experienced colleagues. Some young researchers in the natural sciences even faced the problem of whether their doctoral research experiment would succeed in time. Compared to young researchers in the social sciences, these researchers do not have the option to adopt a rather pragmatic approach to publishing by submitting research papers to local journals. Due to this, researchers in the natural sciences with a weak publishing record show feelings of total discouragement at the end of their socialization period:

> *It is not easy, you feel guilt because you aren't productive, and others will say that you don't work hard enough. But you know that you have worked a lot, maybe even more than anyone; every day you've worked for 15, 18 hours. And it doesn't show… I have had no support whatsoever and you can't do anything in this field without experienced support and a good international network. I am actually very saddened by it all. They had promised me a lot, and have fulfilled none of it.* (PZ5)

The above narrative illustrates an important finding that all novices in the natural and social sciences that failed to be productive or else felt competent as a result of their professional socialization emphasize a lack of support by a senior researcher (i.e., by their formal supervisor, as the person most responsible for their training). In the above narrative, the novice in particle physics has even had two supervisors/managers of his research project, and both have failed to instruct or guide him. The situation is no different in the social sciences, where novices attribute their lack of competence and skills to a lack of experienced guidance during their professional socialization:

> *I didn't have structure and that is what I needed and what I was expecting. Maybe my formal supervisor is a good researcher, but this mentoring role is not what suits him. He is certainly popular and a very intelligent person, but something is missing. Since there are many novices in our department, I have witnessed that their mentors work with them, suggest research topics to them, develop bibliographies and methodologies, and encourage them to present at conferences. I didn't receive any of that from my supervisor.* (DN4)

Young researchers from both disciplines who perceived their formal supervisors as genuine mentors view this as an exception in an otherwise poor-quality system. They are perceived as experienced and distinguished researchers who uphold certain values regarding research that are in line with those of the international research community, but that are far less present in the Croatian research community. Often, such formal supervisors are comparatively younger senior researchers who have worked and/or educated themselves internationally, or are senior researchers who are highly productive and are both visible and well-connected internationally.

4.2. High-quality mentoring practices

4.2.1. Direct mentoring activities: structuring of socialization in phases and providing support for publishing productivity

The two most important aspects of mentoring provided by formal supervisors that were discussed by novices in both disciplines were: structure and the close guidance of disciplinary socialization; and publishing practice to increase the productivity of young researchers.

In the social sciences, a structured introduction implies step-by-step guidance and learning regarding how to approach research problems, gather important literature, construe research instruments and choose an appropriate research methodology. Such guidance is usually provided by supervisors themselves, and even in cases when formal supervisors do not provide direct guidance to young researchers, the socialization process is still closely structured by them, because they coordinate the work of the research project team. Research teams as a community of learning, practice and socialization experiences were found in the fields of sociology, social work, economics and political sciences:

In the first few years, the professor (formal supervisor) included me in all project activities. I actively participated in the fieldwork, I gathered data from different institutions, and my job was at one point to analyse all of it. In another project, research associates were constructing questionnaire instruments. They even sent us finished instruments to check whether the instrument could be improved, etc. We observed and listened to how associates conducted focus groups, and through all that experience we were slowly becoming independent. (DN2)

Novices in the natural sciences mostly enter (highly) specialized research projects, where they face a whole new world they know very little about. Due to the social and organizational specificities of the fields of the natural sciences, an expected finding of this paper was that research teams as whole (rather than supervisors themselves) would play the most important socializing role in this discipline. However, almost all of the testimonies about good mentoring practices in the sample of young researchers in the natural sciences were related to the relationship with the formal supervisor. It seems that the formal supervisors' constant and active presence, their expressed concern and their readiness to teach and guide, were crucial to novices as beginners in their fields:

He [the formal supervisor] has practically taught me all the skills that are needed in our profession and are necessary for me to be able to work on my doctoral research. He has also taught me how to do the fieldwork and all the stuff that the institute does that I knew nothing about. He has really worked hard with me. (PZ7)

A crucial characteristic of good mentoring in the natural sciences is the support of supervisors during experiments, who can predict possible obstacles, take responsibility and guide the novice through the process. As young researchers in the natural sciences develop, the help they (should) receive from supervisors becomes more complex but also more collaborative in nature: young researchers and supervisors spend more time debating ideas for research and papers, and their collaboration becomes more equal in nature, although still very much guided. Because this process is complex, discussion about research-related issues — but also about issues relating to the self-confidence of researchers — is one of the key elements of high-quality supervision:

It often happens that, when I talk to my supervisor, I tell him what I did and that I am stuck, and at that moment I spontaneously come to the idea what to do next. I talk to him and everything falls into place. And he has

> *that ability, every time I lose enthusiasm, he motivates me again. It happens through our conversation, I speak to him about issues and I always feel better in the end.* (PZ1)

The most important issue of productivity in the social sciences was its visible output as a published paper, meaning that the kind of support that was considered to be most important was connected to learning about the use of discourse, about structuring a paper and making ideas publishable. Generally, this assistance is both provided and initiated by the formal supervisor, through a combination of comment and criticism, and most novices do not really co-author a paper but rather write the paper themselves. On the other hand, those novices with genuinely collaborative experiences (which include the writing of papers together with a formal supervisor) gain greater self-confidence, express a feeling of competence and achieve higher productivity. They also view this practice as the most genuine act of mentoring:

> *I've written most of my papers with my professor (formal supervisor). We agreed what we will write about, how it should look and who will write certain parts of the paper. I would write my part as well as I could, and then she would give me her suggestions and comments. She would also send me her parts for me to provide comments and suggestions. For me it was really the best way to learn and to become productive.* (DN2)

Unlike young researchers in the social sciences, writing in the natural sciences is perceived as *actually a final phase, when you reflect and see if something needs to be done differently, when experiments are over* (PZ5), and it is usually a result of working on a research problem in all of its phases. Senior researchers are an important guide and role model in all of those phases, and usually it is the formal supervisor who fulfils that position:

> *I started to work on one of the articles I co-authored during the first year of my assistantship. I had simple tasks: to take something, wash it, grind it, melt it and dialyse it. During the next year, I started to have some research ideas that I couldn't have had earlier. I was second, third and fourth author on previous articles, and now I would be the first. While working on those previous papers I was doing proofreading, sorting literature, searching for the references. At the end of the whole process you find out that you have learned how to prepare a research paper.* (PZ8)

Based on the collected testimonies of young researchers in the natural sciences, in most cases the writing of an article was carried out in its entirety by the formal supervisor (the manager of the project). Writing appears not to be perceived by supervisors as something that a young researcher has to be taught how to do, but rather something that he will be able to do by tacit learning, when his time for writing comes. However, the few novices from the natural sciences sample that were pedagogically taught research writing in a similar way to the social sciences (in phases, until reaching independence as sole author), seem to profit the most, since they become fully independent in their publishing activities early in their career:

> *She [the formal supervisor] analysed references and I made images for the first article. In every next paper I was participating more. It was so gradual that it is even hard to say when it happened, but at one moment I realized that I was writing the paper on my own and she was just commenting on it.* (PZ6)

The results clearly show that a formal supervisor is undeniably the most important mentor, as a source of information and guidance, for novices in both disciplines. Additionally, analyses of mentoring practices in both the natural and social sciences show that the characteristics of high-quality mentoring are perceived by young researchers in both disciplines as being trust, devotion, frequent meetings and the close collaboration of formal supervisors and novices.

4.2.2. Indirect mentoring practices: international networks and good management skills

Apart from the direct and active mentoring of young researchers, novices described two qualities of formal supervisors that indirectly support the professional socialization of young researchers: engagement in international disciplinary networks and good project management.

In the social sciences, the international contacts of formal supervisors with strong international networks are recognized as a great asset by novices. Through their mentors' networks, novices are introduced to renowned international scholars:

> *An international researcher was on a scholarly visit to our institute, looking for a person who could help him with his current calculations. My formal supervisor introduced me to him and recommended me for that job. In those key moments, my formal supervisor played an important role because she introduced me to important people.* (DZ2)

International project collaboration arranged by a formal supervisor emerged as an even more important subject in the natural sciences. The project manager is the person who secures active and high-quality international collaboration, not only as a funding opportunity for the project but also as a source of ideas, knowledge and productivity. For some novices, connections from a supervisors' global network can enable young researchers to work in a rapidly evolving and exciting field or specialization:

> *My new formal supervisor has international connections and is working on the research front. He automatically connected me to his international associates and I went abroad to work with a professor who gave me an important 'problem' to solve. It enabled me to work on the stuff that is 'in', that 'matters', and is 'hot' in my research specialization.* (PN1)

The second characteristic of a good mentor that indirectly influences the professional socialization of novices involves good management skills. As described by young researchers in the social sciences, the supervisor is the person who can dictate the atmosphere of collaboration and support within the research team and who can connect peers and make them partners rather than competitors:

> *Our formal supervisor initiated the support group, 'the peer circle'. He (the formal supervisor) would gather us and say: "Today our young colleague will present his research draft, and we will share our thoughts and brush it up together." We benefited a lot from this; we were functioning day-to-day as a small research society, sharing our thoughts, ideas, advice, experiences, results, books and knowledge. We became a true community.* (DN6)

High-quality formal supervisors in the natural sciences also create a positive atmosphere that often boosts not only professional development but also the productivity of the whole research team. However, a significant lack of funding for research projects plays an important role in the day-to-day functioning of research teams in the natural sciences, and the management role of the lead researcher is extremely important. For example, when engaging the research team in a commercial project, the project manager has to carefully distribute work tasks to make sure that the research-related and professional progress of individual researchers is not endangered:

> *A lot of time is consumed by commercial projects. I am getting tons of samples that I have to determine in a month's time. But I also need 15,000*

> *Euros for the single technique I will have to use in my science research work. We are lucky because our lead researcher, my formal supervisor, is a great manager, [and] always succeeds in finding commercial projects. But he also takes care that everybody has his fair share of work and that you are never overwhelmed.* (PN6)

Two important characteristics of the practice of indirect mentoring so far described point to changes taking place at the global level, as well as to disciplinary differences between the natural and social sciences, because of which: the management of the research team has gained increasing importance in the social sciences; and the management of international projects and collaborations, as well as the combination and management of commercial projects in parallel with core research projects, becomes an important skill of project managers in the natural sciences, and one that influences the project team as whole.

