NANOSCIENCE ON THE MOVE
The Impact of Global Scientific Mobility on Academic Research and Career Development

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ABBREVIATIONS

ALMs – Academic Labour Markets
HSM – Highly Skilled Migration
OECD – Organization of Economic Cooperation and Development
S&T – Science and Technology
SMT – Scientific Migration Trajectory
STI – Science, Technology and Innovation
STS – Science and Technology Studies
WoS – Web of Science
ABSTRACT

Nanoscience on the Move: the impact of global scientific mobility on academic research and career development
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This thesis offers a mixed-method exploratory investigation of global scientific mobility. Contextualised as an important factor in the development of national capacities in science and innovation, global scientific mobility has so far remained a relatively underdeveloped subject in current scholarship. In this doctoral research, the focus on the impact of global scientific mobility that entails change of affiliation on (1) research practice, in particular, boundaries of academic activities, and (2) career development trajectories, increasingly affected by globalisation, is assumed.

This research responds to the interest among academic and policy communities in the role of human resources in science-driven economic growth. It integrates three sets of literature, encompassing systems approach to studying learning and innovation; transnational approach to migration studies, and social studies of science that focus on academic citizenship, to explain global transformations in scientific mobility flows across countries and regions; and the post-migration impact of scientists in host organisations and communities.

Empirically, this research focuses on career trajectories and elements of academic practice of Russian-speaking nanoscientists educated in post-Soviet countries and working abroad. The Soviet Union was an internationally isolated research system and developed peculiar norms of organisation, communication and governance of science. After the breakdown, post-Soviet countries experienced large-scale human capital flight. Nanotechnology is a generic technology, thought to aggregate advanced use-inspired areas of physics, chemistry and engineering. Around the world, nanotechnology has significant political importance. Policy and public-driven emerging technology agendas reveal contribution of competent post-Soviet scientists, but also elicit differences in approaches and rewards.

This study finds significant transformations in scientific mobility flows caused by globalisation-induced opportunities. As relocation becomes easier to accomplish, scientists increasingly build their careers not only in multiple organisations, but also in multiple countries. At the same time, national differences in career development paths and norms of academic community membership have significant influence on career development opportunities of scientists. However, unique skills developed during mobility open up alternative options for globally mobile Russian-speaking nanoscientists, such as engagement in transnational science diaspora networks.

This research contributes to understanding of scientific mobility as a simultaneous, continuous, network-based process. It further provides insight into development of multidisciplinary research area that encompasses broader understanding of roles, activities, contributions and opportunities of foreign-born scientists in the globalising world.
DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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I would like to express my deepest appreciation and gratitude to my supervisors, Philip Shapira and Ian Miles, for guiding me through this process. Their ongoing attention and advice are among the core sources of my reflection represented in this work.

For three and a half years I also worked on a research project ‘Emerging Technologies, Trajectories and Implications of Next Generation Innovation Systems Development in China and Russia’ supported by the Economic and Social Research Council [grant number ES/J012785/1]. My work on that project is a ‘connecting vessel’ with this research especially at early stages of idea generation and research design development. I would like to express my gratitude to the Manchester – Atlanta – Beijing Innovation Co-lab team members who helped me develop ideas and skills: Abdullah Gök, Yanchao Li, Jan Youtie, Alan Harding, Sanjay Arora, Oliver Shackleton, Fatemeh Salehi, Marianne Sensier, Alex Waterworth, Chao Li.

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DEDICATION

To Tom,

of course.
CHAPTER 1 INTRODUCTION
Skills and competences, especially in the knowledge economy, become the main asset of nations (Lundvall, 2010). Scientific research plays a key systemic role in knowledge generation of advanced and emerging industries, and also in the process of transforming knowledge into innovations for the ultimate social and economic gain (Carayannis and Campbell, 2009; Etzkowitz and Leydesdorff, 2000; Gibbons et al., 1994). Furthermore, scientific community has potential to make groundbreaking discoveries that can propel countries into a new technological age (Betz, 2011; Lieberman and Montgomery, 1988; Murmann, 2003; Porter, 2011; Zucker and Darby, 1996).

However, most developed countries experience shortage in national skills (Cohen and Zaidi, 2002; Macaulay et al., 2010), especially when it concerns the most advanced and emerging technological areas, such as nanotechnology (Fonash, 2001). Among others, the inflow of human capital from abroad is recognised as a source to replenish the skills missing in the national economy (Burt, 2002). Countries now compete for the global talent (Florida, 2006). Globally mobile scientists constitute a growing part of national skills base of most developed economies. Around a half of all doctorate holders in countries like Canada, Australia, Israel, New Zealand and Luxembourg are foreign-born. A third of all doctoral holders in the USA originate from abroad (OECD, 2015).

In recent years, social research paid much attention to the role of globally mobile scientists and engineers in facilitating technological development of their countries of origin and residence alike (Tang and Shapira, 2012; Saxenian, 2007, 2005; Shin et al., 2014; Sternberg and Müller, 2010). However, the understanding of how exactly diverse and heterogeneous composition of highly skilled human capital contributes to innovative development, and how global mobility affects academic opportunities of scientists themselves is still limited.

On average, findings indicate that foreign-born scientists tend to patent (Hunt and Gauthier-Loiselle, 2009) and publish (Stephan and Levin, 2001) more, and their general positive spillovers tend to outweigh negative implications, such as communication costs (Niebuhr, 2010; Zellner, 2003). While these indicators are important, other literature suggests that academic activities now encompass a much broader area: public research organisations act as innovation and social development agents, partake in policy decisions, train next generations highly skilled human resources (Crow and Dabars, 2015; Etzkowitz et al., 2000; Laredo and Mustar, 2000; Youtie and Shapira, 2008). Rules of ‘academic citizenship’ are
changing across countries as the ‘ivory tower’ perspective on the role of science in society is dismantled (Macfarlane, 2007).

With the advance in communication and transport technologies, the landscape of scientific work is changing towards greater interconnectedness and greater mobility (Archibugi and Filippetti, 2015). Some authors suggest that transnational relations have primary role for scientists, and traditional frameworks of analysis that confine the study of scientific research to country level are simply misleading (Gaillard and Gaillard, 1998; Heilbron and Guilhot, 2008; Meyer et al., 2001). There is, therefore, a tension between the global outlook on academia and its embeddedness in the national social fabric (Latour, 1998). This tension has implications for countries, public research organisations, and scientists themselves.

1.1 Research Problem
The increase in mobility of highly skilled persons, including scientists, is expected to be a major factor shaping the development of science, technology and innovation (STI) systems in the interconnected world (Smits et al., 2010). However, the impact of mobility on academic outputs, strategies and practices of scientists themselves is poorly understood, especially on the micro-level. Only few existing studies explicitly connect the global change towards increasing scientific mobility with the change in academic identity and practice.

This constitutes a research problem as well as a policy problem, as various stakeholder communities, including national governments of sending and receiving countries, and research-performing organisations, have to tackle the problem of managing STI human capital to maximise research, innovative, and societal outputs. This study proposes to investigate the research problem by analysing (i) scientific mobility trajectories (SMTs) and (ii) academic identity and practice of post-Soviet Russian-speaking researchers with the purpose of highlighting the impact of international mobility.

The research objective is therefore to establish a causation link between scientific mobility as a macro-level trend occurring globally across continents, countries and regions, and has been increasingly intensifying in the past years, and tangible aspects of academic practice, such as SMTs, academic activity profiles, career development, and associated strategies that scientists use to cope with challenges of the global situation.

Designing methodologies to measure, understand and manage scientific mobility presents a pressing challenge for academic community. While recent trends focused on macro-level mobilities using recently available bibliometric databases (Moed et al., 2013; Moed and
Halevi, 2014), others point to the increasingly circulatory, transnational and networked nature of scientific research, where the mobility becomes an inalienable aspect of the job (Blachford and Zhang, 2013; Jonkers and Cruz-Castro, 2013; Leung, 2013; Lewin and Zhong, 2013).

Research collectives around the world are communicating more, enabled by modern technology. Scientific mobility is not a physical relocation between two countries anymore, but is rather a state of being, a way to live and work for a researcher. As more scientists become globally mobile, analysts have strived to understand this shift in mobility patterns. This research aims to contribute to this growing body of literature by addressing two research gaps and answering two research questions (RQs), as a way to achieve the research objective:

1. What are the drivers of the global scientific mobility?
2. How does global mobility affect academic activities and career development opportunities of scientists?

The first RQ is contextualised in the framework of global competition for highly skilled human resources in science and technology. I propose, that global scientific mobility becomes easier to accomplish in the circumstances of greater interconnectedness of research-performing organisations around the world. Studies reported the increase in rates of scientific mobility (Ackers, 2008; Morano-Foadi, 2005), and also the diversification of mobility flows, moving away from unidirectional understanding of scientific mobility as the ‘brain drain’ (Cañibano and Woolley, 2015; Ganguli, 2014). Some evidence towards the emergence of global academic labour markets (Musselin, 2005, 2004) implies institutional reconfiguration of scientific mobility flow drivers.

As a result, it becomes easier for scientists to build a global academic career. Consequently, attracting global scientific talent to a country or a region becomes only a part of the task for policy actors. Globally mobile academics can potentially leave just as easily as they arrived. Research on retaining highly skilled professionals has been, with a few exceptions (Khoo, 2014; Oishi, 2012), limited, and is bypassed completely in the scientific mobility scholarship so far.

The second RQ focuses on the impact that the change in social, cultural and institutional context, which is a result of scientific job mobility, has on activities of scientists. Extant research focuses on scientists as bearers of unique embodied knowledge and skills, which
include networks and creativity (Bozeman and Corley, 2004; Heinze et al., 2009). Scientists are seen as assets to the national systems of production and competence building (Lundvall et al., 2002; Powell and Snellman, 2004). As a result, mobile scientists are given incentives to relocate.

However, there is contested evidence for this expected contribution. Human capital is deeply encultured (Erel, 2010), and so are tacit knowledge and know-hows. I propose that the powerful global trends towards greater mobility, greater cooperation and greater cohesion between geographically dispersed research collectives meet a counter-tendency towards very national understanding of the scope and normativity of scientific profession on the large part of this community. It is not, therefore, a given, that globally mobile scientists will contribute to the national STI development in the ways policymakers expect them to.

I, therefore, question and unpack the ‘no-transaction-costs’ of scientific migration assumption that has been prevalent among studies that showed increased scientific productivity returns post-mobility (Baruffaldi and Landoni, 2012; Franzoni et al., 2014). Moreover, I criticise the reductionist approach to scientific productivity assessment by invoking broader understanding of academic communities as nationally bounded scientific, but also economic, political, educational, and social actors (Laredo and Mustar, 2000). I propose that the experience of mobility has uneven impact on different academic activities. Thinking about academic communities as self-governing collectives with autonomous recognition and reward systems (Whitley, 2000), I also propose that mobility can have effect on career development path of foreign-born scientists.

1.2 APPROACH AND DEFINITIONS

1.2.1 APPROACH

RQs point to, first, inconsistencies between traditional scientific mobility frameworks and potentially transformative processes of global change, and, second, to tensions between macro-level assumptions and meso-level findings related to academic activities of mobile scientists. To address them, I attempt to unpack some of the assumptions and undertake an interdisciplinary deductive exploration.

Opening up established ‘blackboxed’ concepts of research (Latour and Woolgar, 2013) is achieved by interdisciplinary integration, and by theory-driven exploration. This study develops a quasi-mixed methods design heavily skewed to the qualitative discovery. While this approach imposes certain limitations, such as generalisability and further data
validation, its findings are useful for multiple disciplines and multiple stakeholder communities.

Scientific mobility is happening on the global scale. In this work, the focus is assumed on post-Soviet Russian-speaking nanoscientists. The two selection criteria – the sending country and the technology area – delineate the study population for multiple reasons.

Exploring differences between academic communities requires a comparison point to clearly distinguish between members of these communities and to elucidate the impact of mobility. Additionally, significant differences in the type and range of academic activities across disciplines of science and technology suggest selecting a technological focus for research. An interest in an emerging technology on part of a variety of stakeholders can illuminate the activities and interactions scientists engage in.

Next paragraphs extend the reasoning behind the focus on Russian-speaking nanoscientists. The following part focuses on the key terminology in the thesis.

**Russian-speaking Scientists**

The case study group for this research is the overseas community of Russian-speaking scientists who were educated in the countries of the former Soviet Union. Russia and other post-Soviet countries stand out among other Eastern European countries who were also severely affected by the brain drain after the dismantling of the Eastern Bloc in the early 1990s, such as Romania (Ciumasu, 2010), Poland (Mulec, 2011), or Moldova (Tejada et al., 2013).

The Soviet Research system was marveled at for its technological achievements, especially in space research, military, nuclear research, and in civilian science - in theoretical physics and mathematics. It was, and Russia is after the USSR broke down, the centre of gravity for scientific cooperation in Eastern Europe (Glänzel, 2001).

The scale and magnitude of ‘brain flight’ from the post-Soviet countries was devastating (see more in Chapter 4). Potentially, the impact of Soviet-born scientists on various areas of science and technology abroad, from discovering graphene to working in the leading IT companies of the Silicon Valley, has also been enormous.

Whereas some effort was made to understand the impact of Eastern European migration flows and scientific diasporas on home and host countries (for examples see Straubhaar and Wolburg, 1999), the issue of Russian(-speaking) migration in comparison has been little
investigated in the Western scholarship. Most studies have concentrated on the attempts to calculate the rates of outward migration from the country (Gokhberg and Nekipelova, 2002; Riazantsev and Pis’mennaia, 2010; Shevtsova, 1992).

The void in the literature exists when it comes for the data on subsequent mobilities and career paths of émigré scientists. One line of scholarship investigates adaptation issues of the general population of Russian-speaking post-Soviet immigrants in large recipient countries, such as Israel (Siegel, 1998). Only a few works have so far attempted to assess the impact of large-scale scientific out-migration. Among them, Borjas and Doran (2014, 2012) find that a significant influx of scientists from the Soviet Union ‘sovietised’ American mathematics, changing research agendas, distribution of human resources and even some institutional elements of the US mathematics.

As the Soviet Union was in almost complete isolation from the rest of the world for the large part of the 20th century, the differences in organisation of Soviet and US mathematics are more striking than those between countries that have been in conversation with one another or even formed a part of the global dialogue.

Post-Soviet Russian-speaking scientists are therefore a unique globally mobile cohort. After departing from the Soviet Union, many internationally renowned scientists brought their unique ‘Soviet’ embodied knowledge with them. They are the typical highly sought-after human resources for STI. Mobility trajectories, drivers and the eventual achievements of these scientists have so far not been investigated and are a good empirical case for this research.

**Nanotechnology**

The task of studying scientific mobility is complex with regard to the focus. With very few exceptions (for example, Jöns, 2007), mobility research divides social, natural sciences, and medical sciences and studies mobility of these three groups. However, even within, for example, natural scientists, say, biologists and mathematicians have very different practical and ethical principles of organising their research, different types of communications with non-academic communities.

Nanotechnology is a platform technology. As an enabling emerging technology, it provides novel approaches and instruments of research in multiple disciplines of natural sciences. Nanoscience spans multiple disciplines, including physics, chemistry and engineering, and is generally defined as research that involves objects on nano-scale. Outputs of
nanotechnology research are diverse and associated with high degree of innovation (Shapira et al., 2011). Therefore, it provides enough homogeneity in the data, but at the same time is generalisable for the sciences in the knowledge-based economy.

The value of using nanoscience as a focus of this research is twofold. First, it is typically use-inspired, but also requires high level of scientific sophistication and the quest for fundamental understanding (Stokes, 1997). Nanotechnology encompasses frontier research of the disciplines that constitute it, which is often complex from methodological, theoretical or experimental perspectives. Significant amount of nanotechnology research is also interdisciplinary. Nanotechnology requires not only the best minds to work on its problems, but also significant and sustained financial support.

Second, nanotechnology has been prized as a potentially revolutionary technology that can transform modern societies (Roco and Bainbridge, 2002). By 2010, Roco (2011) places the total cumulative US investment in nanotechnology at $12 billion, second only to the space programme. This resonated around the world, and over 60 countries of Europe, Asia and Americas also adopted their own National Nanotechnology Initiatives, therefore entering the ‘global Nano race’ (Hullmann, 2006; OECD, 2010).

As a result, nanoscience is a research area with significant public and political attention to it, especially in the USA. Nanoscience research is heavily funded, but returns are expected as well. These returns are not only research results and commercialisation, but also participation in the public dialogue about benefits and hazards of nanotechnology, and ongoing management of political expectations (Fisher and Maricle, 2015).

Some researchers move from a country with the ‘ivory tower’ perspective on science, such as Russia, to highly publicly accountable nanotechnology research environment. The impact of this scientific mobility on academic activities, further mobilities and career development perspectives of émigré researchers provides the empirical data to address the research objective.

1.2.2 Definitions
This thesis employs some unconventional terminology, which has so far gone unexplained. This includes the use of ‘global scientific mobility’ instead of more conventional ‘scientific migration’ and the use of terms like ‘academic career development’ in relation to scientists and researchers. These will be specified in turn below.

Global Scientific Mobility
Global scientific mobility is not a universally accepted definition of the processes of permanent geographic relocation of scientists. A much more dominant approach is the ‘scientific migration’ research, as a part of migration of the highly skilled, as a part of labour migration. Studies of scientific migration use available demographic, bibliometric or other data to track the movement of scientists across countries, sometimes providing an analysis of reasons alongside.

There are multiple problems with the use of the concept of ‘scientific migration’ and associate theories in the context of this study. Mainly, ‘scientific migration’ presumes the existence of a starting point and the final point in the ‘migration project’. Hence, there is classification into sending and receiving countries. There is an increase in accounts of how this actually is not the case. New contributions to the field of general migration research stress the facts that migrants may go through multiple countries (Patterson, 2014); can swing back and forth between the sending and the receiving country (Granes et al., 1998); or be embedded in transnational networks that do not coincide with national borders (Bilecen and Faist, 2015). Additionally, some stress that the ‘migration project’ can’t be said to ever be finished, even if there is no further intention to migrate, because, should the need arise, migrants can migrate again (Constant and Zimmermann, 2011).

This relates all too well to scientific migration. Usually, quantitative scientific migration studies list such limitations, like (a) it is hard to distinguish between temporary and permanent scientific migrants (no intention to return, or no intention to not move onwards), and (b) it is impossible to distinguish between first time migrants and onward migrants.

Therefore, the concept ‘migration’, in its most straightforward sense of permanently moving from one country to another, is not suitable in the context of the social phenomenon examined in this thesis. Instead, the term ‘global scientific mobility’ is employed. It follows a body of scientific mobility, limited so far, which distinguishes ‘job mobility’ and ‘non-job mobility’ instead of ‘scientific migration’ and ‘scientific mobility’ (Flanagan, 2015).

Global scientific mobility may imply permanent as well as temporary movement of scientists across national borders, and between regions of one country, or even cities between one region. All types of permanent (‘job’) mobility – between countries and within one country – are examined in this work.

Some parts of this thesis use the word “scientific migration” interchangeably with ‘global scientific mobility’, but only when it is a part of an established discourse, and is accurate
when used to signify permanent movement from one country (of origin) to another country (of residence).

**Academic Community and the Academe**

All academics are scientists, but not all scientists are academics. All scientists are researchers. In most countries, there is division between private R&D and public academe. These differ by the type of job, the nature and scope of research, funding sources and, usually, paygrade. The two groups are not isolated: scientists may organise themselves into ‘learned communities’ and form ‘invisible colleges’ based on the principles of shared research agendas and not organisational elements of their research.