4.3. Challenges and obstacles to achieving high-quality mentorship

The last part of the analysis focuses on problems that can be regarded as obstacles to the development of a high-quality mentoring relationship within the structure of formal supervision. These obstacles can be divided into macro-level obstacles (that are structurally-induced) and micro-level obstacles (that are individually-induced).

The most prominent macro-level obstacle to achieving high-quality mentoring in both the natural and social sciences is the teaching burden, both of novices and their formal supervisors. Novices who work at teaching-oriented institutions work both as researchers and teaching assistants. However, their role as teaching assistant takes up so much of their time that they often work on research exclusively outside their working hours, on weekends and holidays. Their supervisors also tend to be overwhelmed by teaching and administrative tasks, and suffer from a shortage of time to dedicate to the research socialization of novices:

> *In this system, you don't have much time or space to dedicate to your novices, assistants, doctoral candidates, etc. My formal supervisor doesn't only have to work on our research project; he has to help other doctoral students on their projects, which are maybe completely unrelated to ours. Those are all justifiable reasons why this relationship between the supervisor and novice can't function in a better manner. Supervisors' resources are spent on too many things.* (DN8)

At the micro-level, there are a number of different individually-induced obstacles to the development of high-quality mentoring within a formal supervisory relationship. For example, at higher education institutions, novices face problems when their formal supervisors are professors who prefer teaching to research, despite the fact that they have to lead research projects and have novices to mentor. This results in leaving novices to structure their own disciplinary research socialization by themselves. There are also cases of supervisors in research-oriented institutions in the social sciences who are somewhat absent and who do not actively mentor their novices:

> *He did show interest in me, occasionally asking me what I am working on, but nothing specific. That is why I was really lost. I didn't know what to do, and nobody gave me any assignments. I would describe our relationship as distanced from the beginning. I was missing feedback and was afraid to ask, but you can hardly expect anything else when you see your formal supervisor rarely: no time, no space for communication, for getting to know each other.* (DZ4)

Although the 'absence' of mentors from research projects is also an occurrence in the natural sciences, this has its roots in two different causes. The first cause is that, in some cases, formal supervisors are deliberately absent from day-to-day laboratory work and act only as project managers, which results in two negative consequences for the young researchers working on those projects. Firstly, the supervisors' insufficient knowledge of new techniques and instruments prevents them for directly teaching novices, which is problematic since research teams in the natural sciences in Croatia are small and lack mid-career researchers who can compensate for the absence of the supervisor.[6] The second problem of the absence of formal supervisors — or their disconnectedness — involves the supervisors' unrealistic expectations of the research team and project as whole, which can create negative tensions:

> *He comes to us with an idea, but because he has done nothing in a lab for years, he is not aware that it is not feasible. So, I start working on it, but it doesn't work. Out of my own frustration I start to analyse the literature to see why I am stuck. And then I see that it can't be done in our lab. Then I have to pull out from the references and bold for him parts from which it is obvious that it can't be done, or he will never stop insisting.* (PZ4)

[6] This point was often elaborated by young researchers in the natural sciences, as one biologist explained:

> *That is the advantage of foreign research teams. You always have a postdoc who will guide you in a lab, show you how to do stuff, where to put things, what not to do. And in an hour's time you have already learned something. We don't have that, and you need two weeks to learn that same thing because you are left to discover old news by yourself.* (PZ1)

The second cause of the absence of supervisors in the natural sciences lies in their ambitions in terms of assuming management positions within their institutions or at the university. When supervisors take on a management positions in addition to their work in research, this affects young researchers both directly and indirectly, since it causes a wider dysfunction in the research team and the project as a whole:

> *I noticed that, since he has had that administrative position, my supervisor is losing track of what is happening because our research project is not something he is really concentrated on. For the past three years he hasn't really spent any quality time in the lab and I've even had to change my dissertation research topic because our experiment had tragically failed.* (PZ5)

The last micro-level obstacle to high-quality mentoring in the natural sciences is one which is induced individually, though it is certainly caused structurally: the need to engage in commercial projects. Some formal supervisors/project managers, either due to weak management skills or because they become overly commercially-oriented, overwhelm their novices with technical tasks that have little to do with their research socialization:

> *One of my colleagues had to measure some substances for some external commercial client in the exact same way every day, and then make a huge number of calculations. And because of it, he had no time to work on anything else.* (PZ8)

Overall, the challenges and obstacles to achieving high-quality mentorship in Croatia stem primarily from structural problems in the research system, even when the obstacles appear to be the results of individual actions. The teaching burden as an obstacle is related to the recent restructuring of the Croatian higher education system and was not followed by a serious restructuring of academic staff and their careers (Bilić, 2009). In principle, everybody is engaged both in research and teaching, even though individual career results clearly show that this is not the case for most academics. The results also show that, in the natural sciences, some obstacles have causes related to changes in the funding of research projects and pressures imposing more managerial duties on the leaders of research projects. Besides the fact that project leaders may not necessarily be competent managers, this new situation provides an opportunity for researchers to choose a more entrepreneurial approach to research by disregarding traditional academic values (Jain et al., 2009), to the detriment of other researchers in the project team.

5. Discussion and conclusions

This study has shown that, in the case of Croatian researchers in the natural and social sciences formally socialized in the 'research novice system', developing a high-quality mentoring relationship with a formal supervisor is almost an essential condition for novices to achieve positive socialization results, such as a good publishing record and having a feeling of competence and self-confidence as a researcher. Based on the socio-organizational characteristics of the natural sciences, the research expected to find that mentoring in this discipline would be provided primarily by the research team as whole, or else some of the team members. Instead, the results show that for young researchers in the natural sciences the role of the formal supervisor as a mentor is equally important as it is in the social sciences. Another finding of this research is that, as the novices themselves described, project teams have become an important socializing environment in the social sciences as well, and it is no long so rare for young researchers to learn basic skills and methodologies through teamwork.

The two most important characteristics of successful socialization environments in both the natural and social sciences depend on the young researchers' formal supervisor/project leader. The first characteristic of a positive socialization environment is related to the development of mentoring within formal supervision. It presupposes that formal supervisors are accessible and interested in young researchers' professional development, and that they systematically provide assistance (knowledge, skills and social capital) to the young researchers during their research socialization. Furthermore, assistance provided to young researchers by encouraging early publishing productivity through instructing, guiding and collaborating with young researchers on research articles, is described as an important pedagogic tool that leads to the complete independence of young researchers (which echoes the findings of Tennenbaum et al., 2001, and Kamler & Thomson, 2006). Those findings indicate that only deliberate and proactive mentoring, rather than just technical supervision (Merriam, 1983; Mullen, 2009), can achieve the goal of ensuring the high-quality professional socialization of young researchers in both disciplines. The second characteristic of high-quality mentoring is related to the project group as a successful and stimulating social and intellectual environment. However, this feature is still closely related to formal supervisors, since a project team evolves most when the project leader is a cooperative and internationally-connected person, a good project manager and highly interested in research.

At the same time, the research shows that high-quality mentoring is not automatically developed within a formal supervisory relationship and that there are a number of structural and individually-induced obstacles that influence the relationship between formal supervisors and young researchers. While some obstacles are clearly related to Croatian policies and reforms in the field of higher education and research (whether by producing obstacles or by making them possible — Dolenec, 2007; Bilić, 2009), some are related to global changes in the funding of academic research and in the role of higher education and research in society in general (Musselin, 2007; El Khawas, 2008; Coates & Goedegebuure, 2012).

The limitations of this study are primarily related to its being a rather small-scale study, in terms of quantitative generalization, and to specificities of the Croatian research system. The problem of quantitative generalization is overcome to some extent by fulfilling the conditions for achieving modes of analytical and transfer generalization, which are more central in qualitative research (Polit & Beck, 2010). Furthermore, locating the research in a specific post-transitional context is an advantage in terms of the possibility of the extension of conclusions to other, similar environments, as well as in terms of observing how different global policies and pressures affect vulnerable research and higher education systems.

To conclude the paper, the research findings will now be discussed in the context of theory and previous research in general, as well as in comparison with previous facts and findings relating to the scientific novices in Croatia and the specificities of the Croatian science system in particular.

With regard to mentoring practices in the field of research, although new research suggests that traditional dyadic mentoring provided by senior researchers is now being replaced by different forms of mentoring (provided from multiple sources, including by peers and informal connections (e.g., Chao et al., 1992; Whitley et al., 1992; Dansky, 1996; Weidman et al., 2001; Sweitzer, 2009)), this study shows that this is not the case, at least not in the Croatian context. However, the findings of this research do confirm authors such as Bozeman and Feeney (2007), who argue that mentoring is a relationship that is developed beyond formal obligations, or Mullen (2008) who suggests that mentoring is a personal investment of a senior colleague. Outside the supervisory relationship with their formal mentor, the novices from the research sample did not succeed in developing any other important mentoring relationship (with a peer or more experienced researcher). One could argue that this is also due to the fact that, in the case of Croatian novices, formal supervision indeed limits their possibilities in 'looking' for mentoring possibilities elsewhere. Because they are assigned by contract to a project led by a senior researcher, who is obliged to report on their progress, the project in question becomes — in a way — their socialization 'destiny'.

The organization of work and the production of knowledge between the natural and social sciences in Croatia in many ways still follows historically established disciplinary differences (Biglan, 1973; Whitley, 1984; Braxton & Hargens, 1984; Knorr-Cetina, 1987; Becher, 1989). For example, the process of learning of how to write a research article is much more important in the social sciences, while in the natural sciences it is a more peripheral concern, which suggests that there are still significant differences in the process of knowledge production between these disciplines.

However, the findings of this study show changes in respect of international findings of the disciplinary practices of doctoral-level learning in the natural and social sciences (e.g., Baugh & Scandura, 1999; Higgins & Kram, 2001; Weidman et al., 2001; Austin, 2002; Golde, 2005; Parry, 2007; Sweitzer, 2009), and also confirm the expected convergence in some aspects of disciplinary work in the natural and social sciences (Wuchty et al., 2007; Mullen, 2008). The findings of this research show that there have been interesting changes in the socialization practices within the social sciences, whereby group learning and teamwork are becoming increasingly important. However, while this is partly a consequence relating to changes in the production of knowledge in social sciences at a global level (Hudson, 1996; Abbott, 2001; Moody, 2004), it is probably also a result of the impact of increasing the 'projectification' of academic work (Torka, 2009). In order to be publically funded, Croatian researchers have to submit three-year projects that will be carried out by a 'project team'. This may have influenced changes in the importance of setting up teams to carry out research within the social sciences, although this connection is yet to be investigated.

Regarding the Croatian post-transitional context, the earlier mentioned low level of investment in the R&D sector and the shortage of academic staff are also reflected in the obstacles to mentoring described in this paper, relating to the overburdening both of novices and their formal supervisors with teaching and administrative workloads in both disciplines. However, projects in the natural sciences experience the most negative changes, since they have expensive experiments and increasing needs regarding trained personnel. These problems are often emphasized through descriptions of lacking of mid-career researchers in natural sciences research teams and of the extreme importance of international collaborations and commercial engagement in order to be able to fund primary research. A lack of mid-career researchers in natural sciences research teams is reflected in reduced possibilities regarding sources for the mentoring of young researchers as well as in the overburdening of the formal supervisor — the leader of the project, who, besides being forced to manage the financial functioning and research team of the project is also the one who has to provide mentoring for the youngest, as is traditionally the case in the social sciences.[7]

Finally, the mentoring problems identified in this paper relating to a lack of research engagement and motivation on the part of formal supervisors, together with the interest of some supervisors in assuming administrative positions, are clearly a consequence of current research policies in Croatia. First of all, the system not only funds the research projects of inactive or insufficiently active researchers — which is clearly irrational — but it also enables uninterested or absent researchers to supervise young researchers, which is a counterproductive policy. In order to support the high-quality mentoring of young researchers in times of negative global trends and influences in the field of research, the policy of assigning novices to research projects in Croatia needs to be thoroughly revised, from building a curriculum related to the professional socialization of researchers within the system, through to establishing proper evaluation procedures for the formal supervising of novices on research projects.

References

Abbott, A. (2001). *Chaos of disciplines.* Chicago, IL: University of Chicago Press.

Austin, A.E. (2002). Preparing the next generation faculty. *Journal of Higher Education,* 73 (1), 94–122.

Austin, A.E. & McDaniels, M. (2006). Preparing the professoriate of the future: Graduate student socialization for faculty roles. In: J. C. Smart (Ed.), *Higher Education: Handbook of Theory and Research*, *Vol. XXI* (pp. 397–456). London, UK: Springer.

Baugh, G.S. & Scandura, T.A. (1999). The effect of multiple mentors on protégé attitudes toward work setting. *Journal of Social Behavior Personality,* 14 (4), 503–521.

Becher, T. (1989). *Academic tribes and territories: intellectual enquiry and the culture of discipline*. Milton Keynes, UK: Open University Press.

Biglan, A. (1973). The characteristics of subject matter in different scientific areas. *Journal of Applied Psychology,* 57, 195–203.

Bilić, A. (2009). Akademska prava sveučilišnih nastavnika i suradnika u Republici Hrvatskoj. *Zbornik Pravnog fakulteta Sveučilišta u Rijeci,* 30 (2), 860–885.

Bozeman, B. & Feeney M.K. (2007). Toward a useful theory of mentoring: A conceptual analysis and critique. *Administration Society,* 39 (6), 719–739.

[7] Novices (doctoral candidates in the natural sciences) cannot rely on having a sufficient number of postdocs on the project for their disciplinary education, unlike their international colleagues (Müller, 2013), among other things because of the specific contextual characteristics of the Croatian science system. Until recently, the Croatian research and higher education system has not supported other ways of funding of postdoctoral researchers other than through the scientific novice programme.

Campbell, D.T. (1986). Relabeling internal and external validity for applied social scientists. In: W.M.K. Trochim (Ed.), *Advances in quasiexperimental design and analysis, 31* (pp. 67–78). San Francisco, CA: Jossey-Bass.

Coates, H. & Goedegebuure, L. (2012). Recasting the academic workforce: why the attractiveness of the academic profession needs to be increased and eight possible strategies for how to go about this from an Australian perspective. *Higher Education,* 64 (6), 875–889.

Clark, B.R. (1993). The research foundations of post-graduate education. *Higher Education Quarterly,* 47 (4), 301–315.

Clark, R.A., Harden, S.L. & Johnson, W.B. (2000). Mentor relationship in clinical psychology doctoral training: Results of a national survey. *Teaching of Psychology,* 27 (4), 262–268.

Dansky, K.M. (1996). The effect of group mentoring on group outcomes. *Group Organization Management,* 21 (1), 5–21.

Delamont, S., Parry, O. & Atkinson, P. (1997). Critical mass and pedagogic continuity: Studies in academic habitus. *British Journal of Sociology of Education,* 18 (4), 533–549.

Delamont, S., Atkinson P. & Parry O. (2000). *The doctoral experience*. London, UK: Falmer Press.

Delamont, S. & Atkinson, P. (2001). Doctoring uncertainty: Mastering craft knowledge. *Social Studies of Science,* 31 (1), 87–107.

Dolenec, D. (2007). Društveno odgovorno sveučilište: a što Bolonja ima s tim? *Političko obrazovanje,* 3 (3–4), 142–147.

Eby, L.T. (1997). Alternative forms of mentoring in changing organizational environments: A conceptual extension of mentoring literature. *Journal of Vocational Behavior,* 51 (1), 125–144.

Eby, L.T., Rhodes, J.E. & Allen, T.D. (2007). Definition and evolution of mentoring. In: T.D. Allen & L.T. Eby (Eds.), *The Blackwell handbook of mentoring: A multiple perspectives approach.* (pp. 7–20). Malden, MA: Blackwell.

El-Khawas, E. (2008). Emerging academic identities: A new research and policy agenda. In: U.A. Amaral, I. Belkilie & C. Musselin, *From governance to identity: A festschrift for Mary Henkel, Higher Education Dynamics Vol. 24* (pp. 31–46). Dordrecht, NL: Springer.

Ehrenberg, R.G., Zuckerman, H., Groen, J.A. & Bruckner, S.M. (2010). *Educating scholars: Doctoral education in the humanities.* Princeton, NJ: Princeton University Press.

Feist, G.J. & Gorman M.E. (1998). The psychology of science: Review and integration of a nascent discipline. *Review of General Psychology,* 2 (1), 3–47.

Gardner, S.K. (2008a). Fitting the mold of graduate school: A qualitative study of socialization in doctoral education. *Innovative Higher Education,* 33 (2), 125–138.

Gardner, S.K. (2008b). 'What's too much and what's too little?' The process of becoming an independent researcher in doctoral education. *Journal of Higher Education,* 79 (3), 326–350.

Gardner, S.K. (2010). Contrasting the socialization experiences of doctoral students in high- and low-completing departments: A qualitative analysis of disciplinary contexts at one institution. *The Journal of Higher Education,* 81 (1), 61–81.

Green R.G., Hutchison, E.D. & Sar, B.K. (1992). Evaluating scholarly performance: The productivity of graduates of social work doctoral programs. *Social Service Review,* 66 (3), 441–466.

Golde, C.M. (2005). The role of the department and discipline in doctoral student attrition: lessons from four departments. *Journal of Higher Education*, 76 (6), 669–700.

Golub, B. & Šuljok A. (2005). Socijalni profil znanstvenika i njegove mijene (1990–2004.). In: K. Prpić (Ed.), *Elite znanja u društvu (ne)znanja* (pp. 123–183). Zagreb: Institut za društvena istraživanja.

Hacking, I. (1992). The self-vindication of the laboratory sciences. In: A. Pickering (Ed.), *Science as practice and culture* (pp. 29–64). Chicago, IL: University of Chicago Press.

Henkel, M. (2000). *Academic identity and policy change in higher education.* London, UK: Jessica Kingsley.

Higgins, M.C. & Kram K. (2001). Reconceptualizing mentoring at work: a developmental network perspective. *Academy of Management Review,* 26, 264–288.

Hudson, J. (1996). Trends in multi-authored papers in economics. *Journal of Economic Perspectives,* 10, 153–158.

Johnson, W.B. (2006). *On being a mentor: A guide for higher education faculty.* Mahwah, NJ: Lawrence Erlbaum.

Kamler, B. (2008). Rethinking doctoral publication: writing from and beyond the thesis. *Studies in Higher Education,* 33 (3), 283–294.

Kamler, B. & Thomson, P. (2006). *Helping doctoral students write: Pedagogies for supervision.* New York, NY — London, UK: Routledge.

Kiopa, A., Melkers, J. & Tanyildiz, Z.E. (2009). Women in academic science: Mentors and career development. In: K. Prpic, L. Oliveira & S. Hemlin (Eds.), *Women in science and technology*, (pp. 55–84). Zagreb, HR: Institute for social research.

Knorr-Cetina, K. (1977). Producing and reproducing knowledge: Descriptive or constructive? *Social Science Information,* 16, 669–696.