However, the research environment for scientists employed in public research (distinguished by the criterion to produce results accessible publicly) is drastically different for scientists employed in private laboratories, whose main job is orientation to the need of the client. While the types of knowledge produced may sometimes converge (Crow and Bozeman, 2013), the scope of activities, rewards structures and career development trajectories of the two types are drastically different.

This study will focus on public science, which is termed here as an ‘academic community’. Academic community includes scientists that form an internationally recognised establishment of research activities (Rossi, 2008). Academic communities can be found in public research organisations, mainly universities, and share commonly agreed rules of conduct. These rules include measures of merit, recognitions of achievement, norms and standards of research and communication in the community.

Most works on philosophy and sociology of science study academia. For example, ‘normal science’ is recognised in the academic community (Kuhn, 2012). Scientific programmes are agreed on, approved and adopted by academic communities (Lakatos and Musgrave, 1970).

This thesis deals with the global scientific mobility of academics. It therefore problematises the impact of global mobility on the career development of academics within academic organisations and career paths. The second problematic area is the variety of activities that academics do routinely as a part of their academic job, or because they think that these activities constitute a part of academic identity. Academic identity relates to the scope of practices that are thought to be constituent and appropriate of academic activities, a form of occupational identity. It will be explained further in the conceptual framework of this thesis.
1.3 Thesis Structure
This thesis is organised into three parts and eight chapters (see Figure 1).

![Figure 1 Thesis Structure]

Source: author

Chapters 1 and 8 introduce research questions and provide answers correspondingly.

The first part of the main body of the thesis frames the research problem by, first, contextualising research questions in the literature and by outlining the conceptual framework in Chapter 2. Chapter 3 lists approaches and methods used to collect and analyse the empirical data.

The second part of the thesis contextualises the research problem by giving a detailed overview of the study population and its mobility environments. Chapter 4 overviews Russian-speaking scientific migration flows and lists the literature published in English and Russian that has so far attempted to evaluate the extent of post-Soviet brain drain. It then proceeds to identify scientists of Russian heritage (and, by proxy, of the Russian/Soviet origin) who reside outside of post-Soviet countries and regularly publish in nanotechnology.
The third part explains the social phenomenon studied in this work. Findings from the qualitative research fieldwork are presented in Chapters 5, 6 and 7, which also answer research questions of this thesis.

Chapter 5 analyses globalising academic labour markets (ALMs) in terms of their institutional set-up, career trajectories and academic career development strategies of Russian-speaking nanoscientists who enter these markets. It answers the first RQ.

Findings that provide the answer to the second RQ are split between chapters 6 and 7. Chapter 6 focuses on the micro-level dynamics. It stresses the role of pre-existing practices and habits in the context of scientific research, and their resulting importance for academic identity and practice.

Chapter 7 focuses specifically on one adaptation strategy of globally mobile scientists in the new environment: science diaspora networks. The chapter analyses types, functions and development cycles of science diaspora networks.

The main findings of this work and the explicit summary of answers to the RQs are presented in Chapter 8, which concludes the thesis. The chapter also offers theoretical, conceptual and methodological contributions useful for academic and practitioner audiences.
CHAPTER 2 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION
This chapter reviews relevant streams of literature with the purpose to substantiate research questions in the context of existing scholarship, and to construct an analytical framework for building an exploratory research design that seeks to answer the research questions.

The first part of the chapter reviews three streams of literature and identifies two gaps in existing research. The second part of the chapter introduces sub-research questions and operationalises frameworks and concepts used to address the gaps and provide answers to the RQs.

2.2 LITERATURE REVIEW
This work draws on three streams of literature. The first stream provides general foundations and framing conditions as seen in the role of science and talent as sources of economic development. I draw on endogenous growth theory that describes localised human capital, and on science and innovation research that outline economic significance of scientific research.

Scientific mobility, as embodied human capital transfer, is an increasingly important constitutive element of these general theories. It is the second, core, set of literature reviewed in the chapter. Scientific mobility is a type of migration of the highly skilled and shares some key features with this general global flow. Similar frameworks, such as ‘brain drain’, circulation and exchange, have been mutually developed. Scientific mobility also has distinctive traits and factors, which are reviewed separately.

The third set of literature covers supporting theories and concepts that are used in this work to build critical argument towards the core line of scholarship, and to construct a conceptual framework, allowing to address research gaps. I rely on two main sets of supporting literature. Research that has describes the breakdown of the ‘ivory tower’ and related processes of (various) increasing engagements of academia in the life of society, as well as increasing role of the public in academia, is used to conceptualise academic activity profiles of scientists. Second, the literature on recognition, merit and rewards in science is used to contextualise career-based mobility, influences of globalisation and academic career development opportunities.
Two research gaps are identified at the end of the section. One connects directly with the broader theory of growth within national borders. The other is identified by invoking concepts from the supporting literature to explain inconsistencies within the mobility scholarship.

2.2.1 Theoretical Foundations of Research
Two main theories that provide foundations of this research formulate the basis of assumptions, research questions and propositions in this study. These are endogenous growth theory and science-driven innovation and development, seen in a dominant system of innovation framework. They are reviewed in turn below. Scientific mobility is not directly constituent in either of the theories, but has been named as an important factor of globalisation influence. Effects of scientific mobility for home and host countries in the context of NIS and growth theories are reviewed in the last part of this section.

Endogenous Growth and Human Capital
Endogenous growth theory stresses internal competences of a country for its long-term economic development (Romer, 1994). In the age of increasing global interdependence and volatility of financial markets, endogenous growth theories offer a promise of stable and steady development for countries with strong national capacities.

These models conceptualise two main factors of growth: technological development in the Schumpeterian sense of ‘creative destruction’ (Schumpeter, 1934), and the knowledge base. Accumulated knowledge was regarded by early growth theorists as a source of innovation and development of firms.

On the national level, knowledge is conceptualised as human capital. While most approaches stress the role of education (Aghion et al., 1998), some pay attention to immigration as a way to obtain highly skilled human capital. For instance, Kemnitz (2001) reports higher returns from highly skilled immigration to native population, while Haque and Kim (1995) report accumulation of human capital and increased returns in countries of immigration, and also individual returns of migration proportionate to the level of human capital.

Not only high quality human capital, but also creative and diverse human capital is seen as crucially important for innovative economic development. In a series of works on regional development, Florida (2005) showcased transformations of depressed and impoverished regions into vibrant and productive communities as a result of influx of new diverse groups.
Research points to various sources of diversity. Within the system, highly skilled people move horizontally between types of work and areas of research, bringing in intellectual diversity to new collectives (Zellner, 2003). Diverse human capital can also be obtained from outside of the country, as a result of the ‘global competition for talent’ (Florida, 2006). Developed countries adopt increasingly more sophisticated policies to attract best global talent with explicit purpose to boost international competitiveness and innovation potential (Boeri et al., 2012).

International talent is therefore seen not only as high quality, but also as uniquely beneficial type of human capital, as it provides extra contribution to creative potential of the economy. In the science environment, job mobility was found to be one of the sources of scientific creativity (Heinze et al., 2009), which relates to both temporary circulation and to permanent opportunities, including international opportunities. It was also found that diverse cultural environments enhance R&D and innovation capabilities of regions (Lee and Nathan, 2010; Niebuhr, 2010)

Human capital is a core concept in the growth theory. Economics versions of growth models understand human capital as accumulated formal education that directly correlates with earnings (Schultz, 1971). With regard to STI and scientific communities, notions of human capital specific to scientific work emerged. These approaches complement the notion of capital with professional networks, skills, resources and tacit knowledge (Bozeman et al., 2001; Bozeman and Corley, 2004; Davenport, 2004; Meyer, 2001). This corresponds to broader notions of cultural capital and symbolic capital adopted in social sciences and, in particular, in the studies of migration, that conceptualise capital as adaptable, evolving, and with the capacity to be enacted differently in different circumstances (Bourdieu, 1977; Erel, 2010).

To sum up, growth models regard globally mobile scientists as high value human capital, which is a core constituent part of long-term economic growth. Countries use policy instruments to attract this desired human capital as a part of the global competition for talent. Additionally, the move from highly formalised human capital approach that is utilised in the endogenous growth theory towards more flexible and culture-specific understanding of science and technology capital of researchers provides an opportunity to operationalise a variety of ways in which scientists enact their capital.

The next part of this chapter reviews a variation of growth theory that focuses on the link between science and innovation.
Science-Driven Innovation and Development

Innovation resulting from the enactment of high-quality human capital is seen as another source of growth within broader theories. While approaches to sources of innovation are numerous and include service innovation or user-inspired innovation, technological innovation as a competitive advantage and a source of economic development remains at the core of this research area. Using this approach, societal contribution of scientists is operationalised within these frameworks. This operationalisation enables an analyst to make a proposition about the role of mobile, or foreign-born scientists in processes of innovation and development.

Science-driven innovation models most commonly conceptualise it as a pipeline of transformation of research results into economic gain. Dominant approaches in innovation studies are rooted in evolutionary economics (Freeman 1987). Broader and more inclusive configurations of innovation process acknowledge the role of a wider range of actors as a part of a ‘system of innovation’ (Lundvall et al., 2009, 2002). Carlsson and Stankiewicz (1991) point that institutional infrastructure has an important function to “support, stimulate and regulate the process of innovation and diffusion of technology” (p.109). The role of scientific communities has been recognised as sources of new knowledge, but also as potential entrepreneurs.

For example, the ‘triple helix’ theory looks at the innovation system as a result of interaction between three main groups of actors: firms, science and the government, exploring synergies that underpin innovative development (Etzkowitz and Leydesdorff, 2000, 1995).

The ‘Mode 2’ knowledge production places scientific agenda-setting in the context of application, not purely academic interests, thus moving science from the ‘ivory tower’ framework to an innovation-inspired framework (Gibbons, 2000; Gibbons et al., 1994).

These models are not mutually exclusive and have been integrated in research designs as complementary parts of knowledge and innovation paradigms (Carayannis and Campbell, 2009). Caraça et al. (2009) argue that despite science lost its privileges in terms of autonomy and independence of agenda-setting, its role in innovation shifted considerably as well towards interactive and continuous involvement at all stages of the development cycle.

It is undisputed that the role of scientific advancement in a well-functioning system of innovation is greater than ever before. New specialist studies emerge that investigate various configurations of science and innovation for smooth transition of research results
into innovative products in the forms of patenting (Fabrizio and Di Minin, 2008), technology transfer (Edler et al., 2011), academic entrepreneurship (Murray, 2004), or in terms of broader roles that universities perform as innovation hubs (Youtie and Shapira, 2008).

System views on science and innovation have been widely adopted by research and policy communities and remain reliable frameworks for national-level analysis and policy development. However, they also attracted wide criticisms, which are important to understand in order to conceptualise the role of globally mobile scientists. Main critiques include the static nature of systems of innovation, unnecessary emphasis on the role of the firm and their confinement to national borders (see Klochikhin, 2012 for extensive review).

Initial simplistic conceptualisations of systems of innovation have been developed to accommodate a variety of approaches. Depending on the focus, the system can be national/global (Archibugi and Michie, 1997), regional (Cooke et al., 1997), technological (Hekkert et al., 2007), sectoral (Malerba, 2002), or network-based (Rip, 2012).

However, any ‘system’ has its borders. Defining borders of the system implies methodological difficulties in studying a social phenomenon that overlaps or transcends these borders. This is a general problem for the analysis of all flows intensifying with the rise of globalisation in relation to national systems and, specifically, for the analysis of the contribution of globally mobile scientists. The role of external factors has so far been accounted for by using the ‘input-output’ model and listing these factors as influencing the system (Edquist, 2011; Shapira et al., 2011; Smits et al., 2010).

Alternative approaches attempt to measure relative individual advantages that globally mobile scientists have over domestic and non-mobile scientists post-migration. While these works do not provide macro-level picture, they allow to make some assumptions about beneficial effects of inviting foreign-born scientists to become a part of the national science, technology and innovation, especially in the context of increasing national S&T capital and the national skills base.

**Scientific Mobility and Benefits for Host and Home Country Growth**

The concept of innovation system and the role of (1) scientific outputs for innovation and (2) diversity for innovation serve as operationalisation tools in describing exactly why countries are competing for globally mobile highly skilled human resources. This section reviews the literature that attempts to directly showcase the value of scientific migration on innovative development of host and home countries.
In host countries, there are two main types of contribution by foreign-born scientists that have been identified. First, it is superior research performance. Second, it is spillovers and other positive externalities associated with mobility of scientists.

In the first instance, most studies are comparative: outputs of foreign-born scientists are contrasted against outputs of their non-mobile counterparts in the attempts to explain the benefits of ‘brain gain’ for the receiving countries. The evidence overwhelmingly demonstrates higher average productivity of foreign-born scientists across fields and ethnicities (Franzoni et al., 2014; Gaulé and Piacentini, 2012). Stephan and Levin (2001) find that US foreign-born scientists figure disproportionately more often among authors of highly cited or popular research articles. In the US nanoscience as well, foreign-born researchers demonstrate higher productivity (Libaers, 2007).

While foreign-born scientists usually publish more and better papers, it is a concern on part of some researchers that this tends to prevent natives from entering the field (Hunt and Gauthier-Loiselle, 2009). Similar concerns exist for education, especially postgraduate and doctoral education in the USA (Chellaraj et al., 2008, Gurcak et al., 2001). They are further aggravated by findings that indicate tendency towards clustering of scientists from the same country of origin (Tanyildiz, 2015).

The other set of literature explores innovation spillovers of foreign-born scientists. Patenting, as an early indicator of innovation, has been traditionally used as a metric, and studies generally point to higher patenting intensity of foreign-born highly skilled immigrants (Bosetti et al., 2015; Hunt and Gauthier-Loiselle, 2009; Jones, 2012; Nahm and Tani, 2015).

In particular, Kerr and Lincoln (2010) discover an explicit link between US highly skilled immigration policies and rates of ethnic patenting and conclude that “the total invention increases with higher admission levels primarily through the direct contributions of immigrant inventors” (p.30). Among non-direct effects, Faggian and McCann (2006) elucidate the role of universities to bring high quality human capital, including from abroad, to the regions, which results in the transfer of skills.

A peripheral line of research examines influence of foreign-born scientists on institutional configuration of receiving communities. Burt (2002) suggests that scientific migrants fill in organisational or functional “structural holes” in public research organisations. However, the effects of this reshaping are not necessarily completely positive (Borjas and Doran, 2014).
Globally mobile scientists also have influence outside of their current countries of residence. The literature on scientists (and other highly skilled persons) as development agents integrates science-based view on economic development with theories of return migration and ‘brain circulation’. It was, most famously, initiated in a series of works by Saxenian (Saxenian, 2007, 2005; 2002). Originally studying migrant contribution to the technological success in the Silicon Valley, Saxenian moved on to research exchange and circulation of scientists and engineers between technology clusters in the USA and the developing countries, namely, China, India and Taiwan.

In the book “The New Argonauts” (2007) Saxenian reports the impact of highly skilled mobile persons on the home country development. They usually are 2nd generation migrants and are born and raised in the USA. When they receive qualifications and acquire skills, they may realise that there are more opportunities, more reception, demand and available resources in the countries of their heritage than in oversaturated markets of the USA. These ‘new Argonauts’, not being complete strangers to the culture and language of Asian countries, enter them more easily, and achieve economic success. Sometimes they do so by becoming entrepreneurs or taking senior positions in universities. In other cases, they link the developing countries with the developed countries, taking mediating roles in new networks.

Saxenian’s work set the trend towards exploring the role of returnees and globally mobile mediators between the developed and the developing countries. Tang and Shapira (2012) explore ‘knowledge moderation’ function that globally mobile scientists have in China. When mature scientists return to their home countries, they bring acquired approaches, tacit knowledge and routines back to their native environment, which then contributes to national development (Shuval, 2000; Solimano, 2008; Tung, 2008). Spillover effects from inventors in host countries to home countries may also occur (Kerr, 2008).

**Research Implications (i)**
Globally mobile persons are regarded as a highly valued asset in the take on endogenous growth theory discussed in the sections above. Scientific mobility, be it short-term, long-term, or permanent, is regarded as highly beneficial for receiving systems. Countries around the world attempt to manage highly skilled human capital flows, ranging from attempts to cap the ‘drain’ to easying barriers to highly skilled immigration (Ackers, 2005; Mahroum, 2005).
S&T capital generated externally and brought to nationally delineated systems as a part of scientific mobility flows is so far confined to an input-output model. This positioning has very practical reasons, because economic and innovation policies are usually developed on the national level and are sponsored by public funding. Therefore, the effects and benefits are explored within the impact on national economies.

Social phenomena with distributed effects, such as global scientific mobility, do not fit within these frameworks. While there are national benefits from internationally mobile scientists, the effects may be greater. Global mobility, as shown by the work on scientists as development agents, is far from over after a scientist moves to a different country. More than one nation state may be beneficiaries of spillovers. In this context, studies that compare native-born and foreign-born scientists appear reductionist of the skills and potential contributions of globally mobile researchers.

Research on the impact of global mobility for national benefit therefore becomes problematic to study methodologically as well as theoretically. This partly explains the persistence of approaches that attempt to directly associate geographic residence of scientists with technology and innovation benefits to their country of residence. This brings concerns about how exactly foreign-born scientists contribute to innovative development, the extent of this contribution and the consequences for scientists themselves. These remain relatively unexplored, and the debate is unsettled.

The next part of the chapter reviews the literature on highly skilled migration (HSM) and scientific mobility to expose traditionally rigid analytical frameworks and offer some propositions for exploratory study of distributed, networked and ongoing mobility of scientists.

2.2.2 SCIENTIFIC MOBILITY
Scientific mobility scholarship is a relatively recent branch of a more general stream of HSM research. The general division into skilled and unskilled migration has had policy implications from the inception of these concepts: ‘skilled’ migration is seen as desirable, while ‘unskilled’ migration is not. Both types of migration have been traditionally seen as being driven by economic reasons – few opportunities in home countries and more attractive prospects of well-being in host countries. Economic motivation distinguishes these labour migrants from other kinds of people moving across regions and borders, such as nomads or refugees.
Labour migration is a phenomenon of global significance: over 150 million people around the world are migrant workers (ILO, 2015). Among them, skilled and, especially, highly skilled migrants, is a group of special importance. On the most general level, scientists grouped here with other highly skilled migrants, such as engineers and doctors. Global mobility of scientists shares many features with global mobility of the highly skilled, not the least due to common immigration regulations criteria.

This section of the literature review therefore first outlines relevant concepts and analytical models of the HSM. It will then discuss concepts and frameworks specific to scientific mobility.

**Highly Skilled Migration**

‘Brain drain’ is probably the most well-known concept associated with HSM. While it has been applied to study all kinds of HSM, it was first invoked in the middle of the 1960s in relation to out-migration of scientists from the UK to the USA (Johnson, 1965). Brain drain was first defined in economic terms – as a result of the difference in salaries and research support.

The concept was first developed to describe migration within the First World, but spread rapidly and became a very popular tool to explain migration flows from less to more developed countries. Among the examples are cases of Argentina (Oteiza, 1965) or China (Kao and Lee, 1973). OECD adopted its own definition of the brain drain migrant as a person who holds a university degree and permanently resides in a country other than the one he obtained the degree from (OECD, 1965). Policy efforts were made based on this theory to control the brain drain: not to let people leave the country, or to create the conditions for them to stay (Grubel, 1968), or to hinder the ability to move of those who can move, for example, with taxation instruments (Bhagwati, 1979).