Kram, K. (1985). *Mentoring at work*. Glenview, IL: Scott, Foresman.

Lindholm, J.A. (2004). Pathways to the professoriate: The role of self, others and environment in shaping academic career aspirations. *The Journal of Higher Education,* 75 (6), 603–635.

Louis, K.S., Holdsworth, J.M., Anderson, M.S. & Campbell, E.G. (2007). Becoming a scientist: The effects of work group size and organizational climate. *The Journal of Higher Education,* 78 (3), 311–336.

Lovitts, B.E. (2001). *Leaving the Ivory tower: The causes and consequences of departure from doctoral study.* Lanham, MD: Rowman and Littlefield.

Matelič, U., Mali, F. & Ferligoj A. (2007). Kreativno okolje in uspešnost mladih raziskovalcev. *Družbozslovne rasprave,* 23 (55), 71–94.

Macfarlane, B. (2005). The disengaged academic: The retreat from citizenship. *Higher Education Quarterly,* 59 (4), 296–312.

Merton, R.K. (1973). *The sociology of science.* Chicago, IL: University of Chicago Press.

Merriam, S.B. (1983). Mentors and protégés: A critical view of the literature. *Adult Education Quarterly,* 33, 161–173.

Moody, J. (2004). The structure of social science collaboration network: Disciplinary cohesion from 1963–1999. *American Sociological Review,* 69 (2), 213–38.

Mullen, C.A. (2007). Trainers, illusionists, tricksters and escapists: Changing the doctoral circus. *The Educational Forum,* 71 (4), 300–315.

Mullen, C.A. (2009). Re-Imagining the human dimension of mentoring: A framework for research administration and the academy. *The Journal of Research Administration,* 15 (1), 10–31.

Müller, R. (2013). Postdoctoral life scientists and supervision work in the new corporate university. A case study of changes in the cultural norms in science. (Manuscript accepted pending revision *in Minerva).*

Musselin, C. (2007). The transformation of academic work: facts and analysis. In: M. Kogan & U. Teichler (Eds.), *Key challenges to the academic profession* (pp. 171–190). Paris and Kassel: UNESCO Forum on Higher Education Research and Knowledge and International Centre for Higher Education Research Kassel.

Musselin, C. & Becquet V. (2008). Academic work and academic identities: a comparison between four disciplines. In: J. Välimaa & O-H., Ylijoki (Eds.), *Cultural perspectives on higher education* (pp. 91–108). London, UK: Springer.

Nettles, M.T. & Millet, C.M. (2006). *Three magic letters: Getting to PhD*. Baltimore, MA: The Johns Hopkins University Press.

Neumann, R. (2003). *The doctoral education experience: diversity and complexity.* Canberra: Commonwealth of Australia.

Nyquist, J.D. & Woodford, B.J. (2000). *Re-envisioning the PhD: What concerns do we have?* Seattle, WA: University of Washington, Center for Instructional Development and Research.

Parry, O., Atkinson, P. & Delamont, S. (1994). Disciplinary identities and doctoral work. In: R.G. Burgess (Ed.), *Postgraduate education and training in social sciences* (pp. 34–52). London, UK: Jessica Kingsley.

Parry, S. (2007). *Disciplines and doctorates. Higher education dynamics, 16.* London, UK: Springer.

Patton, M.Q. (2001). *Qualitative research and evaluation methods, 3rd edition.* Thousand Oaks, London, New Delhi: Sage Publications.

Polašek, O. (2008). *Znanstvena uspješnost znanstvenih novaka, doktorska disertacija.* Zagreb: Medicinski fakultet Sveučilišta u Zagrebu. http://medlib.mef.hr/357/01/polasek. Accessed 12 September 2010.

Polit, D.F. & Beck, C.T. (2010). Generalization in quantitative and qualitative research: Myths and strategies. *International Journal of Nursing Studies,* 47, 1451–1458.

Prpić, K. (1997). *Profesionalna etika znanstvenika*. Zagreb: Institut za društvena istraživanja.

Prpić, K. (2003). Društvena podcijenjenost znanosti i razvoj hrvatskog istraživačkog potencijala. *Društvena istraživanja,* 1–2 (63–64), 45–68.

Prpić, K. (2004). *Sociološki portret mladih znanstvenika.* Zagreb: Institut za društvena istraživanja

Prpić, K. (2007). Changes of scientific knowledge production and research productivity in a transitional society. *Scientometrics,* 72 (3), 487–511.

Silver, H. (2003). Does a university have a culture? *Studies in Higher Education,* 28 (2), 157–169.

Simonton, D.K. (2004). *Creativity in science: chance, logic, genius and zeitgeist.* Cambridge, UK: Cambridge University Press.

Sweitzer, V.B. (2009). Towards a theory of doctoral student professional identity development: a developmental networks approach. *The Journal of Higher Education,* 80 (1), 1–33.

Tennenbaum, H.M., Crosby, F.J. & Gilner, M.D. (2001). Mentoring relationships in graduate school. *Journal of Vocational Behavior,* 59, 326–341.

Tierney, W.G. & Rhoads, R.A. (1994). *Faculty socialization as a cultural process: a mirror of institutional commitment. ASHE-ERIC Higher Education Report* 6. Washington, DC: The George Washington University, School of Education and Human Development.

Tierney, W.G. & Bensimon, E.M. (1996). *Promotion and tenure: Community and socialization in academe*. Albany, NY: State University of New York Press.

Torka, M. (2009). *Die Projektförmigkeit der Forschung*. Baden-Baden: Nomos.

UNESCO (2010). *UNESCO Science Report 2010. The Current Status of Science around the World.* Paris, FRA: UNESCO Publishing. http://unesdoc.unesco.org/images/0018/001899/189958e.pdf. Accessed 10 November 2011.

Van Maanen, J. (1983). People processing: Strategies of organizational socialization. *Organizational Dynamics,* 7 (1), 18–36.

Van Maanen, J. (1984). Doing new things in old ways: The chains of socialization. In: J.L. Bess, *College and university organization: Insights from behavioral sciences* (pp. 211–247). New York, NY: New York University Press.

Walker, G.E., Golde, C.M., Jones, L., Conklin Beuschel, A. & Hutchings, P. (2008). *The formation of scholars: Rethinking doctoral education for the twenty-first century.* Stanford, CA: The Carnegie Foundation for the Advancement of Teaching.

Weidman, J.C., Twale, D.J. & Stein, E.L. (2001). *Socialization of graduate and professional students in higher education — A perilous passage? ASHE-ERIC Higher Education Report 28 (3).* Washington, DC: The George Washington University, School of Education and Human Development.

Whitley, R.D. (1980). The context of scientific investigation. In: K. Knorr-Cetina, R. Krohn & R.D. Whitley (Eds.), *The social process of scientific investigation* (pp. 297–321). Dordrecht, Holland: D. Reidell Publishing Company.

Whitley, R.D. (1984). *The intellectual and social organization of sciences.* Oxford, UK: Clarendon Press.

Whitley, W., Dougherty, T.W. & Dreher, G.F. (1992). Correlates of career-oriented mentoring for early career managers and professionals. *Journal of Organizational Behavior,* 13 (2), 141–154.

Wuchty, S., Jones, B.F. & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, 316 (5827), 1036–1039.

Zuckerman, H. (1977). *Scientific elite: Nobel laureates in the United States.* New York, NY: Free Press.

List of contributors

Kenedy Alva received a diploma of Advanced Studies in Mathematical Engineering from the University Carlos III of Madrid (Spain) where he taught Statistics and Operations Research courses in engineering and economics degrees. In Peru, he was granted a bachelor's in Statistics from National University Mayor de San Marcos (Lima) and worked for the Ministry of Health on sample designs and the analysis of risk factors in public health. In recent years, he has worked as a statistician at the Institute of Public Goods and Policies of CSIC, applying statistical techniques to information from various databases.

Nadia Asheulova is the director of the Centre for Sociology of Science and Science Studies at the Institute for the History of Science and Technology (IHST), St Petersburg Branch, Russian Academy of Sciences. She is also the academic secretary of IHST and the assistant editor of the journal *Sociology of Science and Technology*. Currently, she is involved in sociological studies of science and technology, S&T policy and mobility. She is a member of the board of ISA RC23 for the sociology of S&T, ESA RN24 and a foreign expert of the Zaheer Science Foundation. She participates in international conferences, delivers invited lectures and organizes local conferences on S&T.

Marija Brajdić Vuković is assistant professor at the Department of Sociology of the Centre for Croatian Studies, University of Zagreb. During her doctoral education, her research interest focused on the professional socialization and career development of doctoral candidates and young researchers, including questions of research productivity, mentoring and career rewarding networks for young researchers. Her current research interest focuses on the relationships between science, technology and society, with a particular emphasis on the knowledge society and sustainable development issues.

Sofia Branco Sousa is a researcher at the Centre for Research in Higher Education Policies (CIPES). Trained as an educationalist, her main research interests relate to higher education studies and the sociology of science. Since her PhD in 2011, she has been particularly interested in the academic profession, science policies and discourse analysis. Sofia's recent publications have addressed discourse analysis in higher education research and the transformation of research production.

Sónia Cardoso holds a PhD in social sciences from the University of Aveiro, Portugal. She is a researcher at both the Office for Research and Analysis of the Agency for Assessment and Accreditation of Higher Education (A3ES) and the Centre for Research in Higher Education Policies (CIPES). She is member of CHER. Her main research interests and publications concern the perceptions and the relationship of students and academics regarding quality assurance in higher education. She has also been involved in national and international research projects on these topics.

Teresa Carvalho is a senior researcher at the Centre for Research in Higher Education Policies (CIPES) and an assistant professor in the Department of Social, Political and Territorial Sciences at the University of Aveiro, where she is a member of the executive committee. She develops research in new public management (NPM) and has a special interest in issues related to the role of professionals in formulating and implementing public policies. She has been the coordinator of the ESA network of the Sociology of Professions (RN19) since 2011. She has published research both in book chapters and in journals, such as *Higher Education*, *Higher Education Quarterly*, *Higher Education Policy* and *Current Sociology*.