The brain drain framework dominated the studies of HSM for decades and persists to date as powerful analytical tool to examine economic effects of migration on sending as well as receiving countries.

As HSM looks at the patterns of mobility between countries or between regions, several analytical approaches were developed within the literature. Some of them fit in with more general streams of migration research and examine the role of decisions and intentions in migration (Liebig and Sousa-Poza, 2004; Wang, 2013). Others focused on determinants of HSM. Earlier works paid more attention to economic reasons and embodied human capital
transfers. Contributed predominantly from economics, these studies conceptualised factors that ‘push’ migrants from their home countries, such as lower wages, and ‘pull’ factors that attract migrants to various host countries, such as higher wages (Table 1).

More recent studies conducted within this framework usually criticise early simplistic approaches and focus more on distributive effects of ‘brain drain’. For example, they explore hypotheses that intensive ‘brain drain’ may facilitate education-seeking behaviour in the next generation of the source country (Ganguli, 2014), positive network externalities (Docquier and Rapoport, 2012), and return migration after acquiring human capital in the destination country (Dustmann et al., 2011).

Instead of unidirectional ‘drain’, studies explore ‘gain’ and ‘circulation’ of talent between countries, return HSM and knowledge exchange. The range of factors shaping HSM flows also widened to include political, social and cultural aspects. Instead of discussing ‘push’ and ‘pull’ drivers, studies have increasingly focused on structuring conditions of migration flows, such as global inequality and interdependence of states.

Further contributions to this line of work examine the roles of gatekeeping factors: institutions, borders, migration regimes (Amelina, 2013; Ford et al., 2015; Garcia-Rodriguez et al., 2015). These are seen to be barriers that, despite countries’ efforts to attract highly skilled migrants, were preventing them from coming, or settling in host countries. A similar stream of literature studies the role of facilitators of international migration, such as brokers, intermediaries, specialist recruitment agencies, transnational companies (Beaverstock, 2012; Findlay et al., 1996; Groutsis et al., 2015).

These recent perspectives on HSM do not regard it as a linear human capital transfer process with a zero sum gain for the host country. The current debate about HSM revolves around resulting geographically distributed character of competences and skills (Cañibano and Woolley, 2015). The benefits of the highly skilled ‘brains’ do not disappear with the migration to another country (Baruffaldi and Landoni, 2012; Chen, 2009; Ciumasu, 2010; Olesen, 2002). On the contrary, the circulation of knowledge, ideas, artefacts and people contributes to the development of both home and host countries in the ways impossible for non-mobile human capital to provide. Highly skilled migrants themselves are increasingly seen as having transnational lifestyles (Kou and Bailey, 2014).
<table>
<thead>
<tr>
<th>Approach</th>
<th>Type of Reasoning</th>
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<tr>
<td>Brain Drain</td>
<td>Push-pull</td>
<td>Push factors: low income; worse labour conditions; Income inequality awareness. Pull factors: high salaries; high living standards; good research conditions; career opportunities</td>
<td>Beine et al., 2011a, 2008; Stark et al., 1998</td>
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<tr>
<td></td>
<td>Source country effects</td>
<td>Pull factors: agglomeration and concentration effects. Brain drain optimises workers in the home country; Incentive effect (more motivation for education) in source countries</td>
<td>Liebig and Sousa-Poza, 2004</td>
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<tr>
<td></td>
<td>Self-selection</td>
<td>Higher income inequality in the country of origin is generally associated with a higher overall emigration propensity.</td>
<td></td>
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<td></td>
<td>Push-pull</td>
<td>Push: religious fractionalisation; poverty. Pull: return to skills; geographic proximity; immigration policies; existing diasporas</td>
<td>Beine et al., 2011b; Docquier and Rapoport, 2012</td>
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<td>Structuring conditions</td>
<td>'Push': Political conditions; professional employment opportunities. 'Pull': economic interdependency; educational interactions; better working environment; higher salaries; better living conditions; transnational ties; children’s educational opportunities. Non-push/pull conditions: widening economic gap; global inequality</td>
<td>Cheng and Yang, 1998</td>
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<td></td>
<td>Labour inequality</td>
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<td>Return migration</td>
<td>Migration decisions</td>
<td>Family reasons to return transcend economic motivations; economic reasons as a pull factor to leave</td>
<td>Lee and Kim, 2010</td>
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<td>Brain Circulation</td>
<td>Source country effects</td>
<td>Pull: higher return for skills. Brain gain for sending countries – skills acquired abroad may return</td>
<td>Stark et al., 1997</td>
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<td></td>
<td>Distributed effects</td>
<td>Pull factors: demand for capital and talent; linguistic compatibility; inviting policy regimes; earnings gap. Return factors: new opportunities – markets and niches; mobilisation of fresh capital accumulated during migration; technology transfer</td>
<td>Saxenian, 2000; Solimano, 2008</td>
</tr>
<tr>
<td>Transnationalism</td>
<td>Mobility Barriers</td>
<td>Seemingly unfettered mobility of highly skilled (elite) transnational migrants. Visa regimes is a restrictive factor.</td>
<td>Ho, 2011</td>
</tr>
</tbody>
</table>

Table 1: Analytical Frameworks of the Highly Skilled Migration Determinants

Sources: Beine et al., 2011, 2008, 2001; Bhagwati and Hamada, 1974; Cheng and Yang, 1998; Docquier and Rapoport, 2012; Ho, 2011; Humphries et al., 2013; Lee and Kim, 2010; Liebig

Research on particular types of highly skilled migrants became possible as a result of what Findlay and Cranston (2015) call post-Grand Theory turn in HSM research. The authors note a general shift in the agenda at the end of the 1980s towards inclusion of non-national actors and shaping influences in HSM, as well as increasing differentiation of migration geographies.

Scientists could now be seen as a specific type of highly skilled migrant, with specific factors and drivers shaping migration flows. Specific traits of scientific mobility that are not shared with more general trends observed in HSM are overviewed in the next part of the review.

**Scientific Migration and Mobility**

Early scholarship of scientific migration did not focus on its determinants or patterns. The scarce available studies rise the issues related to science policy (Brickman, 1977) or to generation of new scientific ideas as a result of mobility knowledge exchange (Hoch, 1987). It seems like when scientific mobility research emerged in the 1990s, it skipped the ‘brain drain’ stage and plunged straight into circulation and exchange frameworks that were gaining popularity at the time.

For instance, research on scientific elites as one of the most mobile and desired category of migrants found application in the investigation of transnational travel and globalisation (Hunter et al., 2009; Laudel, 2005). Similarly, European integration became a source of scientific mobility research of multiple groups of scholars (Ackers and Gill, 2008; Mavroudi and Warren, 2013; Okolski, 2008).

These studies emphasise historically persistent character of international mobility of scientists. Scientists as far back as ancient Greece and medieval European universities traveled to different countries to acquire new understanding and learn from local communities (Gaillard and Gaillard, 2001). Scientific community has been conceptualised as transnational community early on – for example, the role of ‘invisible colleges’, where scientists grouped by research area or interest, not by organisation or country, has been acknowledged (Crane, 1969).

Recent work on scientific mobility has seen a renaissance of push-pull analytical frameworks (Ackers, 2008; MORE Compendium, 2011). Often dismissed as outdated in the mainstream
HSM research, multidirectional drivers of attraction and extrusion of scientific talent have been regarded as having high explanatory ability.

Working conditions for science in source and destination countries are regarded as less uneven for scientists than for HSM in general. However, the assumed dichotomy between ‘source’ and ‘destination’ countries is diminished as well in these perspectives, when mobility across evenly attractive countries is examined (Heitor et al., 2014; Trippl, 2013a).

Studies list factors specific for scientists that determine ‘push’ and ‘pull’ mobilities, such as research equipment, access to libraries and other resources (Kaczmarczyk, 2010). Others note hardships for scientists to access relevant research networks and to establish collaborations from the periphery (Jöns, 2007; Schubert and Sooryamoorthy, 2009). Scientific mobility scholarship was further sophisticated by recognising the role of non-economic shaping influences, such as transnational family links (Børing et al., 2015; Gibson and McKenzie, 2014).

Scientists are among the most mobile groups of highly skilled persons. In recent studies it has become customary to merge (non-permanent) scientific mobility and (permanent) migration because the lines between the two blur (Ackers, 2005). For scientific mobility, gatekeepers play much less important role than for other highly skilled migrants (Casper and Murray, 2005). Scientific mobility is also strongly associated with academic career development (Wijngaarden, 2015). In contrast with most highly skilled professions, who are affected by deskilling and downward social mobility (Humphries et al., 2013), which incurs trade-offs between career prospects and the standard of life, scientific job mobility is seen as a way to develop academic career and, sometimes, improve the living standard as well.

Finally, scientific mobility is seen as a highly beneficial phenomenon from the policy perspective. It is one of the few mobility flows that is widely and uniformly supported by national and supranational institutions (Heitor et al., 2014; Khoo, 2014; Lavenex, 2007; Mahroum, 2005).

In a trend similar for general scholarship of HSM, scientific mobility literature has tended to move away from rigid ‘brain drain’ frameworks in the attempt to uncover its more complex, heterogeneous and fuzzy effects. Moreover, rigid ‘human capital’ approaches also become a subject of criticism, as evidence arises of distributive effects of science diasporas, ‘pools of knowledge’ and other transnational communities (Flanagan, 2015).
It has been argued that transnationally active scientists may facilitate in the development of science and technology in the home as well as in the host country, leading to a ‘win-win’ situation (Tejada et al., 2013; Yang and Welch, 2010). Gaillard and Gaillard (1998) suggest that in small or unsafe countries there is potential to utilise émigré scientists residing abroad as ‘pools of knowledge’.

These approaches are a conceptually complex, but promising way to understand scientific mobility. They suggest that émigré scientists contribute to the development of science and technology in a networked and distributive manner (Woolley et al., 2008). However, there is strong policy skew among these studies, and relatively little conceptual sophistication.

For example, science diaspora is a type of network that connects researchers of the same country of origin among themselves, and with scientists in their home country. It was pioneered to propose culturally flexible nature of S&T capital, potential of knowledge transfer and home country development using network approach (Barré et al., 2003; Meyer, 2001). The policy was pioneered in Colombia, where the government supported the Caldas diaspora knowledge network (Granes et al., 1998).

From inception, this stream of literature had a strong policy dimension. The overwhelming majority of science diaspora literature understands diaspora knowledge networks as networks the link émigré scientists with research collectives in their home countries (Zhang et al., 2011; Kenney, 2012), including the perspective of scientific diasporas as a tool for home country development (Seguin et al., 2006).

In this light scientific diaspora are described as potential resource that needs to be mobilised or harnessed to get anticipated returns. Another strand of literature conceptualises scientific diasporas as already existing collaborative entities (Ciumasu, 2010; Gaillard and Gaillard, 1998; Seguin et al., 2006; Tejada et al., 2013; Tejada and Bolay, 2010).

It is imperative in both approaches that émigré scientists are either in contact, or can get in contact with the ‘home country’, and only then the diaspora is formed. Such research suffers from what Glick Schiller (2005) criticised as essentialism in diaspora studies. Indeed, calling scientific diaspora ‘displaced scientists’ (Guimaraes, 2002) or separating scientists who have been living outside of their home countries for more than 30 years and who probably attained citizenship and all associated rights, into a group of ‘current migrants’ (Trippl, 2013b) would mean that all scientists who migrated at some point of their lives are forever ‘outsiders’ and are portrayed as such by social scientists.
Science diaspora literature highlights very well the extent to which current scientific mobility scholarship focuses on national level of analysis. Migration of scientists, just as HSM, has traditionally been analysed by invoking the concept of crossing national borders. These frameworks entail *inter*-national mobility, *inter*-national distribution of gains and *inter*-national positionality of scientists that persist in the scholarship to date.

This conceptual weakness can be mediated by reframing science diasporas in terms of knowledge networks (Kuznetsov and Sabel, 2006), or in terms of transnationally connected collectives that do not necessarily have home country links. Transnationalism is a theory that has been widely disseminated in the general migration scholarship. It emphasises the waning role of national borders and the increasing role of non-national entities, such as family, religion and ethnicity, in the movement of people around the globe (Glick Schiller, 2005; Glick Schiller and Faist, 2010). While transnational outlook on mobility and migration has become a reputable approach to develop analytical frameworks to study international migration, it has so far received little attention in the analysis of scientific or HSM.

**Research Implications (ii)**

HSM scholarship has been driven by migration policy agendas practically from inception, which partly explains its methodological nationalist fixation (Mahroum, 2001; Wimmer and Glick Schiller, 2002). Classifications with which HSM and scientific mobility scholarship operated have been constructed in the social sciences domain and correspondingly invoked in the policy domain. Current research of scientific migration still to a large extent conceptualises this social phenomenon on the national level, as the movement of scientists across national borders.

With the increasing number of studies that highlight the lack of immediate ‘brain gain’ for the receiving country and much more limited than previously thought detrimental effect from the ‘drain’ for the sending country, traditional frameworks remain surprisingly rigid. National borders cannot be ignored, but they are not necessarily equally valid for different types of mobilities.

The general literature on migration provides insights into the changing nature of mobility flows as the migration project becomes easier to accomplish. Among them are studies on serial migration (Ossman, 2004), stepwise migration (Paul, 2011), onward migration (Aydemir and Robinson, 2008), and even ‘Eurostar migration’ (Favell, 2008). Some highlight links between internal mobility within the country, and the international migration, in the straight as well as in the reverse order (King and Skeldon, 2010). They all point to the
emergence of ‘mobility lifestyle’ and to the emergence of the entire class of people for whom constant mobility is normal.

Scientific mobility literature is lagging behind these developments. Recent works seem to still be examining bodily movements of scientists across borders and associated economic gains of host countries (or, conversely, return bodily movements and gains for home countries) instead of exploring mobility as an integral part of occupational identity of scientists, which may be resulting in changing drivers of mobility (Geuna, 2015; Wang et al., 2015). Similarly, while there is plenty of evidence of how scientific mobility affects their contexts, the evidence of how mobility affects scientists themselves is fairly limited.

Increasingly, scientists are becoming more mobile, intensifying their networks and frequently travelling around the world. Noting these shifting patterns, new approaches to the analysis of global scientific mobility, especially in conjunction with the role of scientists in the global science, technology and innovation (STI) is needed.

Nation states have been seen as main actors shaping mobility flows. While this perspective has been consistently disputed, as shown above, for scientists national mobility programmes, as well as international agreements, remain important shaping flows. In this context, push and pull frameworks of mobility, albeit heavily criticised, cannot be discarded, as there exist serious effort to channel scientific mobility flows.

However, keeping in mind that scientists are becoming increasingly more mobile, these frameworks need to be significantly reworked. For example, little attention has so far been paid to factors that contribute not only to attraction, but also to retention of scientists in countries, regions or organisations.

The next section outlines supporting theories of this work, which contribute further to the conceptualisation of the research problem.

2.2.3 SOCIAL STUDIES OF SCIENCE
Arguments that help to understand pitfalls in the current scientific mobility scholarship come from the area of social studies of science (STS). In general, this perspective regards scientific communities as social communities and, therefore, acknowledges incorporation of values and norms into research results (Latour and Woolgar, 2013; Leydesdorff, 2015). Since the emergence of social constructivist outlooks that position science as a historically and socially bounded, social science interpretation of research results shifted from seeking ‘truth’ to seeking ‘consensus’ (Kuhn, 2012). Social constructivist STS have regarded scientific
knowledge production as a collective action that is affected by the construction of the actor-network (Latour, 1987), the geography of production of this knowledge (Livingstone, 2010), daily group practices and collective tacit knowledge (Collins, 2001).

The ways in which values affect outcomes of scientific research can be conceptualised in terms of national cultures. In fact, most work in the area takes methodological approach of ethnography and is hence highly contextual. For example, Jagtenberg (2012) writes how scientists have goals, and the direction of goal setting is due to social and contextual reasons.

There is also context of research. The introduction lists the division of scientists into different types of research jobs, such as private R&D or public academe. These scientific professional pathways presume strikingly different organisation of research. For example, for most university faculty teaching is an integral part of their work, while scientists employed privately never have to get involved in teaching. These environmental factors of research organisation are termed in this work as research context. Scholarship on research context of academic communities – in terms of organisations, activities and career development paths – constitutes the body of supporting literature for this thesis.

**Research Context of Academic Communities**

The long-standing perspective on academic communities as autonomous and non-national entities has been contested in STS by the perspective of boundedness along national borders. With reports of the increase of accountability of public spending on research after the WWII (Bozeman and Crow, 1990), the taxation argument stresses the duty of scientists to therefore be accountable for spending public funds, and to make direct contribution to nations that are so generously sponsoring them (Sanz-Menendez and Cruz-Castro, 2003). The variety of hard and soft instruments range from changes in funding policy (Boardman and Bozeman, 2007; Lepori, 2011), to changes in research results evaluation frameworks (de Jong et al., 2011). Science therefore becomes more sensitive to the attempts of public funders to ‘steer’ research agendas (Rip and van der Meulen, 1996).

**Academic community itself is reflexive of its role in the national contexts of development.** The so-called ‘breakdown of the ivory tower’ was not entirely externally imposed in many countries. On the contrary, the recognition of the wider role and responsibilities of scientists to the society, be it in the national or global context, received wide acclaim. The seminal work (Boyer, 1990) famously initiated the discussion by suggesting to broaden up the scope of scholarly activities beyond the ‘scholarship of discovery’ and ‘the scholarship of teaching’.
For example, scholarship of application sets research agendas to address existing consequential problems, and uses the outcomes to inform further research. By enacting scholarship of application, scientists come into a direct contact with their socioeconomic context.

The dynamics are uneven across national contexts. The works cited above are positioned in the Anglo-Saxon discourse. In European countries, for example, in France, scientists are civil servants and have much closer link to the state than in the USA or the UK (Musselin, 2005). Regardless of particularities, the general trend is towards greater involvement of stakeholders, such as the state, industry, social scientists, and the general public, in research process and its results.

The scope of activities that are termed ‘academic’ has broadened up significantly as communication of academic communities with the environment intensifies. For example, the traditional teaching-research equilibrium of universities was shaken by new frameworks that conceptualise their broader and more active roles. Universities are now perceived as economic agents, social development agents, and also agents in the political system. They do not only perform research, but also as have crucial roles in regional development (Faggian and McCann, 2006; Perkmann and Walsh, 2007), facilitate entrepreneurship (Guerrero, Urbano 2010) and contribute to knowledge spillovers (Trippl and Maier, 2011). The perspective on universities as becoming innovation hubs (Youtie and Shapira, 2008) is an umbrella term for this broader change towards greater inclusion.

To sum up, the transformative change in academic community has two main directions. The first one relates to how scientists go about doing their research and how the configuration of external factors influencing the research process is changing, or should change (Crow and Bozeman, 1987; Fisher and Maricle, 2015). The second direction relates to broadening up the boundaries of academic identity, the scope of activities a scientist may undertake and still be able to be called scientist. This results in the emergence of hybrid roles, such as academic entrepreneurs (Powers and McDougall, 2005) and public intellectuals (Bourdieu, 1984).

The shift in research contexts has significant implications for activities of scientists and research collectives on meso- and micro-levels. On the meso-level, organisational and labour markets influences restructure scientific mobility flows. On the micro-level, scientists strive to adapt to internal and external normative expectations of research. The remainder of the
A literature review will cover these two levels of activities before formulating the research gaps explicitly.

**Orientations of Research Groups**
In the changing science landscape, old structural divisions between usually fundamental public research and problem-based applied private research are waning (Rip, 2004). In the US context, Crow and Bozeman (2013) refute stereotypical threefold division of functionary roles to private, university and government laboratories in the US. Instead, the authors stress that the diversity of knowledge produced in public and private contexts is increasing.

In this vein, specialisation of an academic unit is driven by ‘logic’ or ‘orientation’. A line of literature that explores these processes focuses on studying the types of outputs laboratories produce in order to develop classifications, usually on a nexus between ‘scientific visibility’ and ‘market application’ of produced knowledge (Gupta et al., 2000; Joly and Mangematin, 1996; Van Rooij, 2011).

For example, in an earlier work Crow and Bozeman (1987a; 1987b) contextualise laboratory orientations as the influence of environment and propose a typology based on political influences, conceptualised as share of government funding, and market influences, conceptualised as exclusive/general consumption of the end product. Recently, van der Weijden et al. (2012) examined societal orientations of life sciences laboratories, introducing this third dimension to the axis. However, the authors note unrelatedness of societal outputs with scientific outputs, implying role strain in academic researchers.

Moving to an individual level, scholarship in higher education has so far focused on teaching-research nexus and corresponding tradeoffs in academic faculty (Bentley and Kyvik, 2013; Robertson and Bond, 2005). Two problematics have converged: the push towards greater involvement of teaching faculty in research activities and, conversely, greater involvement of researchers in teaching activities. The scholarship is generally skeptical about these tendencies, identifying overload, disbalances and work strain in the academic community (Austin, 2002; Box and Cotgrove, 1966; Sikes, 2006; Singell et al., 1996). However, some studies conceptualise this multitasking in terms of emerging synergies that spillover beneficially across academic activities (Musthafa and Sajila, 2014).

The variety of roles and activities undertaken by academics is integrated in a conceptual model offered by Laredo and Mustar (2000). The authors “consider research as a
professional activity which is inserted in many different contexts, each having its own regulation mechanisms and ways of producing reputation and/or wealth” (p.517). The framework distinguishes the typology of five such contexts:

- Certified knowledge production (conventional approach);
- Public research and the innovation process (knowledge ‘market’ orientation);
- Participation to public collective goods and finalities (achievement of public goals, such as military or environment);
- Research and public debate about science and technology (science in society, public understanding of science and communication with lay audiences about science and technology);
- Training and embodied knowledge (teaching-research nexus and tradeoffs).

Authors note that laboratories can exhibit only limited number of strong involvement in one of the contexts, which implies selectivity and specialisation. They map the laboratories on the ‘research compass card’ that aggregates these complementary activities.

The proposition to map broad laboratory activity profiles currently stands as an isolated attempt to integrate various academic activities within one analytical framework. Later studies fragmented to discuss established tensions between teaching and research, or research produced for different purposes.

The concluding section of this review will discuss non-tangible rewards and career markets, which form the second significant aspect of research context of academic communities.

**Academic Rewards and Labour Markets**

Tangible and intangible rewards stand as important parts of the research context. This section discusses the types of rewards in academic communities, such as material rewards, reputational rewards, and career returns.

Generally, academic communities are regarded as meritocratic, where career seniority corresponds to the level of achievement. Moreover, career stage is closely linked to material rewards of scientists, both in terms of advancement in rank and in terms of access to resources for further research (Long et al., 1993; Stephan and Levin, 2001). Therefore, academic career development delineates and limits research opportunities of scientists. Academic career development is also, as noted above, linked with mobility. The concluding

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1 Italicised by MK
part of the literature review explores this link in more detail by invoking concepts of academic career development and ALMs for the analysis of global scientific mobility.

Collegial recognition has traditionally been perceived as the main indicator of academic career success (Baruch, 2013; Jungbauer-Gans and Gross, 2013; Sabharwal, 2013). Quantitatively, it is expressed when other scientists refer to the work of more reputable colleagues as a way to reinforce their own arguments, by the way of citation. This indicator is captured and routinely used by social scientists as a proxy of ‘quality of research’.

Traditional approach to the analysis of rewards of academics examines extrinsic rewards – informal or in terms of awards and prizes – and material rewards, in terms of positions and research resources (Caplow and McGee, 1965; Reskin, 1977). Whitley (2000) argues that the entire modern science is structured on mutual evaluation of research work by peers. He suggests that in modern (Western) academia rewards are exceptionally closely linked to peer evaluation. Reputation is therefore seen as a cornerstone of recognition within the academic community.

The literature usually distinguishes two types of academic reputation: the one that is external to an individual and is an aggregate of organisations and departments (Finnegan, 1993), and embodied reputation of an individual scientist as a recognition of the quality of work produced (Foster et al., 2015). Gains from one type of reputation can be traded for the other one. For example, Chan et al. (2002) report the individual performance of US finance researchers who relocate to a higher-ranked institution must be about two times higher than average performance at that institution.

In the light of changing scope of academic activities outlined in the previous section, conventional ways to measure and reward reputation in academic community are challenged (Baruch and Hall, 2004). Research has demonstrated that these activities are still inadequately rewarded in comparison with published papers and other straightforward outputs (Bennion and Locke, 2010; Muller, 2014). There is also a national dimension: the rewards structure on different ALMs varies significantly across countries. This not only inhibits mobility of scientists, but also potentially hampers outsiders’ career development should they have activity profiles inadequate to the context.

Conversely, a recent study showcases the discrepancy between increasing demands and non-increasing remuneration, when the demand for skills beyond traditional teaching and research, such as community engagement or working in industry, rises for early career
academics, but no difference in pay or working conditions is offered (Pitt and Mewburn, 2016).

What are the implications of these for global mobility of academics? First, mobility opportunities increase international visibility and international collaboration of scientists, which contributed to the production higher-cited publications (Baruffaldi and Landoni, 2012; Jonkers and Tijssen, 2008; Melkers and Kiopa, 2010). This increases the value of a researcher in the labour markets and underpins most public science mobility programmes.

Mobility of scientists is recognised in the literature that stresses dynamism of academic career development (Dietz et al., 2000). Reputational value in the community and high visibility of labour market actors, as discuss above, structure career development of scientists employed in public research organisations. Academic career development is not flexible: once researchers leave public science, it is costly to return.

The reputational approach to career development distinguishes four main stages in academic career development. Doctoral training is a process that initiates a researcher into academic community. Postdoctoral positions are seen as apprenticeships. Early career researchers need to prove their worth and potential during this stage (Louis et al., 2007). The successful initiation eventually results in the award of tenure, or another type of permanent position, which grants long-term security. Finally, mature researchers have an opportunity to transition further into managerial administrative positions (Parker, 2004).

Transitioning from a postdoctoral career stage to a tenured position is seen as one of the core tensions in ALMs across nations. Ni Laoire and Shelton (2003), for example, establish that casualisation of contractual labour is a result of excessive demand for tenured positions and very low supply. The crowding of early career researchers at the bottleneck of tenure is widely recognised as a pressing ALM problem (Dany and Mangematin, 2004; Rogge, 2015).

Scientific job mobility is seen by most studies as moving between national labour markets. The debate about unified or segmented labour market, initiated by Fairweather (1995) has extended to the debate about the globalisation and academic labor market. Globalised labour market implies intrinsic role of mobility in academic career development, and multiple studies have attempted to propose hypotheses, theorising global labour supply to cover shortages in the public sector (Xiao, 2010). While the situation is desired and is actively promoted in, for example, the European Research Area, the analysts are skeptical.

A darker side of international scientific job mobility stresses insecurity, precariousness and encultured differences in expectations that are not known until the mobility is performed. For example, Hammett (2012) gives a personal account of moving from England to South Africa as full of “challenging encounters with forces of initiation and reproduction within the academy” (p.447).

In different institutional settings, what is tacitly understood by ‘academic career’ or ‘academic labour market’ differs drastically from trends and topics discussed above (Musselin, 2013). This may emerge as a significant issue that globally mobile scientists face.

Going back up to the laboratory level, there has been a strong link reported between how research is organised and the type and quality of its outputs (Carayol and Matt, 2004). Human resources and personnel composition are seen as a core variable of this organisation (Conti and Liu, 2015). Therefore, the impact of globally mobile researchers can be hypothesised.

The transnational turn in migration studies entailed the emergence of research on transnational academia. These works adopt simultaneous and distributive understanding of academic activities (irreversibly of actual physical migration) and operationalise professional networks of academics and students as transnational networks that can be enacted at different times for different purposes (Bilecen and Faist, 2015; Gargano, 2009; Jöns, 2007).

**Research Implications (iii)**
The breakdown of the ivory tower model of academic community has had several implications. First of all, varying policy approaches and stakeholder group interests have an impact on the social configuration of scientific communities. This implies the existence of spatial differences in social and institutional organisation of academia across countries and regions. Prestige, as Whitley argues, is the core value in academic communities that defines social ranks of scientists within academic hierarchies. It is plausible to suggest that the construction of academic prestige has spatial nature and differs from country to country.

These large-scale processes affect meso- and micro-levels of academic practice in different ways. It is plausible to suggest that different configurations of roles and activities with national, organisational and laboratory-level particularities stand as significant environmental factors that globally mobile scientists experience post-mobility. However, the
evidence suggests that while the scope of academic activities is broadening up, the incentives structure for academic career development and promotion has remained fairly unchanged and relies predominantly on the quality of research outputs. Scientists whose networks presume extensive transnational activities have to therefore work and balance research agendas on the cutting edge of science with nationally bounded agendas that incur rewards and promotions.

Furthermore, earlier suggestions about harmonisation and globalisation of ALMs have been termed largely unfounded, and career returns of researchers depend on nationally accepted rules and criteria. Therefore, in the age of mobility, researchers move between countries and organisations much more easily, but rules of integration in host academic communities (notwithstanding societies) seems to be a difficult task that responds to tacit national understandings rather than to global merit.

2.2.4 TWO LITERATURE GAPS
The research objective and the RQs of this work can now be positioned within extant research in this area. By acknowledging the practical need of stakeholders and policymakers to advance local, regional and national development in the knowledge economy, this study has considered global scientific mobility as a potential source of competitive advantage and superior skills base. However, the review of the literature reveals inconsistencies and limitations of existing evidence that may jeopardise more general assumptions of higher-level theories.

For example, there is an assumption that globally mobile scientists are key innovation agents. However, their S&T capital can be enacted in multiple ways and in multiple contexts, and even, in a transnational context, for the benefit of countries other than the ones they reside in.

More specifically, two main gaps can be identified as a result of analysis carried out in this chapter.

*The first gap* is conceptualised as limited understanding of drivers of scientific mobility currents, as these intensify and transform in the globalising world. The gap appears due to the tension between classic frameworks of mobility research, evidence of intensifying mobility, and counter-evidence of persisting nationally bounded labour market rewards in academia.
The gap relates to methodological nationalist orientations of studies of science and innovation. If the general assumption about the positive role of scientists in the development of national competitive capabilities is correct, then national and regional public bodies should continue to compete to attract global talent. However, as scientists are becoming more mobile and the nature of scientific mobility flows is changing, there is a need to understand the nature of this change to accommodate policy instruments.

Incidentally, national borders are losing significance in scientific mobility currents as a result of globalisation. While structuralist approaches that examine skills and innovation therefore limit external factors to input-output flows, general literature on migration reports ongoing and simultaneous engagement of migrants in transnational networks and non-national institutions. Global scientific mobility flows is a social phenomenon with geographically distributed effects and does not fit in well within these frameworks.

The second gap is conceptualised as the discrepancy between the assumption that foreign-born scientists act as innovation and development agents in their host countries when there is only limited evidence to support this, and available evidence from other fields of knowledge that enables conceptualisation of contrary hypotheses.

First of all, effects of transnational human capital can be distributed geographically. Transnationalist conceptualisation of global scientific mobility suggests that researchers may enact multiple institutions in multiple countries simultaneously depending on own agendas and strategies.

Second, ALMs organisation of academic communities has strong national dimension. Moving between markets and entering national systems with different expectations from scientists does not imply that scientists adapt instantly to the new environment and produce expected outputs. In fact, environmental factors that scientists experience post-mobility may hamper their career development opportunities. In this respect, the contribution of foreign-born scientists to technological, economic, or social development of the host country is not a given.

The next section of this chapter develops a conceptual framework that addresses literature gaps, and aims to find answers to the RQs.

2.3 Conceptual Framework

The framework of this study does not seek to give propositions or offer hypotheses, but rather underpins the ways in which answers to research questions are discovered by
outlining concepts, assumptions and beliefs that support and inform this research (Maxwell, 2005).

The research questions of this study are designed specifically to address two gaps in two different sets of literature. More specifically:

**RQ1: What are the drivers of the global scientific mobility?**

The first RQ can now be contextualised in terms of the persisting tension between the significance of national level factors of global scientific mobility, and the emergence of new influences on mobility flows. I aim to contribute to the understanding of new emerging drivers of global scientific mobility by focusing on mobility trajectories and institutions that structure them.

Previous studies on scientific migration and ALMs provide theoretical foundations for this part of research design. To follow a classic assumption (Giddens, 1986), two types of forces are engaged in the formation of global scientific mobility flows: an institutional structuring influence, and the agency of the actors. This division provides grounds to formulate two sub-questions (SQs) of RQ1:

1.1. What are the capacities of nation states to retain, or otherwise extract benefits from the highly skilled and highly mobile researcher workforce?

1.2. How do career development strategies incorporate scientific migration and why?

SQ 1.1 is a capacity question. It builds on the extensive previous evidence of HSM research and modifies a traditional push-pull factor framework to seek answers. Push and pull factors account for the basic ability of nation states to attract or extrude globally mobile scientists. As stressed in the literature review, the global competition also tests capacities of systems to retain highly skilled mobile labour force, therefore, hold factors – retaining capacity – are also explored as a part of the framework.

Following the assumption that the importance of national borders decreases in certain circumstances, the analysis of scientific migration factors is carried out separately for national, regional, research system, organisational, innovation and personal factors.

National level factors encompass broad country-level institutions, barriers and systems that regulate mobility. Regional level factors outline regional institutions and the specific context. Research system factors relate to the principles of organisation of scientific activities. Organisational factors are specific to research-performing organisations scientists are
seeking employment in. Finally, personal factors reflect individual circumstances unrelated to any other type of factor.

The factors found significant in the initial review of scientific mobility literature are summarised in Table 2. Among national factors, language stands for the main language spoken in the country and the degree of familiarity with it. Labour market regulations, immigration regulations reflect general type of legislation that regulates mobility to and from country. Visa and residence permits reflect opportunities for long-term settlement in the country. History and culture reflects affinity with the host society in general. ‘Migrant community’ reflects general attitudes to foreign-born persons in the host society. Finally, regional positioning describes geolocation of the country in relation to other significant locations, such as proximity to the home country.

Research system factors encompass the institutional setup of the system inclusive of the overall organisation and funding structure. The science diaspora concept as a factor of ethnic clustering, is included in the list. Regional factors include research clusters – multiple organisations in close proximity to one another that are engaged in collaborative research. Equipment and facilities is the second important regional factor, which reflects, most of all, large-scale multi-user facilities.

Innovation factors outline elements of the innovation system that may attract, extrude or retain scientists. The literature lists two main significant mechanisms: company and user links in terms of proximity to users and relevant industries; and the availability of knowledge transfer mechanisms for those scientists who are looking to commercialise their research.

Organisational migration factors are numerous and encompass structural elements of organisational academic configuration, such as career development opportunities, time expected to be spent teaching and salary; reputational aspects, such as ‘star’ scientists who work in the organisation and the overall level of organisation’s reputation. Finally, there are factors related to research process, such as previous visits to the organisation and current professional network that extends to the organisation, and working environment.
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<td></td>
<td></td>
<td>Age</td>
<td></td>
<td>Maintaining Personal Relationships</td>
</tr>
</tbody>
</table>

Table 2 Scientific Mobility Factors

Sources: Cornelius and Espenshade (2001); Florida (2003); Gurcak et al. (2001); Heinze et al. (2007); Hemlin et al. (2004); Jones (2012); Meyer (2001); Moed et al. (2013); MORE Compendium (2011); Taylor and Braddock (2007); Whitley (2000); Zucker and Darby (1996)

Only four personal factors are listed as important for scientific migration, but two of them are usually found among the most significant. These are age of the researcher – and it is commonly reported that mobility decreases with age – and childcare/schooling, which is also a factor that contributes to decrease of scientific mobility. The other two personal factors describe parts of informal network that is left behind during relocation, and the necessity to transfer financial accounts, which can also be an impediment.

Lastly, SMTs are expected to be sequential and ongoing. Scientists are expected to move between national systems and organisations in those systems. I will expect to find how scientists diffuse and adapt their ‘migrant capital’ to leverage networks and resources.
available in the home country for the advantage of academic research in host countries to receive better outcomes (Baláž and Williams, 2004; Erel, 2010).

The moves are enabled and structured by institutional setup of ALMs. The literature on SMTs is useful to understand mobility of scientists. The driving force of various other kinds of labour markets will be explored.

In answering the SQ 1.2, I will use the structuration findings to explore ways in which scientists ‘work’ (Lawrence et al., 2011) their available opportunities to, again, receive better outcomes for their starting position and available capital. The main suggestion from the review of literature is that, while macro-level theories analyse global competition for talent and facilitate academic job mobility, mobility between sovereign and nationally bounded academic labour markets may imply potential career return problems for individual scientists.

The reasons why some scientists have global mobility trajectories, despite evidence that they have hazards for career development returns, can be illuminating for the discovery of emerging global career paths, global occupational identity of scientific profession, and global ALMs.

**RQ2: How does global mobility affect academic activities and career development opportunities of scientists?**

The second research question is positioned on the intersection of two areas of knowledge: scientific mobility and micro-level research of academic practice. Areas of problematisation of these two research fields very rarely intersect, which is why the link between scientific mobility experience and academic activities remains relatively uninvestigated.

Analysing science as a social enterprise, it seems fair to suggest that there exists, as in any social enterprise, a certain cultural bias (Douglas, 2011) in the scientific practice that may have impact on research outputs. The second RQ is therefore addressed by conceptualising cultural bias as ‘national academic culture’.

Academic culture is a term that operationalises differences in research context of different academic communities and enables their comparison. The concept of academic culture here is understood to mean the general norms and practices that constitute membership in the scientific community, and associated expectations, activities and attitudes. It provides the underlying context for academic activity, and delineates the boundaries of this activity and
distinguishes members of academic community from non-members. It is on the one hand a value system shared among the members of scientific community, but also involves practices and institutions that are informed by these values.

The proposition is, therefore, that global scientific mobility, when understood as transition of embodied S&T capital, tacitly brings elements of the home academic culture to the host country context. This transfer is operationalised as ‘academic identity’ – internalised sense of belonging to a certain type of academic environment.

The following two sub-questions can therefore be addressed:

2.1. How is the tension between academic identity and academic practice resolved among globally mobile scientists?
2.2. How and why do scientists enact transnational networks?

In SQ 2.1, the tension between identity and practice refers to the differences between academic culture of globally mobile scientists and local norms and expectations. When the two clash, it results in adaptation challenge.