Laura Cruz-Castro, PhD in Sociology, is a CSIC research fellow and head of the Department of Science Dynamics, Innovation and Environment of the Institute of Public Goods and Policies. From 1999 to 2003, she was lecturer at the Sociology Department of the University Carlos III of Madrid. She has been a visiting researcher at different universities: Oxford, Georgia Institute of Technology, Georgia, Colorado, Rutgers, among others. She has published on science, education and innovation issues in research in *Sociology of Work*, *Research Policy*, *The Journal of Technological Transfer*, *Regional Studies*, *Research Evaluation*, *Science and Public Policy*, *Scientometrics*, *Technological Forecasting and Social Change*, *PLOS ONE*, etc.

Svetlana Dushina is a fulltime researcher for the Institute for the History of Science and Technology (IHST), St Petersburg Branch, Russian Academy of Sciences. She is the editor of the journal *Sociology of Science and Technology*. Currently, she is involved in research in the sociology of S&T, S&T policy and academic mobility. She is a member of the research committee of Sociology of Science and Technology of Russian Society of Sociologists. She has participated in several international conferences and seminars on science and technology in Russia and abroad.

Anuška Ferligoj is professor of statistics at the Faculty of Social Sciences, the University of Ljubljana. Her main areas of interest are multivariate analysis, social network analysis, assessing reliability and validity of measurement, and the use of statistical methods in various scientific disciplines. She is a member of several editorial boards of international scientific journals. She has published several books and articles in international scientific journals. For the monograph *Generalized Blockmodeling*, she received the Harrison White Outstanding Book Award for 2007 of the Mathematical Sociology Section of the American Sociological Association. In 2010, she received Doctor et Professor *Honoris Causa* at Eotvos Lorand University, Budapest.

Blanka Groboljšek is a research assistant at the Faculty of Social Sciences, University of Ljubljana. She is an author or co-author of articles in national and international journals from the broader field of social studies of science and technology. Her areas of research include the relationship between science and the public, ethical, legal and societal aspects of new and emerging technologies, scientific collaboration, and science and technology policy.

Luka Kronegger is a researcher and teaching assistant at the Faculty of Social Sciences, University of Ljubljana. His research focus is on the analysis of network dynamics in scientific collaboration networks, but he also works on a wide range of applications of social network analysis and multivariate analysis methods.

Franc Mali is professor for sociology and epistemology of science at the Faculty of Social Sciences (University of Ljubljana). He was a visiting research fellow at the Institute for Advanced Studies on Science, Technology and Society in Graz (2004 and 2009), University Bielefeld (1998), University Klagenfurt (1994), University Johannes Kepler in Linz (1992) and at University of Vienna (1989). His recent research focuses on social studies of science and technology. He is particularly oriented towards the issues of the functioning of modern scientific communities, intermediary scientific structures, the evaluation of scientific productivity, social (policy) regulation, and the ethical challenges of new and emerging technologies.

Katarina Prpić, previously a tenured senior scientist at the Institute for Social Research in Zagreb. Her research has focused on the social organization of science, the relationship between science and society, research productivity and ethics, and corporate science. Her publications (numbering around

100), include 15 books (four in English) and papers in eminent international STS journals. She is a recipient of the Award for Social Sciences of the Croatian Academy of Sciences and Arts. She is a member of the editorial boards of several international social science journals and also of international scientific associations. Currently, she is chairing the ESA network Science and Technology (SSTNET).

Felizitas Sagebiel is associate professor at the Department of Educational and Social Sciences (University of Wuppertal) and until 2010 was responsible for a life-long learning study programme. Since 2001, she has been a scientific leader for the university in several European research projects on gender in engineering education, professions and careers, higher education and engineering; on organizational culture in engineering and masculinities, and men's networks in engineering. She led the German project Change and Innovation Potentials of Women on Top (2009–2012). She has published numerous papers and participated in relevant international conferences of different scientific associations as well as in Women's World conferences.

Luis Sanz-Menéndez, a PhD in political science and sociology, is research professor at the National Research Council (CSIC) and director of the Institute of Public Goods and Policies. He has published on research systems, science, technology and innovation policies, and academic careers in journals such as *Public Understanding of Science*, *Research Policy*, *Science and Public Policy*, *Scientometrics*, *The Journal of Technological Transfer*, *Regional Studies*, *Research Evaluation*, *Technological Forecasting and Social Change* and *PLOS ONE*, among others. He has also published a reference book on the analysis of Spanish science and technology policies [*Estado, ciencia y tecnología en España*, Madrid: Alianza Universidad, 1997].

Pleun van Arensbergen works as a researcher at the science system assessment department at the Rathenau Institute in The Hague. Her main topics of research are academic careers and talent selection, with special reference to quality assessment and group decision-making on grant applications. In early 2014, she will finish her PhD on academic careers and talent selection at the VU University, Amsterdam. She studied cultural anthropology and cultural and personality psychology at Radboud University, Nijmegen.

Peter van den Besselaar is a full professor of organization science at the VU University, Amsterdam, Department of Organization Sciences and the Network Institute. Previously, he was research director of the science system assessment department at the Rathenau Institute of the Royal Netherlands Academy of Arts and Sciences; professor of communication studies, University of Amsterdam; director of the Netherlands Social Science Data Archive; and associate professor of social informatics at the University of Amsterdam. His current research focuses on: (i) the organization and dynamics of science, technology and innovation, and (ii) the development of e-social science.

Inge van der Weijden, a PhD in organization sciences, works as a researcher at the Centre for Science and Technology Studies of Leiden University. Previously, she was a researcher of the science system assessment department at the Rathenau Institute of the Royal Netherlands Academy of Arts and Sciences as well as a researcher at the VU Amsterdam University, Department of Organization Sciences. She conducts research on the motivation, selection and evaluation of scholars in order to better understand the career development of scientists. Special attention is given to the academic gender balance. She is also interested in academic leadership.

Izabela Wagner is Polish-French sociologist/ethnographer (PhD, EHESS/Paris). Her research focuses on scientific and artistic careers. She was a visiting scholar in the Department of the History of Science at Harvard, visiting professor at Fudan University (Shanghai), and currently serves as Associate Professor and Vice Director of the University of Warsaw's Institute of Sociology (Poland). She has published, among others, in *Studies in Symbolic Interactions*, *Societes Contemporaines*, *QSR*, and in the book *Becoming transnational professional* (2011). Her forthcoming book, *Producing excellence: Making of virtuoso* will be published in 2014 in Chinese by Normal University Press (Shanghai) and in English by Rutgers UP in the US.

Subject index

academia 5, 7, 13, 55, 59, 64–66, 68, 71, 72, 75, 80, 86, 88–90, 92, 97, 99, 104, 108, 109, 160
academic career(s) 1, 3–8, 10, 17, 25, 26, 55, 56, 60, 61, 86, 87, 99, 100, 104, 106, 108, 118, 122, 123, 127, 136, 140, 171–173, 195, 201, 209, 254
academic elite 8
academic's employment contracts
    duration of 8, 117, 118, 124, 125, 126, 128, 134, 192
academic institutions 8, 110, 174, 175, 191
academic job market 11, 80
academic positions
    non-tenured 127, 132, 141
    tenured 64, 127, 129, 132, 137, 141
academic profession 8, 13, 117, 118, 120, 122, 124, 130, 141, 175, 184, 225, 251
academic women leaders 12
academic work 3, 5, 188, 225, 230, 245
academics' working conditions 8, 13, 117, 118, 124, 126, 134
authoritative agenc(y)ies 16, 17
bibliometric analyses 6
brain
    waste 14
    drain 14
career
    achievement 17, 159
    advancement 7, 11, 17, 18, 55, 56, 61, 72, 75, 80, 81, 104
    determinants 10
    effects 12, 14, 61
    implications 5, 9, 15, 199
    linear career path 17
    polytechnic 13, 121, 129, 132
    professional 8, 109, 171, 178, 197, 199–202, 208, 219
    progression 14, 86, 110, 134, 141, 172
    promotion 10, 16, 103, 104
    prospects 9
    regulations 8
    research 18, 47, 208, 227
    scientific 3–6, 9, 10, 13–16, 18, 19, 21, 27, 87, 164, 167, 173, 184, 186, 197, 199, 200, 218
    stage 17, 226
    studies 1, 3–7, 10, 18, 19
    top 7
    university 13, 58, 121, 129
collaboration
    global trends of 9
    own initiatives for 9
    practices 9, 197, 199, 215, 220
    pragmatic reasons for 9
    scientific 7, 15, 197–199, 202–209, 214–220, 253
comparative research 15, 87
competitiveness 16, 63–68, 80, 118, 203
concept of interregnum 9
concept of relevance 9
concept of scientific fields 9
context
    cognitive 14
    cultural 7, 218
    institutional 8, 9, 56, 122, 171, 172
    national 9, 10, 18, 199
    social 5, 9, 10, 12, 14, 218
    techno-scientific 3, 14
cooperation
    international scientific 14, 180
Croatia
    research community of 227, 235