The difference between academic identity and academic practice is that identity is normative (reflects idealised and desired state of affairs), whereas academic practice profile can be prescribed: certain elements of it may be in the job description and accompany straightforward research work. Adaptation challenge in this work will be only explored in terms of boundaries of academic activities of Russian-speaking scientists to identify the influence of their academic culture on the scope of academic activities and the attitudes.

Academic culture/identity adaptation challenge is explored by analysing activity profiles of Russian-speaking scientists and matching them against perceived external pressures to adapt to the environment. This is done in an exploratory manner by using two frameworks that differ in scope and complexity.

The first framework operationalises academic activities in the context of research on workweek time allocation. Initially, the distribution of an average workweek time between the three institutionalised academic activity elements - research, teaching, and service – is measured. Scholarship in university faculty time allocation has traditionally reviewed research and teaching, sometimes adding service (‘faculty roles’) as requiring trade-offs between each other (Bentley and Kyvik, 2013; Link et al., 2008; Whelan and Markless, 2012; Winslow, 2010). While some time allocation studies examine engagement and
commercialisation, elements of academic practice that are becoming increasingly important, 
the research focus is on the probability of academic faculty to be engaged in these activities 
(Libaers, 2012).

Then the analysis is operationalised within the research compass card model that assumes a 
broader understanding of academic roles (Laredo and Mustar, 2000). The components of the 
five complementary contexts of academic activities (see section 2.2.3 for details) have been 
modified to suit the scope of this research (Figure 2). The application of the modified 
research compass card is twofold: first, it was used to assess general parameters of national 
academic cultures. Second, a simplified version was used to map activity profiles of 
scientists.

![Research Compass Card for Academic Practice](image)

Certified knowledge production includes straightforward research and some elements that 
are related to research process. Group factors are *communication* – in-group 
communication, which includes communication between researchers with different 
specialisations; and decision-making processes. *External communication* is analysed in forms 
of research networks, research collaborations, including social dynamics of collaborations 
(Youtie and Bozeman, 2014), and internationalisation of research networks. *Research*
hierarchy is an indicator of distance between junior and senior members of the research group, and between disciplines. Resource capacity is materials and equipment, human resources and their potential capacity in terms of training. Resource strategy includes ways of obtaining funds to continue research. Publication intensity and research topic change are a part of research context.

The second component of academic practice is Education and Training. The original model only includes postgraduate students in the scope of this parameter. In the light of a finding that on average 30% of time of public sector researchers is spent on undergraduate teaching, this element was included in the model. Supervision of postgraduate students is a hybrid type of activity, which is also a part of this component. Organisationally, such element of teaching practice as teaching distance – availability of the tutor to be contacted outside office hours; engaging students outside office hours – was included. Finally, a perception-based indicator ‘teaching-to-research transfer’ indicates ways in which scientists make undergraduate and postgraduate teaching benefit their research was included.

Proprietary knowledge and commercialisation outlines two complementary elements of competitive advantage creation: first, it is the production of knowledge that has commercial value in the form of patents, consultancy services, and testing services. The second component involves tangible assets: it includes such practices, as joint use of facilities, co-funded research projects, including institutionalised co-funded projects, co-funded doctoral researchers, and, finally, direct commercialisation of technology in a form of a spinoff or licensing of technology.

Informing the wider public about the advancement of science and making science more inclusive are the two main element of the Outreach and Engagement component. The other two elements are science and art collaborations and overcoming epistemological distance between the two, and pre-University outreach, which deals not as much with informing and inclusivity, but rather with raising the university profile among school pupils as a part of a wider strategy to bring in the brightest human resources.

Scientific expertise is often sought after in the development of science policy programmes, so the final component of the model is Public Goods and Policy Making. Scientists from the community may act traditionally as visionaries of advisories to policymakers, or also take positions in funding committees and organisations to decide on the distribution of public funding across projects. Finally, scientists sometimes purposefully adjust their research agendas to contribute towards the development of societally important technology, for
example, sustainable energy solutions. These outputs are classified as *publicly responsive technology*.

I will expect to find cases of adaptation problem among post-Soviet scientists, and identify strategies of resolving this tension. Findings from this SQ 2.1 cannot be underestimated. While globally mobile scientists are on average more productive and are more cited than non-mobile scientists, discrepancies in expectations and organisation of academic activities may result in serious setback not only for the 4 non-traditional academic activity contexts, but also for the main process of certified knowledge production.

The final SQ 2.2 invokes yet another discrepancy identified in the literature. Networks of scientists are also often seen as a key social component of competence and community membership (Barabasi et al., 2002). While scientific research networks are often international, in the circumstances when globally mobile scientists face strictly national career development expectations, it can seem unproductive that they allocate significant share of their network management to participation in science diaspora activities.

By turning to transnational theory of migration, I investigate circumstances under which globally mobile scientists enter and maintain transnational research networks, focusing the science diaspora of Russian-speaking researchers.

The interconnectedness of globalisation gives an opportunity to individual and research collectives to distance themselves from their immediate research environment and act as a part of more favorable academic environments and communities. The transnationalism theory portrays societies as interconnected networks that exist simultaneously with nation states (Wimmer and Glick Schiller, 2002).

Following the social field approach to transnational migration studies, the ways of ‘being’ a part of the social field and ‘belonging’ to it are distinguished. According to Levitt and Glick Schiller (2006),

“[W]ays of being refers to the actual social relationships and practices that individuals engage in rather than to the identities associated with their actions. <...> Individuals can be embedded in a social field, but not identify with any label or cultural politics associated with that field. <...> In contrast, ways of belonging refers to practices that signal or enact an identity, which demonstrates a conscious connection to a particular group. <...> Ways of belonging combine action and awareness of the kind of identity that action signifies” (p.1010).
Additionally, science diaspora is conceptualised here in terms of its network definition, in contrast with home country-based definition that has dominated recent studies. Kuznetsov and Sabel (2006) discuss diaspora networks of scientists rather than scientific diasporas and define them as “networks of diaspora members to advance their collective goals, often (but not necessarily) for the benefits of home countries” (p.1). The authors eventually conceptualise diaspora networks as “transnational search networks” (p.6), where the search “allows to find and collaborate with those who already know what we need to know” (p.1).

Professional networks (including collaboration networks and weak ties) are useful concepts to understand the nature and the process of global scientific mobility on an individual level. Ultimately, transnationalism theories suggest the diminishing role of nation states in the processes of global mobility and migration. I use these findings to see whether the same maintains for global scientific mobility.

2.4 CONCLUSION

Essentially, the conceptual framework of this study poses research questions and operationalises ways to address them on the intersection of two axes. The first axis represents the link between macro-level processes and meso- and micro-level dynamics. While the research objective is formulated on the meso-level, it is contextualised in a macro-level context for the first RQ and on a micro-level for the second RQ. The second axis reflects the tension between the impact of international and transnational influences on social processes, and the maintained importance of nationally bounded social phenomena. This tension is brought up repeatedly across the literature used to explain and position this research.

The research questions are answered in three data-based chapters in the ‘Explanation’ part of the thesis. Chapter 5 adopts a macro-level perspective and analyses drivers of mobility, while Chapters 6 and 7 adopt micro- and meso-level perspectives and explore academic cultures and activity profiles of post-Soviet scientists (SQ2.1), and circumstances of science diaspora network engagement (SQ 2.2) accordingly.

The next chapter of the thesis outlines the methodology of research.
CHAPTER 3 METHODOLOGY

3.1 INTRODUCTION
This chapter reviews main methodological foundations of the study, and approaches used to design and execute it. First, it discusses research approach and design. It then moves on to discuss the two-stage research process in more detail. The core part of this chapter is section 3.4, which sets the boundaries of the scope of this study and discusses the particular methods used to collect and analyse the data. The next section reports data collection results. The chapter is concluded with the discussion of research bias and reflexivity.

3.2 RESEARCH APPROACH AND DESIGN
This is exploratory research. It brings together areas of knowledge rarely used jointly, and addresses gaps that emerge on the borderline between multiple areas of knowledge. This research also does not rely on any consistent line of work done previously. The purpose of exploratory research is to develop further hypothesis and provide the ground and reasoning for the next round of research questions (Kothari, 2004). Ultimately, this study aims to pave the way for new research questions, rather than dispute existing findings. More broadly, my strategy in this research was to keep an open mind and maintain open approach to discovery (Stebbins, 2001).

This study is designed accordingly. A conventional way to design an exploratory study is grounded theory – an approach that builds cohesive high-level concepts inductively from the collected data and observed phenomena (Glaser and Strauss, 2009). However, my approach is more deductive and relies on a set of theories and existing constructs. This makes the grounded theory method uncomfortable and bulky to position to answer diverse research questions. Additionally, the problem of identifying and measuring the study population was a significant obstacle in designing a qualitative research framework. As a solution, this study adopts a quasi-mixed method research design.

This design allows to collect and analyse both qualitative and quantitative data within the single study framework. Creswell (2002) recognises that “biases inherent in any single method could neutralize or cancel the biases of other methods” (p.15) as the main reason of the popularity of this research framework. For this study as well, due to the absence of any previous information about the distribution of Russian-speaking scientists abroad, the qualitative data collection bias would not have been possible to assess should this study have adopted a fully qualitative framework.
The qualitative method is, however, dominant in the mixed method strategy of this thesis. The research process is therefore sequential. The quantitative data was collected and analysed previous to the initiation of the qualitative stage of the research, and therefore informed subsequent qualitative data collection. Quantitative data insights were also used at the stage of final analysis and integration.

The object of this research is a cohort of globally mobile scientists. Their mobility stretches not only across space, but also across time, which makes it a difficult case of a ‘mobile phenomenon’. Mobile and geographically distributed research object is dealt with poorly by existing social methodologies. Holding down and patterning mobile phenomena reduces their rich and complex nature, making it harder to interpret. Mobile phenomena are conceptualised within the ‘mobilities paradigm’:

“It enables the social world to be theorised as a wide array of economic, social and political practices, infrastructures and ideologies that all involve, entail or curtail various kinds of movement of people, or ideas, or information, or objects” (Büscher et al., 2010, p. 4).

Mobilities paradigm investigates the ways in which various kinds of ‘moves’ make social and material realities. This study makes use of the notion of “intersecting mobility systems” – where human and non-human objects are in the adaptive and evolutionary relationship with each other – to conceptualise global scientific mobility and understand spatial implications of research practice of mobile scientists

3.3 RESEARCH PROCESS
The research process of this study consisted of two main stages (Figure 3). The first stage was mainly desk research, from the narrowing down of the initial research idea following through with the development of research design and the bibliometric analysis. The second stage consisted of the iterative process of data collection and analysis.

The initial development of the study focus went from thinking about broad ideas about change in research-performing organisations, globalisation and innovation systems, to doing a literature review and eventually focusing on the problem of human resources in public research organisations. Finally, Russian-speaking nanoscientists became the research object of this study for the reasons outlined above (see section 1.2.1).
Then, a pilot project was developed to test the interviewing strategy and research questions. The pilot project took place in May and June 2013 and consisted of two semi-structured qualitative interviews with senior Russian-speaking nanoscientists in the UK and Brazil. The interview protocol was tested. At the end of each interview feedback was requested from the pilot project participants on the quality of questions and suggestions were invited for other types of questions.

The final part of desk research before going into the field was the task to identify distribution patterns of Russian-speaking scientists abroad to make decisions about the scope and locations of the qualitative fieldwork. To solve this problem, a novel method was developed to identify Russian-speaking scientists abroad using author surname information in bibliometric data. It was first tested in summer 2013 and is outlined in Chapter 4.

The second stage of the research process was initiated in September 2013. From that time, until January 2015, it was iterative: rounds of fieldwork were interchanged with the rounds of data analysis, which informed further rounds of fieldwork. The data analysis was conducted along the lines of major themes identified as research questions: SMTs (Chapter 5), science diaspora and home country links (Chapter 7), and, finally, academic practice of globally mobile researchers (Chapter 6).

The fieldwork was completed in December 2014, when the saturation of collected information was reached, and the margin of new data obtained in each interview decreased significantly (Guest et al., 2006). From then on, the data analysis entered its final stages: by October 2015, all main analytical techniques were revisited and results were verified.
Bibliometric analysis methodology was revisited and improved. Finally, synthetic analysis was conducted.

Intermittent data analysis results were presented at academic events and conferences, as well as discussed with advisors. As this study is interdisciplinary, advice was sought about the research process, strategy and initial results from other academic communities:

- Mainstream international migration community for feedback on SMTs analysis (July 2014 and September 2014)
- Transnational academic studies community and STS community for science diaspora analysis (March 2015 and April 2015)
- Sociology and economics of science community for academic practice analysis (May 2015)

Designing the research process to be iterative and, therefore, revisiting each interview multiple times over 2 years of intermittent data analysis was the strategy to achieve consistency with the resulting conceptual models and research results (Boyatzis, 1998). Seeking external expertise for the interdisciplinary elements of this research reinforced cohesion in the conceptual framework, ensured correct interpretation and translation of terms and theories. Ultimately, this strategy also enabled generalisability and relevance of results of this study towards other disciplines enacted in the conceptual framework.

3.4 RESEARCH SCOPE AND METHODOLOGY

3.4.1 RESEARCH SCOPE

Defining the scope of research was a methodological challenge of this study. While the geographic distribution scientists conforms to national borders, and the fieldwork can be limited by examining science diaspora populations in multiple countries, the definition of the study population is ambiguous and needed to be constructed carefully.

All countries of the Soviet Union experienced high scale of outward migration after the breakdown of the Iron Curtain. With this regard, previously uniform Soviet academic culture did not break down into national research cultures and maintained common Soviet elements. Moreover, the majority of scientists who were trained in the Soviet Union spoke Russian as their first language and identified themselves as Soviet, rather than Russian or Ukrainian, scientists. Therefore, the outflow of scientists from post-Soviet countries should be regarded as one continuous phenomenon.
However, the subsequent global mobility of post-Soviet scientists becomes fragmented. As post-Soviet countries set on their own development trajectories, some of them joined the European Union, while others formed confederation union-type governance with Russia. 25 years after the breakdown of the Soviet Union, it is impossible to draw all post-Soviet countries and their scientific migration management approaches in one study.

Hence, the scope of this research is dynamic: it regards all Russian-speaking scientists who were trained within Soviet research system, as belonging to one cohort of researchers with the same academic outlook and culture. As the years pass, the scope narrows down to Russia – the country-successor of the Soviet Union, politically and economically, and also Belarus and Kazakhstan, the two countries which moved on to form a united confederation with Russia with open borders and common economic policies.

The main target group of scientists are those “who were born in the countries of the former Soviet Union, for whom Russian is a native language, independently of their ethnicity” (Kopnina, 2005, p. 1). Language, not ethnicity, sets the boundary of the study population. This maintains for the quantitative as well as qualitative methods of this study.

Then, nanoscience is the second broad delineation of the study population. It has been noted that physicists, mathematicians and chemists are among the highest sought after groups of Russian-speaking scientists in the countries of Western Europe and the USA, due to the quality and the competences of Soviet research (Ganguli, 2014). Nanoscience is an interdisciplinary research area that encompasses advanced topics on the intersection of these fields. For the Russian nanoscience, physics and microelectronics are still strong and competitive areas, but in others, the national science competences are lagging far behind (Terekhov, 2012).

Therefore, focus on nanotechnology allows delineating the scope of this study towards scientists engaged in advanced complex research that requires unorthodox solutions and potentially yields great technological and innovative benefits. This group of researchers includes elite scientists at the advanced stages of their career as well as younger promising scientists. Their specialisation on nanotechnology implies high competitiveness and high output potential of their research.

Such strict delineation was a potential hazard to arranging any interviews with relevant scientists. Therefore, a three-tiered sampling strategy was developed prior to initiating the fieldwork (Table 3). The core sample includes scientists who can be identified as carriers of
the ‘Soviet’ research culture and are actively engaged in nanoscience research, therefore constituting the core study population.

The general sample scientists include younger researchers and researchers who completed their doctorates abroad, hereby initiating their academic careers within other national research systems than the post-Soviet one. SMTs were analysed as a part of the general analysis of globally mobile researchers, but their academic practice profiles were only used as a comparison reference. The same analysis was done for nanoscientists and non-nanoscientists.

Finally, snowballing was used as a strategy to explore networks and connections between Russian-speaking scientists abroad. Snowballing is also called ‘opportunity sampling’, which signifies sampling on-the-spot (Arksey and Knight, 1999). Snowballed interviewees did not always fit the sampling criteria, but instead were an important source of context information, contributing to general understanding.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Criteria</th>
</tr>
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<tbody>
<tr>
<td>Core</td>
<td>• Russian as a first language&lt;br&gt;• Belonging to the ‘soviet scientific school’ – having received doctoral degree in the Soviet Union or post-Soviet countries&lt;br&gt;• Left home country before 2000&lt;br&gt;• Nanoscientist according to the lexicological query&lt;br&gt;• Live outside of the home country permanently (position may be non-permanent)</td>
</tr>
<tr>
<td>General</td>
<td>• Russian as a first language&lt;br&gt;• Higher education completed in Russia or post-Soviet countries&lt;br&gt;• Natural Sciences discipline&lt;br&gt;• Live outside of the home country permanently (position may be non-permanent)</td>
</tr>
<tr>
<td>Snowballing</td>
<td>• Russian as a first language&lt;br&gt;• Natural Sciences discipline&lt;br&gt;• Live outside of the home country permanently (position may be non-permanent)</td>
</tr>
</tbody>
</table>

Table 3 Sampling Strategy

Source: author

Fieldwork destinations were determined with the use of bibliometric analysis. The core set of countries – USA, UK and Germany – was defined on the basis of the secondary sources, as the countries of the highest emigration of Russian-speaking scientists. Within the countries, several regions and organisations were identified as target fieldwork locations. Subject to
transport and financial restrictions, the scope of research fieldwork aimed to cover the following locales:

- Top level world class research universities;
- Specialised (entrepreneurial, teaching) research-performing organisations;
- Locations with high and low concentrations of general Russian-speaking population;
- Nanotechnology centres of excellence.

Due to proximity, several interviews were conducted in Switzerland and France. These countries are not the core study locations, therefore, less information is provided on the background context and institutional configurations of academic careers of globally mobile researchers. However, scientific migration patterns and practice profiles of the Swiss and France-based Russian-speaking scientists were used to contrast findings in other countries, and contrast the profiles of the core population sample.

This way, the data obtained for mobility patterns in the core sample underwent double triangulation (Richards, 2014, p. 26). In the first instance, core set of interviews was contrasted with ‘snowballed’ and general interviews. In the second instance, the data on mobility patterns in core fieldwork countries was triangulated against mobility patterns in France and Switzerland.

3.4.2 METHODOLOGY

The methodology of this research, including linking research questions with operating concepts, and separating methods of data collection and analysis, are illustrated in Table 4.

Bibliometric analysis of research publications is now routinely used by social scientists to link research performance with the development of science and technology (Daim et al., 2006; Leydesdorff et al., 1994; Shapira et al., 2012). In recent years, address information has been used to track the changes in affiliations of scientists and, this way, bibliometric analysis is employed to study scientific migration (Conchi and Michels, 2014; Moed et al., 2013). Using author address information for approximation of the author’s nationality and background presents a fundamental problem with this approach.

The bibliometric analysis in this work instead of the address information uses author names as approximation of their background. This way, Russian-speaking scientists who left the Soviet Union and post-Soviet countries decades previously, can be identified for as long as they regularly publish in journals indexed in bibliometric databases. The data for bibliometric analysis was collected from the Web of Science (WoS) using the surname
endings method detailed in Appendix 4. At a later stage, publication data of scientists who participated in research interviews was collected from the Scopus database. In both instances, the data was analysed in the VantagePoint software developed by Search Technology.

<table>
<thead>
<tr>
<th>Research Task</th>
<th>Operating Concepts</th>
<th>Data Collection</th>
<th>Data Analysis</th>
</tr>
</thead>
</table>
| Identify Russian-speaking scientists abroad | • Scholarly publications  
• Nanotechnology lexicological query | | Bibliometric Analysis |
| RQ1: What are the drivers of the global scientific mobility? | • Biographic data  
• Academic career trajectories  
• Academic positions  
• Academic labour markets  
• Pull/push/hold Factors | | Narrative Analysis (thematic encoding) |
| RQ2: How does global mobility affect activities and career development opportunities of scientists? | • Academic culture  
• Academic identity  
• Academic activity profiles  
• Workweek time allocation  
• Research collaboration networks  
• Science diaspora networks | Qualitative Interviewing | Thematic Analysis |

Table 4 Research Methodology

Source: author based on Aronson (1995); Boyatzis (1998); Chase (2005); Robinson-Garcia et al. (2015)

The qualitative data was collected via semi-structured interviews with Russian-speaking nanoscientists. The database of candidate scientists was identified at the stage of bibliometric analysis. The background of each scientist was checked, and contextual information obtained from websites of employing organisations and from any articles in press and other materials available online, including academic CVs.

Semi-structured interviewing is a core technique for qualitative data collection. It is widely used in science and technology studies, especially if the research object spans multiple stakeholders. In case of this research, semi-structured format was chosen for several reasons.

First, the stories and current activities of participating scientists contain much variation. In the exploratory research that tests multiple frameworks and approaches, semi-structured
interview framework is flexible to explore these. Second, in the context of multi-sited fieldwork, using semi-structured interviewing ensures consistency in answers to some questions, which provide comparison points in further analysis. Lastly, semi-structured interviewing is a balanced data collection method that provides comparability of data, but leaves room for rich descriptions of phenomena.

The interview protocol developed for this study (can be examined in Appendix 1) structures questions in three compartments. The first part contained few questions and was tailored to inquire about details of the academic career progression of the interviewee and obtain biographic data. The second part contained questions about current research practice activities of the interviewee, including workweek allocations and topic change. The third part contained questions about the wider academic practice, including industry and stakeholder engagement, science diaspora and adaptation questions.

In a minority of interviews, the list of printed mobility factors (See Appendix 2) was offered to facilitate the discussion. Generally, all questions were open-ended.

During the data collection stage, using a three-part interview protocol assisted with time management. Routinely, interviews lasted for one hour or longer, but several interviewees had time constraints. In these cases, the aim was to obtain comprehensive data on one of the parts of the study, instead of attempting to cover all three.

The data analysis of all three parts went through the initial stage of thematic encoding. As Boyatzis (1998) points out, thematic encoding of qualitative information is not an analysis method itself, but rather a technique preparing the rich and unstructured qualitative data for further analysis. The coding system for the qualitative interviews was theory-driven, and the themes were informed by previous research.

The interviews were recorded after obtaining appropriate informed consent (the form used is available in the Appendix 3). Interview notes were written up, and most interviews were partially transcribed. Only a selected number of key interviews were fully transcribed. Where available, interview notes contained ‘thick description’: contextual information about the interview environment and other factors that I thought could be insightful during the analysis (Geertz, 1994).

The three parts of interview answers were analysed at different points of time. The information from the first part of questions contained mainly biographical information. Theme-based narrative analysis was used to make sense of this data. Thematic encoding of
the biographic interviews and further contextualisation of these themes lay within personal life-stories.

Thematic data obtained in the third part of the interviews was matched against the codes derived from the research compass card model. Themes identified during the analysis of national research cultures provided the framework for positioning of the resulting practice profiles within the framework of academic culture adaptation.

The qualitative data is reported in Chapters 4-7 of this work. Direct quotations are italicised and are singled into a separate paragraph when they are longer than 1 sentence. The position of the interview participant and the country of residence are reported in all instances, as this study problematises academic career development in the age of mobility. Additionally, longer biographic narratives are given in Section 5.5 to illustrate global mobility strategies for career advancement among interview participants.

3.5 DATA COLLECTION RESULTS
The bibliometric analysis identified 5114 authors with Russian surnames (approximating them to Russian-speaking scientists) who were active researchers by 2012. Among them the vast majority reside in the USA, followed by Germany, France and the UK.

<table>
<thead>
<tr>
<th>Country of Residence</th>
<th>Sending Country</th>
<th>Position Name</th>
<th></th>
</tr>
</thead>
<tbody>
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<td>USA</td>
<td>Russia</td>
<td>Assistant Professor</td>
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</tr>
<tr>
<td>UK</td>
<td>Belarus</td>
<td>Associate Professor</td>
<td>10</td>
</tr>
<tr>
<td>Germany</td>
<td>Moldova</td>
<td>Professor</td>
<td>24</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Ukraine</td>
<td>Privatdozent</td>
<td>3</td>
</tr>
<tr>
<td>France</td>
<td>Israel</td>
<td>Senior Scientist</td>
<td>5</td>
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</table>

<table>
<thead>
<tr>
<th>'Wave' of Migration</th>
<th>Type of Organisation</th>
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<tbody>
<tr>
<td>1988 -1991</td>
<td>Research Institute</td>
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<td>Research Scientist</td>
<td>1</td>
</tr>
<tr>
<td>1992-1993</td>
<td>National Laboratory</td>
<td>1</td>
<td>Research Professor</td>
<td>4</td>
</tr>
<tr>
<td>1999 - 2006</td>
<td></td>
<td>1</td>
<td>Research Fellow</td>
<td>1</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Position Type</th>
<th>Research Area</th>
<th>Principal Investigator</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenure-track</td>
<td>Chemistry</td>
<td></td>
<td></td>
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<tr>
<td>Permanent</td>
<td>Engineering</td>
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<td></td>
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<tr>
<td>Contract</td>
<td>Physics</td>
<td></td>
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<td></td>
<td>Biology</td>
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<td>Microelectronics</td>
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<td></td>
<td>Neuroscience</td>
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<table>
<thead>
<tr>
<th>Gender</th>
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<tr>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td>Male</td>
<td>56</td>
</tr>
</tbody>
</table>

Table 5 Qualitative Data Collection Results
As a result of the 4 rounds of fieldwork, 66 semi-structured interviews were conducted with scientists in the USA, Germany, UK, Switzerland and France (Table 5). The majority of the interview participants were physicists, with the minority doing highly interdisciplinary research and research in other disciplines. The sample is diverse in terms of the seniority of interview participants, types of their academic careers and the migration ‘waves’ they belong to.

51 interviewees are engaged in nanotechnology research. The majority of them are physicists. As there is a variety of positions that interviewees were occupying, the diversity was reduced by looking at whether the position was permanent, or had a condition to become permanent at the end of the term or the contract. According to this criterion, the majority of interview participants were occupying permanent positions. There is a skew towards scientists employed in universities in the sample, and towards male representation.

3.6 Research Bias and Reflexivity
There is bias in the data of this study. The boundaries drawn to delineate the study population are artificial and may not necessarily coincide with the actual self-identification of Russian-speaking scientists themselves. After conducting the series of research interviews, it became clear that the constructs used in the study, such as ‘science diaspora’, were not necessarily used by the study population, and therefore were often misinterpreted.

To mediate these, I adopted an aggressive interviewing style. I challenged interviewees, who were natural scientists and therefore were familiar with the principles of research methods, by asking them to provide more precise definitions, by using alternative definitions, and by explicitly discussing theories and assumptions behind the questions and the terms used. This way, I was able to change interview questions accordingly in further rounds of fieldwork.

The change of interview protocol and the variance in the duration of interviews is another data collection bias of this study. By elaborating the terms and the questions I was asking I was able to become more clear and precise in getting the information about certain aspects of academic practices of interviewees. However, I may have missed on some of the elements in earlier interviews, which were not as focused. Therefore, some approximations made

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2 Out of the 66 interviews, 3 were conducted by Skype, the rest were in person.
further in this study on the basis of responses given are not representative of Russian-speaking scientists and are only indicative of some patterns in behaviours among interview participants.

There is sampling bias: an average interview participant of this study seems to be a middle-aged male physicist, originally from Russia, who is currently working in a permanent position in a US university. Therefore, some outputs, including policy implications, can only be offered in relation to research universities. However, other indicators (USA, physics, male) are consistent with the general pattern of post-Soviet emigration. Not only Russia was the largest Soviet country with excellent physics, but the system is also heavily gender segregated, predominantly professionally, and female scientists do not access senior roles (Paul-Hus et al., 2015). As scientific migration literature suggests, female scientists are also less likely to start a migration project (MORE Compendium, 2011).

Additionally, the very top US universities, broadly grouped as ‘Ivy League’ are underrepresented in this study. My attempts to arrange an interview with Russian professors engaged with Skolkovo-MIT initiatives were unsuccessful.

Finally, a note on reflexivity should be added. In any social science research the research object eventually coincides with research subject, and, therefore, objectivity is unattainable (Linstead, 1994). However, acknowledging the researcher bias and accounting for it during the data collection and analysis is a key to producing reliable qualitative information. This is also the case in this study. Being a Russian-speaking academic abroad myself, I could relate to my study population, and I also have some skills, such as the language proficiency and the insider knowledge of the Soviet system and of the crisis of the 1990s, to speak with the interview participants from a shorter distance than a domestic researcher would.

Therefore, boundaries were played down – as I share social membership in the Russian-speaking community (Shinozaki, 2012). At the same time, there was constant insider-outsider dynamics throughout each interview, because I was also approaching the topic as a social scientist, asking certain types of questions that could displease and even anger interviewees. And while I could solidarise with the interview participants when discussing, for example, issues of adaptation in a foreign country, or prospects for further mobility, we could almost immediately be in opposition when discussing other types of questions, such as communication with the science diaspora or public engagement.
This researcher bias, one part, gave me more information, verbal and non-verbal, to make more accurate assessments. For example, I gave the choice to the interviewees whether to conduct the interview in English or in Russian. I did not hide my own opinion on the issues we were discussing, sometimes openly confronting interview participants, therefore shaking the subordination established between us, especially if they are senior researchers. This way, I attempted to collect the information of the best quality available under the circumstances. My own normative perceptions – those of the broadening up academic identities and vouching for multi-functional research teams that produce accountable and societally important research, but also enjoy mobility opportunities and job security – are reflected in the following chapters.

Ethical considerations were present at all stages of designing and implementing this research project. In doing so, I aim to stand up to professional expectations in implementing qualitative data collection and analysis. Miller et al. (2012) list four main elements of qualitative research procedures: informed consent, confidentiality, participation and rapport.

Prior to each interview, informed consent was asked from interviewees to participate. Where available, interviewees signed a form and retained project information sheet containing short Q&A about the project with my contact details. Confidentiality of interviewee data was preserved by, anonymising the data, storing it digitally and not sharing it with third party persons, including technical services, such as transcription. The participants of this project had an opportunity to read the draft of this work after it was completed. While part of the interviewing strategy was to challenge interviewees, rapport was reached in most interviews.

The next chapter contextualises the social phenomenon of global scientific mobility of Russian-speaking nanoscientists.
CHAPTER 4 POST-SOVET SCIENTIFIC MOBILITIES

4.1 INTRODUCTION
This chapter is organised to give the reader relevant details about post-Soviet scientific mobility in order to better explain specificities of the academic culture and mobility flows discussed later in this work. It integrates literature-based review on the Soviet science system organisation and its post-Soviet dynamics. The outflow of scientists that followed the breakdown of the Soviet Union forms the core of the first part of the chapter. Literature-based overview is complemented by biographic narrative insights from the interviewees.

The second part of the chapter presents the results of bibliometric data analysis conducted with the purpose to identify the distribution of Russian-speaking scientists abroad. The results are provided for research areas of science diaspora scientists and the distribution of Russian-speaking science diaspora around the globe. The subsequent analysis provides comparative analysis of productivity of diaspora scientists in comparison with scientists who reside in post-Soviet countries.

The analysis is concluded with the overview of recent science diaspora initiatives in the Russian public policy.

4.2 FROM SOVIET TO RUSSIAN RESEARCH
The research system of mature Soviet Union was internationally isolated and focused on the development of ‘branch sectors’ of science - up to 75% according to the official data (Centre of Statistical Studies and Science Studies RAS, 1990). Public science was dominated by the Soviet Academy of Sciences. The funding was distributed vertically, and overall, scientists enjoyed privileges and prestige in the society, but followed the principles of ‘ivory tower’. Universities were solely educational establishments (David-Fox and Péteri, 2000; Fortescue, 1992; Tolz, 2000).

Post-Soviet research system reforms initially were modest and unsystematic (Yegorov, 2009). As the military orders for science declined (Dyker and Radošević, 2012), the Russian Academy of Sciences, the successor of the Soviet Academy, became the main research-performing organisation in the country and, until 2003, in the world (Kostoff et al., 2008). The series of economic crises in the 1990s, however, undermined the financial stability of the Academy.
Science funding in the post-Soviet Russia was similarly organised on a distributive basis by the way of government-set Federal Target Programmes. Public and private foundations, most notably, the Russian Foundation of Basic Research, were allocating small awards on competitive basis (Karaulova et al., 2014a).

One significant change in the institutional configurations of science was opening up of post-Soviet countries to collaboration opportunities with abroad. The pace of international collaboration of Russia has grown explosively post-USSR breakdown (Glänzel et al., 1999).

The failure of large-scale science investments, especially the ambitions nanotechnology project (Karaulova et al., 2015) has stimulated the Russian government to address some systemic rigidities and Soviet legacies. Within several years in mid-2000s, state-led reforms spanned across several strategic STI areas: institutional reform, funding reform, science priority setting reform, and the innovation system development initiative.

The ambition of the Russian government was to use the existing science competences to boost technological development and eventually catch-up with the major economies in terms of the cutting edge STI competences (Klochikhin, 2011). This was accompanied by a series of efforts to build and stabilise the institutional of a national system of innovation to ensure the transfer of technologies from science to the industry (Gokhberg et al., 2012).

Research and innovation capabilities of universities were supported in a series of policies in 2009. The Academy of Sciences was reformed in 2013 towards decentralisation of its authority. As a part of a wider move from the distributive to competitive system of science funding, two new public funding bodies were established in 2013.

The development of the post-Soviet science system, therefore, went through two major stages: the initial crisis and stagnation, which lasted from 1991 until mid-2000s, and the stage of development and reform, which was initiated around 2004 and continues to this date. Since 2004, science policy frameworks of Russia have grown and diversified, and the system itself became more competitive in retaining its highly skilled scientists, and even in attracting some émigrés to return.

4.2.1 Russian Nanoscience
Nanotechnology became a key priority within the new effort of redistribution of funds to competitive areas of science. It was included in the Science and Technology FTP for the first time in 2004 (Connolly, 2013), and remained a key priority until 2012, when the policy shift occurred towards biosciences. The importance of nanotechnology in Russia peaked in 2007,
when its National Nanotechnology Initiative was announced, a big and ambitious intent to invest $11 billion in the development of nanotechnology research and commercialisation (Schiermeier, 2007).

In Russian nanoscience, physics, the most competitive research area, was the main recipient of nanoscience funding (Liu et al., 2011; Terekhov, 2013). The entire Russian science system is heavily skewed towards natural sciences, mainly physics (Pislyakov and Shukshina, 2014). Issues with the science base were among the most widely claimed reasons for the Russian nanotechnology funding programmes. As nanoscience research in Russia is very fundamental, even the high rate of publications in the top international journals could not provide commercialisable knowledge (Terekhov, 2013, 2012).

The Academy of Sciences is still the dominant research-performing organisation in the country and in nanoscience, producing over 70% of all research outputs throughout the post-Soviet period, and even within the Academy nanoscience is highly centralised in only few leading Institutes (Karaulova et al., 2014b). The underperformance of Academic research in nanotechnology programmes was a large incentive towards science policy reforms of the later 2000s.

4.2.2 Russian Science at a Glance
Throughout the post-Soviet period, Russian research system has maintained traditionally strong and weak features. It is still competitive in certain areas of physics and mathematics above the average level (Markusova et al., 2009). Natural and technical sciences have the biggest rates of scientific employment: the share is maintained at about 85% throughout the 2000s (gks.ru, 2016).

However, Russia has lagged behind other developing countries in terms of the pace of its scientific development, especially in the leading areas of science, and among the most cited research papers (Bornmann et al., 2015; Wong and Wang, 2015). From the 1990s through to the present, Russian scientific research has remained severely underfunded (Figure 4). R&D spending as the share of GDP fell from about 2% to about 1% after the breakup of the Soviet Union, and has plateaued since. Countries that adopted STI-based development model, such as China, have been steadily increasing their science spending over the last decade. In contrast, there are only minor spikes in Russia.
Science funding comes predominantly from government sources: the share of state spending on science has been increasing from the low point of about 50% after the 1998 economic crisis to almost 70% in 2014 (OECD, 2016).

Figure 4 GERD as Percentage of GDP in Russia compared with Other Countries, 1990 – 2014

Source: OECD Statistics (OECD, 2016)

Figure 5 Scientific Journal Articles and Resident Patent Applications in Russia, 1990-2011.

Source: World Bank Science and Technology Indicators (World Bank, 2016)

3 2013 for the USA
Russia has also been plateauing in terms of the productivity and key research outputs (Figure 5). Patent application rates demonstrate slow climb. The general shift towards adopting the innovation-led growth strategy has resulted in the shrinkage of basic research areas. According to the data from the National Office for Statistics (gks.ru, 2016), the balance between government spending on fundamental and applied science research shifted dramatically throughout the 2000s from the balance in 2000, by 2014 the share of fundamental research spending was about 40% of the applied research spending.

On the part of human resources, Russia still has over 3000 researchers per million inhabitants in 2015, which is a comparable level with the leading developed countries of the Western Europe (UNESCO, 2015). Keeping in mind the much smaller share of GERD funding, Russia is country where researchers are overrepresented in the general population, but science itself is ineffective. The number of scientists per population has been decreasing throughout the Soviet period, falling from almost 9 researchers per 1000 population in 1994 to just below 6 researchers in 2014 (OECD, 2016).

The participants of this study embody the historical transformations of the Soviet and the Russian research system. They were all educated in universities and were working in Academic research institutes before leaving the country. They are predominantly male, and predominantly trained in the most competitive areas of Russian science: theoretical physics and mathematics, nuclear physics, condensed matter physics, spectroscopy. About a half eventually changed their research topics, moving into new ‘modern’ interdisciplinary areas from traditional frameworks of the times of their training.

4.3 Post-Soviet Scientific Migration Currents

4.3.1 Soviet Era Emigration
Initially after its formation, the Soviet Union did not particularly inhibit international travel of Soviet scientists. Most famously, the future Nobel Laureate Pyotr Kapitsa was allowed to go to the UK to do research in Cambridge University with Ernest Rutherford (Kapitsa, 1974). Later, groups of Soviet scientists stopped returning from their business trips abroad. The Soviet authorities passed the law “On Defectors” in 1929, which enacted capital punishment for defection. Defected scientists were stripped of the Soviet citizenship, their property was confiscated and their ranks and achievements were withdrawn. Defection was widely condemned publicly, contributing much to the attitudes towards migrating scientists after the breakdown of the Soviet Union.
The Soviet legislation was liberalised in 1960. However, opportunities to go to countries beyond the Soviet Union and the Eastern Bloc was still highly limited until as late as 1988, as a result of Perestroika reforms. Restrictions were lifted completely after the breakdown of the Soviet Union, which signifies the start of the modern history of scientific migration from Russia and other post-Soviet countries.