research novice programme in 282
science system in 15, 244
cross-national investigations 14
cultural origin 8, 159, 168
culture
collaborative and publication 15
disciplinary 9, 15, 220
immigrant 8
discrimination 9, 13, 18, 30, 88, 89, 101, 102, 109, 110, 146, 147
diversity
socio-cultural 6, 150, 163
socio-economic 6
techno-scientific 6
EC (European Commission) 19, 20, 51, 111
education policy studies 3
engineering 7, 8, 16, 18, 32, 62, 65, 68, 73, 75, 80, 81, 85, 86, 88, 89, 90, 92, 95, 96, 98, 99, 100, 101, 103–110, 183, 190, 251, 254
environment
academic 81, 183, 229
social 11, 80, 220
ethnic minority 8
ethnographic studies 145
EU (European Union) 14, 18, 86, 146, 151, 154, 159, 167, 203, 209, 221
evaluation
cognitive and non-cognitive aspects of 11
different aspects of 10
nature and mechanisms of 12
peer 11
scientific performance 10
scientists' work 11
system 217
focus group 91, 100, 236
Gastarbeiter 167, 168
GCI (Glass Ceiling Index) 18
gender
bias 7, 25, 47–51, 88
differentiation 10, 17, 18
gap 18, 59
sensitive 7, 33, 91
stereotypes 87, 88, 90, 92, 94, 95, 100, 105–107, 109
studies in S&T 17
Germany
case studies in 85, 91
ghetto laboratories 8, 13, 145, 146, 149, 150, 163, 166
governance 5, 12, 56, 200, 230
grant
allocations 11
competitive 11
HE (higher education) 3, 5, 62, 82, 85, 86, 88–90, 102, 117, 120, 123, 142, 188, 221, 228, 241, 242, 244, 246, 248, 249, 251, 254
HEI (higher education institution)
public 126, 127, 135
private 126, 135
immigrant scientist(s) 13
governmental research institutions 8
integration 55, 60, 61, 67, 68, 72, 80, 81, 83, 247
international mobility
effects of 182, 187
long-term 68
motives for 186
internationalization of scientific work 8
interview
guided 91
in-depth 9, 183, 230
knowledge production
mode of 5, 9
scientific 5, 22, 249
labour
division of labour 12, 16, 85, 87, 99, 195
leadership style 8, 85, 88, 92–94, 107, 108
life science laboratories 8

mentoring
high-quality 9, 225, 238, 240, 242, 243, 246
practices 9, 15, 225, 230, 235, 236, 238, 244
within formal supervision 243
mobility
across research groups 61, 64–66, 68, 72, 76, 78, 81
international 7, 9, 14, 65, 71, 74, 75, 171, 172, 178, 181–184, 186, 187, 193–195, 201
programmes 192, 194, 195
researchers' 14
scientific 14, 21, 171, 172, 196
sectorial 72, 80, 81
multicultural laboratories 150, 156
national database 6, 8
network(s)
men's 89, 90, 92, 100–102, 105, 109, 110, 111, 254
role of 8, 90, 92, 99
women's 104, 105, 109
networking 12, 17, 60, 82, 85, 87, 90, 91, 99–105, 108–110, 163, 164, 166, 196, 201, 208, 223, 229
non-merit criteria 10, 12
non-tenure period 7
NPM (new public management) 117, 119, 120, 122, 123, 126, 132, 140, 200, 252
NSF (National Science Foundation) 1, 28, 29, 190
output orientation 96, 108
participatory (participant) observation 6, 8, 148, 156
permanent job 13, 55, 56, 60, 63, 64, 80, 81
personnel
development 8
scientific 8, 182, 184
PI (principal investigator) 146, 150, 152–159, 161, 162, 164, 165
policy
local 17
national 17
science 14, 171, 190, 193, 194, 203, 204, 208, 220
Portugal 1, 8, 117, 118, 122, 126, 134, 135, 138, 140, 150, 151, 252
post-socialist 14, 15
post-Soviet 172, 174, 178, 193, 195
promotion
academic 7, 11, 16, 17, 54, 56, 58, 81, 110
speed 7, 16
system 59, 80, 84
productivity
publication 9, 82, 197, 205
research 19, 22, 55, 59, 82, 84, 141, 219, 226, 233, 249, 251, 252
scientific 59, 63, 80, 83, 84, 189, 194, 221, 222, 253
qualitative 4, 6–9, 85, 91, 149, 168–170, 183, 198, 199, 202, 210, 212, 214, 223, 225, 230, 231, 244, 247, 249
quantitative 4, 6–8, 21, 22, 63–65, 67, 183, 190, 198, 202, 203, 222, 223, 244, 249
questionnaire survey 6, 7
RAS (Russian Academy of Sciences) 1, 2, 171, 174, 175, 177, 178, 182, 193, 196, 251, 252
RES (research evaluation system) 5, 11, 12, 15, 21, 22
research funding 11, 88, 164, 185, 203, 204, 209
R&D (research and development) 52, 64, 174, 184, 200, 201, 204, 208, 220, 227, 245
RN24 (Research Network 24) of ESA 1, 251
Russia 1, 9, 14, 102, 150, 165, 171, 172, 174, 175–178, 180, 184, 188–190, 192, 193-195, 252

science(s)
biomedical 66, 68, 75, 77, 78, 168
life and medical 32
natural 16, 17, 50, 62, 68, 75–79, 85, 86, 88, 90, 96, 98, 99, 103, 105, 108–110, 183, 190, 202, 203, 225, 228, 229, 231, 234, 236–243, 245, 246
public and corporate 5
social 9, 15, 16, 19, 21, 32, 46, 62, 82, 83, 135, 173, 183, 196, 202, 203, 207, 214, 222, 225, 227–231, 233–235, 237–241, 243, 245, 246, 248, 249
scientific field(s) 3, 9, 15–17, 61, 62, 75, 80, 110, 182–184, 194, 214
scientific performance 4, 5, 10, 11, 26, 62, 217
scientists' professional socialization 9
self-realization 9, 178, 184, 185
SET (science, engineering & technology) 86, 88
Slovenia
science policies in 209
science system in 208, 209
scientific community of 200, 201, 208, 211
social embedding 7
socialization outcomes 232
sociology
of academic work 3, 21, 143
of higher education 3
of science 4, 5, 12, 19, 21, 27, 51, 53, 169, 182, 196, 200, 223, 248, 251, 252
Soviet science organization 174
Spain 1, 7, 57, 61, 64, 76, 78, 150, 251
specialization 12, 204, 206, 222, 228, 229, 239
SSH (social sciences and humanities) 16, 32, 35, 36, 42, 43, 50, 62, 173, 196, 228
SSTNET (The Sociology of Science and Technology Network) of ESA 1, 3, 254
S&T (science and technology) 4, 5, 12, 13, 17, 18, 21, 222, 251, 252
STS (science and technology studies) 1, 3–7, 10, 12, 19, 22, 254
system(s)
national science 12, 14–16
national university 13
post-socialist science 14
socio-cultural 13
talent
evaluation of 7, 11, 25
evidence of 25, 34
selection process of 7
top 25, 33, 36–39, 50
The Netherlands
career grant applications in 28
time-to-tenure 11, 16, 63, 65–69, 74–76, 78, 80, 81
universit(y)ies
public 7, 8, 57, 62, 64, 121, 125–131, 136, 137, 139–141
uni-ethnical teams 13
US(A) (United States) (of America) 8, 13, 14, 18, 121, 191, 193
USSR (Union of Soviet Socialist Republics) 173, 174, 181, 182
vertical segregation 18
website analysis 8, 91
young researcher(s) 9, 14, 15, 25, 30, 50, 167, 183, 193, 194, 201, 202, 209, 223, 226–230, 232–239, 241–246, 251

Name index

Abbott, A. 119, 143, 245, 246
Abramo, G. 206, 221
Acedo, F. J. 198, 202, 221
Acker, J. 89, 111
Ackroyd, S. 120, 143
Addis, E. 26, 51
Aksnes, D. W. 194, 195
Allen, T. D. 247
Allison, P. D. 21, 59, 82, 83
Alonzo, J. 20
Altbach, P. 136, 140, 142
Alva K. iv, 7, 55, 84, 251
Amaral, A. 21, 135, 142–144, 247
Amsterdamska, O. 20
Anderson, M. S. 248
Andrade, H. 201, 221
Aran, L. 61, 82
Arbesman, S. 176, 195
Arraujo, E. 147, 168
Ashburner, L. 143
Astvatsaturyan, M. 190, 195
Atkinson, P. 221, 229, 247, 249
Austin, A. E. 226, 228, 245, 246
Bagilhole, B. 89, 90, 96, 111, 113
Bagues, M. 30, 54
Bankart, C. A. S. 202, 221
Baron-Cohen, S. 26, 51
Barron, F. X. 26, 52
Barroso, C. 221
Bartelse, J. 20, 52
Baugh, G. S. 226, 245, 246
Bauman, Z. 9, 174, 195
Bazeley, P. 29, 51
Beaver, D. 204, 212, 221
Becher, T. 15, 19, 228, 231, 245, 246
Beck, C. T. 231, 244, 249
Bell, D. 118, 142
Ben-David, J. 61, 82
Bennet, C. 17, 19
Bensimon, E. M. 228, 250
Bento, S. 147, 168
Berelson, B. 58, 60, 64, 82
Berman, J. E. 201, 223
Berryman, S. 19
Biagioli, M. 206, 221
Biglan, A. 228, 231, 245, 246
Bilić, A. 242, 244, 246
Blackburn, R. T. 60, 82
Blagus, R. 223
Blau, P. M. 56, 58, 82
Boardman, P. C. 204, 223
Boeckmann, M. E. 82
Bohmer, S. 52
Bolshakov, K. G. 182, 195
Bond, N. W. 52, 53
Bony de, J. 147, 168
Bordons, M. 84
Bornmann, L. 16, 19, 26–29, 50, 51, 53
Bourdieu, P. 9, 86, 99, 158, 168, 172, 195
Box-Steffensmeier, J. M. 58, 82
Bozeman, B. 5, 19, 60, 61, 82, 198, 201, 205, 221, 222, 227, 244, 246
Braun-Munzinger, P. 206, 221
Broder, I. E. 29, 51
Brouns, M. 26, 51
Bruckman, S. 119, 142
Bruckner, S. M. 247
Brüderl, J. 59, 82
Bureau, V. 119, 142
Burrage, M. 119, 144
Burt, R. S. 89, 111
Busse, T. V. 26, 51
Cameron, S. M. 82
Campbell, D. T. 231, 247
Campbell, E. G. 248
Campbell, R. A. 200, 221
Cañibano, C. F. 61, 82
Caplow, T. 58, 60, 82
Carvalho, T. 8, 13, 117–120, 122–124, 135, 140, 142, 144, 252