4.3.2 POST-SOVIET SCIENTIFIC MIGRATION

Russian brain drain from plays a significant role in frameworks offered to explain poor performance of the country in the post-Soviet period. Estimates of the scale of scientific migration from Russia are sporadic and inaccurate. Federal statistics maintain that no more than 25 scientists left Russia throughout the 1990s, whereas the data provided by the Ministry of Foreign Affairs peaks at 5991 people employed in ‘science and education’ who left in 1995 (Latova and Savinkov, 2012). Gokhberg and Nekipelova (2002) put the estimate down to about 20 000 people leaving Russia throughout the 1990s.

There are other estimates as well, but what they all maintain that scientists have been leaving the research system in dramatic numbers, especially in the first years after the breakup of the Soviet Union. Graham and Dezhina (2008) provide an estimate of up to 35% shrinkage in university staff in 1992-1993, albeit noting that this data may be attributed to the horizontal migration of scientists seeking employment in the private sector.

Possibly, what affected the post-Soviet science so much was not the sheer scale of the exodus, but the fact that scientists who left the country were among best performing. Graham and Dezhina endorse this by suggesting that the majority of scientists who left Russia during the crisis of 1990s were either senior, or early career researchers, mainly physicists and mathematicians (Graham and Dezhina, 2008, p. 23). The initial invitations from top research organisations abroad came for Nobel Prize winners, professors and other reputable scientists. They left in great numbers, sometimes taking entire laboratories along.

The impact of the very phenomenon of the ‘brain drain’ from the country previously unaffected by it, to countries that were former rivals in the cold war, was a bigger blow on the public consciousness than the actual scale of scientific exodus.

One factor that complicates the assessment is the suggested large scale of pendulum, or seasonal scientific mobility that post-Soviet scientists adopted as a survival strategy. Pendulum migration – taking short-term assignments and posts abroad without resigning
from a position in the home country – enabled scientists receive funds, use equipment and gain experience abroad, but eventually to bring these back home.

**Waves of Migration**

Some studies conceptualise multiple ‘waves’ of out-migration from the Soviet Union and Russia, indicating anywhere from 4 to 6 such ‘waves’. Graham and Dezhina (2008) outline 4 ‘waves’ of brain drain from Russia (pp.24-25).

The first wave of the late 1980s and early 1990s consisted of elite scientists, as well as scientists who left as a part of larger ethnic migrations. The second wave happened in 1992-1993 and is classified as the most intensive, but also with the smallest share of émigrés continuing their academic careers abroad. The third wave consisted of scientists of marginal research areas in the Russian science (biology, computer science), and happened on a smaller scale than the previous out-migrations. Finally, the fourth wave started in 1999 after the 1998 economic crisis, and consisted mainly of scientists dissatisfied with the low level of life in Russian academia.

There were further ‘waves’ of brain drain from Russia subsequently. Arguably, the latest ‘wave’ of brain drain started in 2014. The annexation of Crimea was followed by the capital, as well as human, flight (Holodny, 2014). However, due to improving economic situation and the working environment, the complexity of scientific mobility flows from and to Russia increased, adding elements of brain circulation and even return migration.

**4.4 Reasons to Leave the Home Country**

Due to political and economic shocks the science system of the late Soviet Union and then Russia went into deep crisis. Factors that have shaped decisions of post-Soviet scientists to leave their home countries are well documented in the literature (Table 6). These factors are consistent across various sources and data collection methods and include, most importantly, the fall in the quality of life, obsolete equipment and low funding.

There is a consensus among existing studies that the crisis of Russian science of the early 1990s severely affected the ability of the system to function properly, and was therefore a cause of extensive ‘brain drain’. A reader will notice that the vast majority of factors listed below are ‘push’ factors based on lacking tangible assets in the home country.
<table>
<thead>
<tr>
<th>Source</th>
<th>Emigration Factors</th>
<th>Impact on Brain Drain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graham and Dezhina (2008)</td>
<td>• Obsolete equipment (including computers)</td>
<td>Cause of extensive internal and external brain drain</td>
</tr>
<tr>
<td></td>
<td>• Inaccessibility of libraries and electronic information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Level of science funding in 1994 was 20% of 1991</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Demilitarisation</td>
<td></td>
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<tr>
<td></td>
<td>• Fall in the living standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Obsolescence of science (not interesting, theoretical)</td>
<td></td>
</tr>
<tr>
<td>Ivakhnyuk (2006)</td>
<td>• Low wages</td>
<td>Shift in strategy from permanent emigration to temporary labour migration</td>
</tr>
<tr>
<td></td>
<td>• Low prestige of academic career</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low opportunities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Economic instability</td>
<td></td>
</tr>
<tr>
<td>Ganguli (2014)</td>
<td>• Low or no salaries</td>
<td>Significant</td>
</tr>
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<td></td>
<td>• Drop in prestige of ST occupations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Contact with the Western world</td>
<td></td>
</tr>
<tr>
<td>Shlapentokh (2012)</td>
<td>• Country Openness politics</td>
<td>Constant outflow, along with other highly skilled and members of art and culture occupations</td>
</tr>
<tr>
<td>Latova and Savinkov (2012)</td>
<td>• Low wages</td>
<td>Brain drain became more severe after 2000</td>
</tr>
<tr>
<td></td>
<td>• No housing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Obsolete equipment in laboratories</td>
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</tr>
<tr>
<td></td>
<td>• Low prestige of scientific work</td>
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</tr>
<tr>
<td></td>
<td>• No policies to remedy the situation</td>
<td></td>
</tr>
<tr>
<td>Korobkov and Zaionchkovskaia</td>
<td>• Fall in living standard</td>
<td>Labour migration became the main emigration flow after 1995</td>
</tr>
<tr>
<td>(2004)</td>
<td>• Decline in state support for research</td>
<td></td>
</tr>
<tr>
<td>Erokhina (2009)</td>
<td>• Opportunity to receive higher education abroad</td>
<td>For the younger generation – migration through education</td>
</tr>
<tr>
<td></td>
<td>• Higher compensation and environment of work abroad</td>
<td></td>
</tr>
<tr>
<td>Naumova (2005)</td>
<td>• Science not demanded by the society</td>
<td>Cause of extensive internal and external brain drain</td>
</tr>
<tr>
<td></td>
<td>• Decline in science funding from 2% GDP to 0.31% GDP</td>
<td></td>
</tr>
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<td></td>
<td>• Property differentiation and salary policy</td>
<td></td>
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<tr>
<td></td>
<td>• Discrimination of Russian-speaking scholars in post-Soviet states</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Scientific Emigration Factors from Russia

Source: Erokhina (2009); Ganguli (2014); Graham and Dezhina (2008); Ivakhnyuk (2006); Korobkov and Zaionchkovskaia (2004); Latova and Savinkov (2012); Naumova (2005); Shlapentokh (2012)
Most of these factors have been named and experienced by the interview participants. Economic factors underpinning emigration decisions of post-Soviet scientists, however, were not the only factors behind the eventual decision to leave the home country. Emigration decisions reasons can be economic, opportunistic, political and personal.

Opportunistic decisions to leave were dictated by the new openness of the borders of the Soviet Union and Russia. Some scientists did not need another reason beyond their own curiosity to experience what was previously available to the chosen few:

“I graduated from a university in 1991. Back then everybody realized that it was time to leave as long as the gate was open otherwise it would close back down soon. The gate has remained open, but everybody left nevertheless. That’s pretty much all about it” (Professor, USA).

Politically based decisions were not related to the ideology, but rather to the feeling of loss and statelessness after the breakup of the Soviet Union. Some interview participants were working abroad during the turmoil of the early 1990s, and the breakdown of the Soviet Union left them to be citizens of the country that no longer existed. As there was nowhere to return anymore, most of these researchers decided to stay abroad. For them, political transformations implied mainly impending disruption of research.

Main reasons for moving abroad for the overwhelming majority of scientists were, however, economic. During the period immediately following the breakdown of the Soviet Union, side-effects of neoliberal reforms escalated quickly and plunged Russia into the state of economic shock (Rutland, 2013). Science system, previously funded completely from the state budget, stopped receiving money. As the US-based Professor who left before the USSR breakdown remembers, “I went to visit my former institute and saw that they all sit in candlelight”.

Even the professorship salary was not enough to get by, especially with a family, and for many scientists the dilemma arose between maintaining research activities and simple survival. Those who did not wish to disrupt their research process, or work in multiple jobs as well as proceeding with research, chose to leave the country. As an Assistant professor, now in the US, put it: “I realised that I either need to change the country, or I need to change the occupation”. The choice to keep doing scientific research for many only left the option to go abroad. For some interviewees it was a temporary measure, but subsequent events made them change their mind about staying permanently.
Other post-Soviet scientists appreciated the availability of good equipment, working conditions, resources and acceptable salaries in the developed countries during their initial, temporary visits. A Principal Investigator, now working in Germany, reminisced: “Ten years of my life [doing post-doctoral research – MK] in Siberia went by like a life in a work camp”. The contrast between the level of prestige and the quality of life enjoyed by German-based scientists in comparison with the Russian scientists was too great to go back.

A group of scientists in the study had personal reasons to leave their home countries. Certainly among them are several researchers who followed their spouses, who were also scientists and won fellowships of received offers for positions abroad. Others followed their families, who moved to Germany, USA and Israel as Jewish refugees. A small minority of scientists left their home countries in fear of ethnic persecution.

**Generational Effect**

There is a generational effect in the decisions to leave abroad among the participants of this study. Among the scientists of the 1st and the 2nd generations of post-Soviet émigrés the conditions of life and work were quickly deteriorating, and economic reasons behind the eventual decision to leave the country made this decision in some aspect forced, because it would not happen had the circumstances been different.

In contrast, scientists who left Russia in the 2000s never experienced this dilemma. They had options for career development in the public science and in the domestic industry. Science reforms started bringing more funding to central and peripheral universities. Therefore, young researchers, also driven by economic circumstances, were not in a desperate need to leave the country, and were not as reluctant to return.

It is among the representatives of these, later generations, where new discourse of science in Russia emerges:

“It [emigration] happened absolutely accidentally. I started doing a PhD in Novosibirsk. After half a year there was a call to my professor from the UK. Someone asked whether I wanted to speak with a professor from England. I said yes, took the phone and someone greeted me with a “Hello!” in Russian. It was a professor from Exeter, in the South where palm trees grow. I was very reluctant to go initially, and I resisted for a while, it took a lot of persuading to make me go. It [international migration] is always a potential career pit and it takes courage to do it. I didn’t want to make any commitment initially” (Royal Society Fellow, UK).
For these young researchers, further career development in the country of their current residence, in any other developed country, or in Russia are equally competitive options, where each option has a list of benefits and losses associated with it. Such types of mobility are unimaginable among the older scientists who left the Soviet Union and post-Soviet countries decades previously.

4.5 Overseas Science Diaspora

Those who leave, however, usually leave for good. Extant research reports very little rates of return migration to Russia, and it only marginally improved after science reforms of the 2000s. However, the location and geographic distribution of the (potentially) highly numbered science diaspora of post-Soviet scientists abroad remains a blank spot in the books.

Using publicly available data on nanotechnology research globally, I developed a method to approximate heritage of a researcher based on the morphological structure of their surname (Unbegaun, 1972). Heritage is defined as the common background in training and working in the Soviet and post-Soviet research systems. After testing multiple scenarios, I balanced Precision and Recall measures of the data retrieval at acceptable marks of 0.98 and 0.95 correspondingly. Publications in nanotechnology were collected from the Web of Science using lexicological query to identify nanotechnology papers. The application of the procedure on a three-year dataset, which for the 2010-2012 time period consisted of 208,962 nanoscience publications, indicated 3.5% of authors that had post-Soviet surnames. After further manual cleaning just over 5 thousand Russian-speaking nanoscientists were identified (for a detailed outline of the procedure development, testing and validation, address Appendix 4).

In this section, authors that publish with address locations in post-Soviet countries are called ‘domestic’ authors. Authors with post-Soviet names who publish with their affiliation address outside of post-Soviet countries are called ‘diaspora’ authors. 5,114 diaspora authors published 10,405 publications. Over the same period of time domestic authors produced 8,570 publications, which makes diaspora scientists marginally more productive. The following sections overview productivity, research areas of science diaspora and its role in the internationalisation of domestic research.

4.5.1 Science Diaspora Productivity

Both the diaspora scientists and the domestic scientists demonstrate comparable input in the volume of publications across the three years of observation: 33-35% in 2010, 40-41% in
2011, and 35-26% in 2012. Diaspora scientists published twice in 3 years on average, whereas domestic scientists produced on average 0.5 publications per scientist. Looking at the top end of research productivity, 24 diaspora scientists published more than 25 papers in 2010-2012. Only 14 of the domestic scientists published more than 25 papers. Looking at the middle ground, 661 diaspora scientists (12.8%) published more than 5 research papers in 3 years, whereas among domestic scientists 967 (6.3%) reached this level.

At the first glance, these results support an assumption about higher productivity rates of diaspora scientists in comparison with researchers who never moved. However, this interpretation should be taken with caution. First of all, the ‘domestic’ dataset spans across 14 countries. In each of these countries, small number of authors publishes high number of publications and large numbers of authors publish very few publications. Accumulated from 14 countries, the proportion in the number of authors who publish very few papers is substantially higher than among the group of diaspora researchers.

Additionally, the diaspora authors usually have publications previously and are in their majority ongoing researchers. In contrast, publication activity from domestic scientists may come from PhD and even undergraduate students who may choose to not pursue an academic career in the future. Therefore, the ‘domestic’ dataset has more unique author name with lower publication rates.

4.5.2 Research Areas
There is difference in the structure and the diversity of topics in which the diaspora scientists published in comparison with the domestic scientists and with the rest of the world.

Domestic authors demonstrate a skew to physics typical for the post-Soviet research pattern: 4 physics categories are among the top 10 reported WoS categories, amounting to about 50% of publications (see Table 7). Researchers around the world published about 30% of all nanotechnology publications in the area of physics, and only two categories – applied and condensed matter physics – are among the top-10 categories.

Diaspora scientists occupy the middle ground between domestic scientists and the world average in this respect: 4 physics categories are in the list of top-10 most published in categories and they amount to 47%, but other patterns of thematic distribution of publications relate more to the world average than to domestic science patterns.
Diaspora researchers also published more widely than domestic scientists. The diaspora scientists, despite their smaller numbers, acquired publications in 156 WoS categories in 3 years, and the domestic scientists published in 122 WoS categories. Publications of domestic scientists also tended to be more mono-disciplinary. It is possible to assign more than one WoS category to each publication, and domestic scientists assigned on average 1.64 WoS categories per publications, while the diaspora scientists assigned 2.06 categories per publication.

<table>
<thead>
<tr>
<th>Web of Science Category</th>
<th>Worldwide</th>
<th>Domestic</th>
<th>Diaspora</th>
</tr>
</thead>
<tbody>
<tr>
<td>1   Materials Science, Multidisciplinary</td>
<td>30.70%</td>
<td>20.20%</td>
<td>30.98%</td>
</tr>
<tr>
<td>2   Chemistry, Physical</td>
<td>20.94%</td>
<td>13.34%</td>
<td>22.58%</td>
</tr>
<tr>
<td>3   Physics, Applied</td>
<td>19.41%</td>
<td>19.53%</td>
<td>23.44%</td>
</tr>
<tr>
<td>4   Chemistry, Multidisciplinary</td>
<td>18.49%</td>
<td>7.35%</td>
<td>18.96%</td>
</tr>
<tr>
<td>5   Nanoscience &amp; Nanotechnology</td>
<td>17.28%</td>
<td>9.68%</td>
<td>19.71%</td>
</tr>
<tr>
<td>6   Physics, Condensed Matter</td>
<td>11.59%</td>
<td>19.57%</td>
<td>15.94%</td>
</tr>
<tr>
<td>7   Polymer Science</td>
<td>6.53%</td>
<td>2.52%</td>
<td>4.34%</td>
</tr>
<tr>
<td>8   Electrochemistry</td>
<td>4.55%</td>
<td>3.09%</td>
<td>2.45%</td>
</tr>
<tr>
<td>9   Chemistry, Analytical</td>
<td>4.32%</td>
<td>1.72%</td>
<td>2.51%</td>
</tr>
<tr>
<td>10  Engineering, Chemical</td>
<td>3.93%</td>
<td>1.59%</td>
<td>2.09%</td>
</tr>
<tr>
<td>11  Optics</td>
<td>3.54%</td>
<td>6.32%</td>
<td>5.62%</td>
</tr>
<tr>
<td>12  Engineering, Electrical &amp; Electronic</td>
<td>3.11%</td>
<td>3.17%</td>
<td>3.28%</td>
</tr>
<tr>
<td>15  Physics, Atomic, Molecular &amp; Chemical</td>
<td>2.67%</td>
<td>3.48%</td>
<td>3.85%</td>
</tr>
<tr>
<td>18  Biochemistry &amp; Molecular Biology</td>
<td>2.23%</td>
<td>1.68%</td>
<td>2.99%</td>
</tr>
</tbody>
</table>

Table 7 Web of Science Category Publication Structure among Domestic Scientists, Diaspora Scientists and the Rest of the World

Source: Web of Science. Calculations by the author

Nanotechnology is a fuzzy research area, and its configuration differs from country to country, depending on each country’s strong research areas and established collaboration patterns. Russian-speaking nanoscience diaspora demonstrates a hybrid profile in nanotechnology: areas of diaspora research include traditionally strong subject areas for post-Soviet science, such as condensed matter physics, but also have strong characteristics that align them with nanoscience profiles of the leading developed countries.

Part of it is attributed to negative selection – scientists with rare or non-prestigious specialisations would be looking to leave post-Soviet countries due to the lack of expertise.

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4 Worldwide publications exclude ‘Domestic’ research (Russia and other post-Soviet countries), but include the ‘Diaspora’ research, as it is a part of the worldwide input. Percentage indicates the share of each WoS category to the total number of publications of the group.
and resources; and to horizontal migration – scientists with theoretical training may move to applied areas and even to different research disciplines, should there be high supply of resources. As a result, diaspora scientists seem to occupy intermediate position and, as a community, have a hybrid research profile that has features of both domestic science, and of the global nanotechnology research.

4.5.3 Overseas Science Diaspora Location
The vast majority of diaspora scientists (36%) are affiliated with organisations in the USA (see the map in Figure 6). Germany follows with about 13.6% and the UK and France host 5.8% of the Russian overseas diaspora each. Czech Republic, Canada and Israel are the forth cluster of countries, hosting from 3.4% to 4.9% of the overseas diaspora. In total, 16 countries have more than 1% of the post-Soviet overseas diaspora population. Spain and Italy are in the top of this minority group, followed by Poland, Sweden, Japan and Switzerland. In the bottom are Finland and South Korea with 1% and 0.98% of the overall diaspora shares accordingly.

4.5.4 Top Scientists
Geographic distribution of the top scientists of the overseas diaspora is somewhat different than the overall group. The top 100 most productive overseas diaspora researchers published 1889 publications, which is about 18% of all diaspora papers. In contrast, the top 100 domestic scientists from the post-Soviet countries published 1322 papers, which is about 15.4% of all post-Soviet publications.