Casanueva C. 221
Castells, M. 118, 142
Chan, K. B. 12, 19
Chapman, D. W. 82
Chinchilla-Rodríguez, Z. 205, 221
Choi, S. 207, 221
Chompalov, I. 223
Chubin, D. E. 61, 82
Cicchetti, D. V. 50, 52
Ciriaco, A. D. 221
Ciumaasu, I. 184, 196
Čižek Sajko, M. 223
Clark, B. R. 142, 228, 247
Clark, R. A. 226, 247
Clemente, F. 4, 19, 59, 82
Coates, H. 230, 244, 247
Cole, J. R. 11, 19, 28, 29, 52
Cole, S. 11, 19, 27, 28, 52
Connell, R. W. 90, 95, 111
Copeland, J. 112
Corley, E. 198, 221
Cota, D. 147, 168
Cotter, D. A. 17, 19
Cozzens, S. E. 62, 82
Crane, D. 59, 82
Crockett, J. 83
Cronin, B. 206, 221
Crosby, F. J. 250
Cruz-Castro L. 7, 11, 13–15, 17, 55, 58, 60–62, 82, 84, 252
Dahan, A. 164, 169
Dahmen, J. 89, 113
Dainty, A. 113
Danell, R. 28, 53, 223
Dansky, K. M. 244, 247
Davey, G. 12, 19
Davidson, J. W. 52
De Boyser, K. 52
De Bruin, R. E. 84
De Grande, H. 22, 52
De Paola, M. 30, 52
De Solla Price, D. 22
De Stefano, D. 198, 203, 222
De Weert. E. 20, 52, 200, 222
Defazio, D. 204, 205, 221
Dekker, P. J. 84
Delamont, S. 200, 221, 228, 229, 247, 249
Di Costa, F. 221
Diekmann, A. 59, 82
Dietz, J. S. 5, 19, 61, 82
Dolenec, D. 244, 247
Doppler, D. 111
Doreian, P. 222
Dougherty, T. W. 60, 82, 250
Drakich, J. 84
Dreher, G. F. 250
Drucker, P. 118, 142
Eby, L. T. 226, 247
Edge, D. 4, 20
Ehrenberg, R. G. 226, 247
Eisenhart, M. 28, 29, 52
El-Khawas, E. 230, 244, 247
Enders, J. 13, 20, 57, 82, 119, 136, 143, 200, 222
Ericsson, K. A. 26, 52
Erokhina, K. S. 14, 20
Etzkowitz, H. 17, 19, 20
Evetts, J. 89, 92, 111, 119, 143
Exworthy, M. 120, 143
Farnham, D. 119, 143
Faulkner, W. 88, 89, 102, 105, 108, 109, 111, 112
Feeney, M. K. 60, 82, 227, 244, 246
Feist, G. J. 12, 20, 27, 52, 226, 247,
Felt, U. 200, 201, 222
Ferlie, E. 118, 119, 120, 143
Ferligoj, A. 9, 197, 222, 248, 252
Ferreira, J. 142
Fitzgerald, L. 143
Fleck, L. 160, 161, 168
Fletcher, J. K. 94, 112
Forret, M. L. 60, 82
Fournier, V. 119, 143
Fox, M. F. 56, 59, 61, 62, 82, 83
Frantsouz, Y. 178, 196

Freidson, E. 117, 119, 143
Frenken, K. 222
Fuchs, S. 13, 15, 20
Funken, C. 89, 112
Galán, J. L. 221
García, C. E. 64, 83, 84
Gardner, S. K. 228, 247
Garrison, H. H. 146, 168
Garzón-García, B. 83
Gaughan, M. 82
Geisler, C. 63, 83
Genuth, J. 223
Georgiev, G. 177, 196
Gerbi, S. A. 168
Gheradi, S. 112
Gibbons, M. 5, 20
Gilner, M. D. 250
Giordano, G. 222
Giza-Poleszczuk, A. 160, 168
Glänzel, W. 21, 203, 204, 207, 222, 223
Glaser, B. 149, 168
Gläser, J. 5, 11, 15, 16, 20, 22
Goedegebuure, L. 230, 244, 247
Golde, C. M. 226, 245, 248, 250
Golub, B. 16, 20, 227, 248
González-Molina, A. 221
Goode J. 89, 90, 96, 111
Gorman M. E. 226, 247
Goulden, M. 84
Green R. G. 54, 248
Groen, J. A. 247
Gross, M. U. M. 26, 52
Grudzinski, S. 148, 168
Guetzkow, J. 21
Gupta, N. 18, 20
Hackett, E. J. 4, 20
Hacking, I. 229, 248
Hagstrom, W. O. 59, 83, 200, 222
Halford, S. 120, 143
Hallsten, M. 29, 53
Hara, N. 212, 222
Harden, S. L. 247
Hargens, L. L. 60, 61, 83, 245
Haslam, N. 205, 222
Hassan-Montero, Y. 221
Heidler, R. 212, 222
Hemlin, S. 5, 20, 22, 27, 50, 52, 113, 223, 248
Hendrix, U. 85, 96, 104, 112, 113
Henkel, M. 21, 143, 229, 247, 248
Henriksson, L. 142
Hermsen, J. M. 19
Hessels, L. K. 201, 223
Higgins, M. C. 226, 245, 248
Hodgson, C. 26, 50, 52
Hoekman, J. 205, 222
Hofstede, G. 147, 168, 169
Holdsworth, J. M. 248
Hörlin, S. 112
Hornbostel, S. 29, 52, 221
Horta, H. 55, 58, 83
Horton, S. 119, 143
Howe, M. J. A. 26, 52
Höyng, S. 90, 112
Hudson, J. 245, 248
Hughes, C. 149, 169
Huisman, J. 13, 20, 25, 52, 53
Husu, L. 89, 112
Hutchings, P. 250
Hutchison, E. D. 248
Huutoniememi, K. 21
Ioffe, A. F. 179–181, 196
Ishida, H. 59, 83
Jasanoff, S. 4, 20, 21
Jasinska-Kania, A. 169
Jayasinghe, U. W. 29, 52, 53
Jeong, S. 198, 222
John M. A. 21
Johnson, T. 119, 143
Johnson, W. B. 227, 247, 248
Jones, B. F. 224, 250
Jones, B. S. 58, 82
Jones, L. 250
Jonkers, K. 54, 194, 196
Južnič, P. 223
Kalejs, L. 224

Kaminiski, D. 63, 83
Kamler, B. 226, 243, 248
Katz, J. S. 202, 204, 222
Keerfoot, D. 90, 112
Keith, B. 83
Kemelgor, C. 20
Khodyakov, D. M. 165, 169
Kim, J. 152, 222
Kiopa, A. 60, 83, 226, 227, 248
Kirkpatrick, I. 118–120, 143
Klingsporn, B. 52
Knights, D. 90, 112
Knorr-Cetina, K. 11, 21, 27, 52, 169, 228, 245, 248, 250
Kogan, M. 13, 21
Kolchinsky, E. I. 178, 196
Kozek. W. 148, 169
Krais, B. 86, 99, 112
Kram, K. 226, 245, 248
Kronegger, L. 9, 197, 209, 210, 214, 222, 253
Kuhn, T. S. 161, 169
Laham, S. 205, 222
Lamont, M. 4, 11, 21, 27–29, 50, 53
Lange, R. 90, 112
Lange, S. 20
Langfeldt, L. 28, 29, 50, 53
Larson, M. 119, 143
Lassibille, G. 59, 83
Latour B. 147, 169
Laudel, G. 20, 29, 53, 198, 222
LaViolette F. 148, 169
Leahey, E. 61, 83, 204, 222
Leblebici, H. 84
Lee, S. 201, 222
Levin, S. G. 59, 84
Lewis, S. 112
Leydesdorff, L. 25, 26, 29, 51, 54, 84
Limoges, C. 20
Lind, I. 89, 112
Lindholm, J. A. 228, 248
Lintern, S. 112
Lockett, A. 221
Long, S. J. 4, 21
Long, J. S. 56, 59–61, 83
Lopez, E. 57, 221
Louis, K. S. 226, 248
Lovitts, B. E. 225, 226, 229, 248
Lynch, M. 20
Ma, J. 196
MacDonald, K. 117, 119, 143
Macfarlane, B. 230, 248
Machado, M. 142
Mali, F. 9, 15, 21, 197, 201, 222, 227, 248, 253
Mallard, G. 11, 21
Maloney, N. G. 207, 224
Mansfield, R. S. 26, 51
Maresi, N. 83
Marle, G. E. 20, 21
Marsh, H. W. 29, 48, 52, 53
Martin, B. R. 4, 21, 22, 202, 204, 222
Martin, T. 221
Martín-Sempere, M. J. 60, 61
Mason, M. A. 84
Matelič, U. 201, 223, 226, 248
Matthies, H. 89, 112
Mayo, E. 157, 169
McDaniels, M. 228, 246
McDonald, G. 224
McGee, R. J. 58, 60, 82
McGinnis, R. 21, 59, 60, 83
McGuire, G. M. 101, 112
McLean, C. 88, 112
Melin, G. 28, 53, 61, 83, 212, 223
Melkers, J. 60, 83, 248
Merriam, S. B. 243, 248
Merton, R. 11, 21, 27, 53, 59, 83, 169, 200, 203, 223, 228, 248
Mesec, B. 212, 223
Metz-Göckel, S. 89, 112
Meuser, M. 90, 103, 112, 113
Meyer de, A. 147, 169
Miller, G. 89, 113
Millet, C. M. 226, 249
Mindeli, L. 175, 196

Minkov, M. 169
Mirskaya, E. 14
Moed, H. F. 4, 21, 222
Moody, J. 245, 249
Morano-Foadi, S. 14, 21
Morley, L. 89, 96, 113
Morrison, E. 59, 83
Moya-Anegón, F. 221
Mulkay, L. 20
Mullen, C. A. 226, 229, 243, 244, 245, 249
Müller, R. 230, 246, 249
Mullins, N. 223
Murray, F. 5, 21
Musselin, C. 3, 5, 13, 20, 21, 56, 84, 119, 134, 140, 142–144, 229, 230, 244, 247, 249
Mutz, R. D. 19, 51, 53
Nakhaie, M. R. 59, 84
Nandagopal, K. 52
Navarro Gómez, M. L. 59, 83
Navarro, V. 119, 144
Neave, G. 118, 142, 144
Nederhof, A. J. 62, 84
Nelis, A. 21
Nettles, M. T. 226, 249
Neufeld, J. 52
Neumann, R. 226, 228, 229, 249
Neuschatz M. 20
Newman, M. E. J. 211, 223
Nightingale, P. 21
Nowotny, H. 20
Nozawa, T. 224
Nyquist, J. D. 249
O'Neill, B. 112
O'Brien, T. L. 204, 223
Ohlendieck, L. 89, 103, 113
Olbrecht, M. 28, 53
Oliveira, L. 223, 248
Oliver, E. 140, 144
O'Mara, A. 53
Ornstein, M. 84
Ostrovitjanov, K. V. 179–181, 196
Otamendi, J. 82
Ovadia, S. 19
Owen-Smith, J. 147, 169
Parry, O. 221, 228, 247, 249
Parry, S. 228, 229, 245, 249
Patton, M. Q. 231, 249
Pečlin, S. 208, 223
Pedró i Garcia, F. 84
Penders, B. 5, 21
Perc, M. 208, 211, 223
Perkin, H. 119, 122, 144
Persson, O. 205, 223
Pestre, D. 164, 169
Peterson, J. C. 20, 21
Pettigrew, A. 143
Pfeffer, J. 60, 84
Pike, T. W. 198, 223
Pinch, T. 20, 21
Piro, F. 195
Polašek, O. 226, 228, 249
Polit, D. F. 231, 244, 249
Ponomariov, B. L. 204, 223
Porter, A. L. 29, 53, 60, 82
Powell P. 54
Powell, A. 89, 92, 108, 113
Preisendörfer, P. 59, 82
Prosperina Vitale, M. 222
Prpić, K. 3, 15, 17, 20, 21, 22, 86, 113, 201, 223, 226, 227, 248, 249, 253
Rabinow, P. 147, 167, 169
Rabkin, Ya. 14
Ranga, R. 20
Rasmussen, S. B. 4, 20
Rastetter, D. 89, 113
Reed, M. 119, 144
Reikowsky, R. C. 204, 222
Reskin, B. F. 61, 84
Rey-Rocha, J. 83
Rhoades, G. 118, 144
Rhoads, R. A. 228, 250
Rhodes, J. E. 247
Rijnsoever, F. J. 201, 223
Roring, R. W. 52

Rorstad, K. 195
Rosen, R. 204, 221
Rosser, S. 18, 22
Rossini, F. A. 29, 53
Rubí-Barceló, A. 205, 223
Rudd, E. 83
Sabatier, M.59, 84
Sagebiel, F. 8, 17, 85, 89, 90, 96, 99, 100, 103, 104, 112, 113, 114, 254
Salanzik, G. R. 84
Salter B. 120, 144
Samuelson, P. 202, 223
Sandstrom, U. 29, 53
Santiago, R. 119, 120, 122–124, 140, 142, 144
Sanz-Menéndez, L. 7, 11, 13–15, 17, 55, 57, 58, 60–62, 64, 65, 73, 75, 82–84, 254
Sapir, E. 148, 169
Sar, B. K. 248
Scaffidi, A. K. 201, 223
Scandura, T. A. 226, 245, 246
Schiffbänker, H. 86, 87, 113
Schimank, U. 20
Schmoch, U. 21
Schneider, S. C. 147, 169
Schrettenbrunner, C. T. 85, 104, 113
Schubert, A. 203, 204, 207, 222
Schütz, A. 9, 176, 177, 196
Schwartzman, S. 20
Schweer, M. K. W. 101, 103, 114
Scoppa, V. 30, 52
Scott, P. 20, 248
Sen, A. 118, 144
Seung-Lye, K. 222
Seymour, E. 20
Shapin, S. 5, 22, 142, 147, 169
Shauman, K. A. 59, 60, 84
Shibui, S. 224
Shrum, W. 198, 204, 223
Šidlauskienė, V. 18, 22
Silver, H. 148, 169, 230, 250
Silvert K. H. 148, 169
Simon, G. A. 52
Simonton, D. K. 26, 50, 53, 202, 224, 226, 250
Singh, A. 198, 224
Sivertsen, G. 195
Sloboda, J. A. 52
Smith, S. R. 27, 28, 53
Solís, F. 82
Solomon, P. 222
Sonnenwald, D. H. 205–207, 222, 224
Spiegel-Rösing, I. 22
Spilerman, S. 59, 83
Stare, J. 223
Stein, E. L. 250
Stephan, P. E. 59, 84
Sterligov, I. 191, 196
Stewart, J. A. 82
Stewart, P. 61, 84
Stith A. L. 168
Stoll, A. 112
Storer, N. 200, 224
Strauss, A. L. 149, 168
Su, K. -H. 59, 83
Šuljok A. 16, 20, 227, 248
Suzuki, T. 224
Sweitzer, V. B. 226, 244, 245, 250
Tanyildiz, Z. E. 248
Teichler, U. 13, 21, 249
Teixeira, P. 135, 142, 144
Tennenbaum, H. M. 243, 250
Thomson, P. 243, 248
Tien, F. F. 59, 61, 84
Tierney, W. G. 228, 250
Tijssen, R. J. W. 222
Torka, M. 245, 250
Torstendahl, R. 119, 144
Trow, M. 20
Trowler, P. R. 15, 19
Twale, D. J. 250
Uzzi, B. 20, 224, 250
Van Arensbergen, P. 7, 11, 16–18, 25, 28, 34, 37, 41, 47, 53, 54, 254
Van Balen, B. 25, 54

Van den Besselaar, P. 4, 7, 22, 25, 26, 29, 34, 37, 41, 47, 51, 53, 54, 254
Van den Brink 49, 54
Van der Weijden I. 1, 2, 7, 22, 25, 37, 53, 255
Van Maanen, J. 228, 250
Van Raan, A. F. J. 4, 22
Van Rossem, R. 52
Vanneman, R. 19
Vargas-Quesada, B. 221
Vaske, A. K. 101, 103, 114
Vázquez-Cupeiro, S. 95, 114
Verbakel, J. M. A. 21
Verbree, M. 5, 22
Viner, N. 29, 54
Von Ins, M. 52
Wagner, I. 8, 13, 145–147, 152, 153, 166–168, 170, 255
Wajcman, J. 20, 88–90, 92, 105, 108, 109, 114
Walker, G. E. 228, 250
Walker, R. 143
Walsh, J. P. 55, 207, 224
Weidman, J. C.226, 244, 245, 250
Wennerås, C. 29, 54
Whitley, R. 5, 11, 13, 15, 17, 20, 22, 200, 224, 228, 229, 231, 245, 250
Whitley, W. 244, 250
Wierzbicka, A. 151, 155, 170
Wilder, R. L. 161, 170
Wilz, S. M. 89, 114
Wirth, L. 149, 170
Wold, A. 29, 54
Wolfinger, N. H. 59, 84
Wong, P. K. 198, 224
Woodford, B. J. 249
Woolgar, S. 147, 169
Wouters, Paul 2, 3, 55
Wray, K. B. 176, 195, 202, 203, 205, 206, 220, 224
Wrede, S. 142
Wright, M. 221
Wuchty, S. 205, 224, 229, 245, 250
Xie, Y. 59, 60, 84
Yegros-Yegros, A. 21
Yoshikane, F. 224
Young Choi, J. 222
Yurevich, A. V. 174, 196
Yusupov, R. M. 175, 196
Ziman, J. 200, 224
Zimmermann, K. 89, 112
Zinovyeva, N. 30, 54
Zola, I. 119, 144
Zuckerman, H. 202, 203, 224, 226, 247, 250
Zulueta, M. A. 84
Zutshi, A. 201, 207, 220, 224
Zwaan, R. A. 84

(RE)SEARCHING SCIENTIFIC CAREERS

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AND NADIA ASHEULOVA

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Katarina Prpić
Inge van der Weijden
Nadia Asheulova

The rationale for preparing a scientific meeting and subsequent book on academic careers rests not only on the cognitive and policy relevance of this research theme but also on its neglect and underrepresentation in STS (science and technology studies).

The twofold meaning (of its title) denotes the two aims of the book. The first one is to present some relevant findings on searching for a scientific career, which has an additional connotation of a personal activity in career development. The second goal was to simultaneously present some interesting approaches and methods for researching scientific careers. In a word, both the social phenomenon and the modes of its study are the subjects of this book.

All the book chapters are empirical but theoretically well-informed and well-founded research. The qualitative studies are based on interviews, and one of them also applied participatory observation. The quantitative studies mostly use questionnaire surveys or national databases, sometimes combining them with bibliometric analyses. There are also combinations of both quantitative and qualitative methods, which have become a desirable methodological option for research into more complex social phenomena. Such methodological variety indicates that career studies might have promising reconciliatory potential, to encourage bridging the gap between the two traditional streams of STS, the hiatus between qualitative and quantitative methodologies, and their alleged critical or positivistic theoretical correlates.

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