Out of the 100 top publishing diaspora scientists, 40 were affiliated with organisations with the USA, 12 - with Germany, and 7 – with the UK, which maintains the proportion of the overall diaspora distribution, with a slight skew towards the US share. However, the 5th country with the most top diaspora scientists is Australia (7 scientists) and the 6th is Canada (6 scientists). Both of the countries have less than numerous overall Russian-speaking diaspora population (41 and 240 researchers accordingly). On the contrary, countries like France, Israel, Spain and Italy have communities of Russian-speaking scientists among whom there are no or very few highly productive researchers.

The implication of this finding is that in post-Soviet scientific mobility flows quantity and quality are separated. More broadly, there may be different factors underpinning the mobility of elite scientists, who go to English-speaking countries, and all other scientists, who gravitate to countries with existing high concentration of Russian-speaking science diaspora.
Figure 6 Overseas post-Soviet Science Diaspora Visualisation

Source: Web of Science Calculations by the author

Visualisation was constructed using the Google Fusion Tables instrument and can be found online at https://www.google.com/fusiontables/embedviz?q=select+col0+from+1g83LyzlHprAxP1qbCshh759xRgGNCq3ze2qhMXP&viz=MAP&h=false&lat=27.55274108266968&lng=-15.68754850000003&t=1&z=2&l=col0&y=2&tmplt=2&html=ONE_COL_LAT_LNG
4.5.5 ROLE OF DIASPORA IN DOMESTIC RESEARCH
Overseas diaspora scientists collaborate with domestic scientists and contribute to the development of domestic research. 474 diaspora scientists published jointly with domestic researchers. 1 of them is in the top-10 of the most prolific domestic authors; 7 of them are among the top 50 authors, and 9 – among the top-100 domestic authors.

There are 3,270 internationally collaborated publications in the overall set (38%). Out of these, 765 publications (23%) were collaborated with the participation of diaspora scientists. The rates of diaspora collaboration intensity vary greatly across country collaborators. For instance, Germany is the largest international collaboration partner of post-Soviet countries: almost 25% of all international collaborations were with Germany. The contribution of the overseas diaspora to this volume was 23.3%. In contrast, the role of diaspora scientists is very significant in joint publication activity with countries like Portugal, Belgium and Australia – over a half of all joint papers contain an overseas diaspora author (see Table 8 that lists all countries where the share of diaspora involvement in publication activity exceeds 25%).

<table>
<thead>
<tr>
<th>Country</th>
<th>Publications of post-Soviet Countries Collaborated Internationally</th>
<th>Among them, Publications coauthored with Diaspora Scientists</th>
<th>Diaspora Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>814</td>
<td>190</td>
<td>23.34%</td>
</tr>
<tr>
<td>USA</td>
<td>663</td>
<td>226</td>
<td>34.09%</td>
</tr>
<tr>
<td>France</td>
<td>425</td>
<td>93</td>
<td>21.88%</td>
</tr>
<tr>
<td>UK</td>
<td>254</td>
<td>104</td>
<td>40.94%</td>
</tr>
<tr>
<td>Poland</td>
<td>215</td>
<td>27</td>
<td>12.56%</td>
</tr>
<tr>
<td>Japan</td>
<td>176</td>
<td>42</td>
<td>23.86%</td>
</tr>
<tr>
<td>Spain</td>
<td>157</td>
<td>53</td>
<td>33.76%</td>
</tr>
<tr>
<td>Italy</td>
<td>147</td>
<td>18</td>
<td>12.24%</td>
</tr>
<tr>
<td>Sweden</td>
<td>138</td>
<td>28</td>
<td>20.29%</td>
</tr>
<tr>
<td>Finland</td>
<td>135</td>
<td>45</td>
<td>33.33%</td>
</tr>
</tbody>
</table>

Table 8 Diaspora Share in Overall Internationally Collaborated Publications Volume of Post-Soviet Countries

Among the top-5 international collaborators of the post-Soviet countries – Germany, USA, France, UK, and Poland – UK has the highest rate of domestic and diaspora collaboration, exceeding 40%. The USA, being the largest hub of Russian-speaking diaspora, has relatively modest diaspora involvement in international collaboration, and the tendency is comparable for another large hub, Israel. Other countries that host large population of diaspora
scientists, such as France and Canada, include a diaspora scientist in about 20% of their publications authored with post-Soviet countries.

For other countries that are significant international collaboration partners for the post-Soviet countries, low rates of diaspora involvement are explainable by low numbers of diaspora scientists living in these countries. For instance, Poland, the fifth bigger international collaboration partner of post-Soviet countries, has only 12.5% of publications collaborated with diaspora involvement, but also only has a nanoscience diaspora of 31 researchers (0.85% of the total overseas diaspora).

The share of diaspora contribution is lower in the countries, which are already strategic research partners of the home country. In some of these countries the overseas diaspora will grow with time (in case of Russia, these countries are USA, Germany, France and the UK), but the rate of diaspora involvement will not necessarily increase due to existing sustained links. In countries with high intensity research collaboration activity, but low numbers of diaspora researchers, these researchers will have very limited effect on the overall research collaboration dynamics between countries due to limited numbers, like in case of Spain, Italy and Poland for the Russian-speaking scientists.

Diaspora scientists can have significant effect on the scope and intensity of collaborations in countries that are not strategic partners of the home country, be it because they are smaller in size than their more attractive neighbors, like it happened in the case of Belgium and Portugal. The effect is more pronounced in countries with the overall low collaboration intensity (Chile, Argentina, Ireland). Due to the overall very limited collaboration intensity between the home country and these countries on the macro-level, papers collaborated with the participation of diaspora scientists, driven by different dynamics (network and personal relationships) constitute the majority of this limited output.

4.6 Return Migration to Russia
Existing studies note an increasing interest of the Russian diaspora scientists if not in returning to their home countries, but definitely in participating in domestic research (Dezhina, 2010). The relationship of the Russian scientific community and the Russian government with its scientific diaspora collectives abroad has been complicated. In one instance, émigrés were perceived if not by the domestic community, but certainly by the policymakers as Soviet-style defectors who abandoned their country in the time of urgency and crisis (Li et al., 2015).
However, some research collectives never got out of touch with the colleagues who left the country. Some academic institutes, such as the Landau Institute of Theoretical Physics, even kept registers of ‘externally affiliated employees’ – which in fact were the scientists who left the country and were working full time abroad. Maintaining Russian affiliation for the émigré scientists was at times a bureaucratic necessity, and at other times a sign of loyalty. For the academic institutes and domestic research collectives, this link was an opportunity for international visits, ‘pendulum’ migration, and the increase in internationally coauthored publications (Karaulova et al., 2015). Among the interview participants, this practice is widespread.

The big shift occurred in the mid-2000s, when the Russian government started launching new big science projects that were targeted at the ‘world leading scientists’. Vocal government support mobilised the science diaspora, and the first official conference for Russian-speaking scientists residing abroad but still interested in the development of Russian science took place in St Petersburg in 2010 (Rossii’skie Vesti, 2014).

### 4.6.1 DIASPORA ENGAGEMENT INITIATIVES

Diaspora engagement programmes in Russia are currently disguised as international co-operation programmes. They do not have specific filter to target scientists who had been engaged in research with Russia or the Soviet Union, but are open for any scientist who wishes to establish or enhance collaboration links with Russia. Two most publicly resonant policies are discussed below.

The Directive of the Government No.50, nicknamed the ‘mega-grant programme’, is among the most ambitious attempts to boost domestic science using science diaspora resource. The programme aims to attract leading scientists to Russian institutions of higher learning, research organisations of the government academies of science, and the governmental research centers of Russian Federation. So far it succeeded in attracting several dozen of the post-Soviet émigré professors back to the country. A handful of them are known to have settled back permanently. However, several serious organisational, bureaucratic and policy problems emerged with this initiative (Dezhina and Ponomarev 2013) and most researchers went back with disenchantment.

Skoltech – Skolkovo Institute of Science and Technology was established as a part of the Russian ‘Silicon Valley’ experiment in collaboration with MIT. Skoltech is designed to be a new generation entrepreneurial university that will contribute to research, but also to training of student entrepreneurs, and also to the development of resident companies of the
Skolkovo Technopark by the way of collaboration and partnership networks. Skoltech professors are encouraged to establish companies themselves. Among the internationally renowned scientists that Skoltech managed to attract so far, the majority are actually representatives of the Russian-speaking diaspora abroad\(^6\). Therefore, it appears as an international collaboration initiative, but it is in fact a hybrid action that involves the Russian-speaking émigré scientists.

Other return migration policies that Russia enacted so far follow a similar pattern. The next round of science policy in Russia incorporates communication with émigré researchers as a part of broader frameworks. For example, the recent Project 5-100, expected to propel five best-performing universities in Russia in the top-100 best universities in the world in all major international rankings, includes the increase in foreign professorship numbers as one of the main indicator of the success of the programme. Inviting foreign professors to Russian universities is still funded and encouraged.

The variety of science diaspora engagement policies enabled researchers who were already actively collaborating with Russia to enhance the pace and quality of these collaborations. For those who were looking to return, these policies became a perfect opportunity to maintain dual academic career – by working in the home country as well as maintaining the position and prestige abroad. However, there is still a lot of skepticism among the diaspora scientists towards these attractive propositions. The reasons are discussed in detail in Chapter 7 of this work.

4.7 CONCLUSION
This chapter has outlined the context and the source of global mobility of Russian-speaking scientists, and the changes in this context throughout the years of the post-Soviet Russia. After the Soviet Union broke down, the Russian science system underwent one of the biggest crises it its history, with catastrophic drops in funding and prestige of scientific profession. This has become a driving force that extruded not only large number of scientists abroad, but also the best ones among them.

This is widely perceived as a national tragedy in the Russian science, and at the same time it underpins the subsequent uneasy relationships of Russia with the community of overseas scientists. In a country that punished mobility throughout the 20\(^{th}\) century, a shift had to

\(^6\) This is partly informed by project fieldwork in November 2015. I went to Skoltech personally to participate in research interviews (see the Acknowledgements in the beginning).
occur not only in academic community, but also in the public about the value of overseas diaspora as a ‘pool of knowledge’. However, science output in Russia is still stagnating, many hurdles exist, and science diaspora policies seem to be misplaced.

This work identifies important parameters that give the grounds to classify Russian-speaking diaspora abroad as a potential asset for domestic science. These include higher rates of publication and higher citations collected by diaspora researchers in contrast with domestic scientists. Diaspora scientists occupy median positions in terms of research areas, and are potentially acting as moderators in international cooperation links between post-Soviet countries and peripheral countries of the Western Europe. All these support suggestions about the role of science diaspora made previously.

This chapter is a useful reference for the subsequent data-based parts of the thesis. The next chapter takes off where most studies on Russian scientific migration end and explores SMTs of Russian-speaking scientists after they left their home countries. Chapter 5 elaborates on the Soviet/Russian academic culture and roots it in the social and institutional configuration of the national science system, referencing this chapter continuously. Finally, Chapter 7 brings the issues of brain circulation and science diaspora engagement once again, but discusses them from the perspective of diaspora scientists.
CHAPTER 5 ACADEMIC CAREERS AND LABOUR MARKETS

5.1 INTRODUCTION
This chapter explores the link between scientific migration and academic career development. As the majority of interviewees experienced subsequent mobility beyond the first destination, this chapter aims to go beyond the analysis of economic drivers and uncover non-linear SMTs to answer the first RQ.

The findings indicate a significant structuring role of mobility drivers and institutions. Researchers only have some agency in making strategic decisions about coming to, and staying in certain research organisations and countries. Some interviewees had a definite plan about their desired route of career development prior to leaving their home countries, while others exhibit high degree of spontaneity and adjustment of international migration career plans. At the same time, notions of the global identity of scientific professions emerge. As a part of twofold development, ALMs are becoming more globalised, but national aspects remain strong at the same time.

The chapter starts with the ‘descriptive story’ of SMTs of interviewees that outlines where they went from their countries of origins and why. It then moves on to discuss global scientific mobility factors, separately exploring national, regional and organisational capacities to attract, extrude or retain globally mobile scientists. The structuring influence of academic institutions is discussed next, specifically, of the globalising labour markets and alternatives for academic career development ladders. The chapter is concluded with the discussion of the variety of academic career development strategies employed by interviewees to cope with and manage macro-level influences.

5.2 CAREER TRAJECTORIES OF GLOBALLY MOBILE SCIENTISTS

5.2.1 DESCRIPTIVE STORY
While there is not much variety among final destinations of interviewees due to the sampling bias, not much variety is observed among sending organisations either. The majority of 37 scientists, regardless of their nationality, originate from a small set of elite research and educational organisations, almost exclusively situated in central Russia, in Moscow and St Petersburg. Five scientists originated from research institutes in Siberia, and another three – from peripheral universities in Central Russia. The rest were educated in Eastern Ukraine, Belorussia and Moldova. Centralisation and unevenness of research
persists in Russia and other post-Soviet countries to this day. When prompted to name places or clusters in Russia that are still competitive in nanoscience, most researchers named the top sending organisations.

For the sake of conceptual harmonisation, in the following text permanent transition of a researcher to a new position that requires spatial relocation is conceptualised as a ‘move’. A move, be it national or international, differs from exchange visits, circulation visits and other arrangements whereby researchers may work in a new research organisation for several years, but also maintain affiliation with their ‘home’ organisation. The fact of scientific migration is acknowledged when (1) a scientist changes the affiliation in publications and (2) the scientist makes a physical move to a new locale.

**Onward Mobility**

On departure from Russia, scientists left to a variety of countries, among which the USA, Germany and the UK were top destinations, closely followed by Israel (refer to the infochart depicted in Figure 7). During subsequent mobility, the US, UK, Switzerland and France gained researchers, Germany and all other first destination countries lost researchers. Onward international and national (in-country) mobility is evident among the vast majority of interviewees. Only 12 interviewees out of 66 found employment in the first organisation they relocated to from the home research institution. On average, a researcher moved internationally 3 times, with the highest average number of moves of researchers who eventually settled in the US.

The USA and the UK are the countries with the highest national mobility: researchers did the highest numbers of intermediate moves. In contrast, Germany is a ‘transition’ country with higher proportion of international migration moves in contrast with the combined number of international and internal moves, followed by France. Great Britain and Switzerland demonstrate high rates of retaining capacity: researchers who enter the system are rare to leave. SMTs vary from extremely international, gaining work experience in up to seven countries throughout the course of their career, to extremely conservative, when scientists prefer to stay and develop within one locale.

Figure 8 illustrates the network formed by initial, intermediate and final international destinations within SMTs. It amounts to the total of 188 moves and involves a variety of countries, some of which only feature in this study as intermittent temporary destinations in SMTs.
62 scientists initially moved from post-Soviet space abroad.

Out of the total of 188 moves,

- 74 were national
- 114 were international

On average, a scientist moved 3 times ranging from 2 times in/to France to 3.4 times in/to the USA

40 scientists now have permanent positions.

- 19 worked in more than 1 country abroad and
- 15 worked in more than 1 place in a single country

2 received permanent positions on arrival

For others it took between 5 and 20 years

Years until Permanent Position

The timespan is usually longer for scientists with onward migration trajectory

Figure 7 Scientific Migration trajectories

Source: author
Figure 8 Scientific Migration Trajectories by Country

Source: author

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7 Figure 8 and Figure 9 were made with the use of NodeXL Basic software ([http://nodexl.codeplex.com](http://nodexl.codeplex.com)). Figure 8 is a social network visualised using Fruchterman-Reingold layout that places the most attractive nodes in the centre of the graph. Figure 9 has a ‘Circle’ layout.
The visualisation on Figure 9 depicts the balance between international and national moves. Among the 188 moves, over a half – 114 – are international. Among non-initial migration moves, all of which are international, the numbers of internal and international moves balance out: there were 74 secondary national moves and 53 secondary international moves. Final moves (at the point of the interview) are mostly national as well: 38 researchers were employed in the same country prior to the position they held at the time of the interview, and 24 researchers were employed in other countries.

Scientists building their careers in Germany and the UK are more mobile nationally and are less mobile internationally. The proportion is balanced across other case study countries. International onward SMT is prevalent among scientists who held permanent positions at the time of the interview: out of the total of 40 researchers, 15 experienced only internal
mobility within the country they first moved to and 19 moved internationally before eventually getting a permanent position.

Scientists move internationally predominantly at earlier stages of their careers. Postdoctoral fixed-term contractual positions host the most internationally mobile population: 67% of contractual moves were international, whereas only a quarter of all tenure-track moves and permanent moves were international. For 17 researchers these moves (9 international and 8 national) eventually led to receiving a permanent position, whereas 23 had to move again to secure it, and other 22 were at intermediate stages.

**Doctorate at Home or Abroad?**

Receiving a PhD outside of the home country has been reported as highly beneficial for the global career development. Indeed, out of 20 researchers who did their PhD degrees abroad 15 have permanent positions and 4 have tenure-track positions (Table 9).

Scientists who received their doctoral degrees in the post-Soviet Russia found it hardest to integrate in career development structures abroad. Almost a half of these scientists are still looking for a secure job. Whereas for some it is a matter of gradual advancement of their career, others reflect on would-be beneficial effects of doing a PhD abroad and the timing of their scientific migration:

> “The bottom line for getting a tenure-track position in the Ivy League university is to get a PhD in the American university, preferably in the Ivy League. It is not like you are dealing with an insider then. Yes, with an insider as well, because he knows what really the standards are like in a place like this. He knows what kind of crazy long hours people work here and how much they demand from their students. There will be no surprises” (Scientist, USA).

Completing a doctorate in the country where the scientists intend to build their further academic career (14 out of 20 researchers who completed their doctorates abroad indeed stayed in the country where the doctorate was completed) lowers entry costs to the labour markets. Knowledge of the system, professional network and the time spent there allows early career researchers to kick-start their academic careers from the insider position. The overall trend for these scientists is to stay in the country where the PhD was awarded, but not in the university where it was completed.
Continuity of Career History

All SMTs are continuous. Researchers do not have gaps in their resumes and never mention if they spent any time unemployed between their positions. International migration in the vast majority of cases was supported by the inviting organisation. In some cases, scientists spent less time than anticipated in some organisations – for the reasons of climate, work culture, or because they found better employment opportunities.

In research areas with narrow specialisations, dropping out of the conventional progression of job titles (PhD followed by postdoc followed by another postdoc, eventually leading to a tenure-track and resulting in a tenured position) is much more dangerous than moving abroad. It is possible for scientists to maintain the continuity of their academic career progression by being internationally mobile. There is much more pressure on researchers to not break the continuity of this progression, to not overextend the duration of contractual engagements, and to not delay applications for permanent positions. The pressure to remain “an eternal postdoc” (Associate Professor, USA), or the concern that a person “should leave science if he doesn’t have a professorship by the age of 40” (Scientist, Germany) are very strong drivers in mobility decisions that scientists make.

Migration Search Strategies and Mobility Enablers

Scientists used a variety of strategies to search for relevant positions in their area. These include, in the order of popularity, professional networks, including transnational networks of other Russian-speakers at home or abroad, lottery, and targeted application (refer back to Figure 7). A small proportion of scientists were mobile due to non-research reasons.

Lottery is a search strategy that reflects submission of large numbers of job applications based on loose criteria, such as a country, or a minimum level of reputation of the organisation, or extended research areas that may go beyond the applicant’s competences. The strategy, as any lottery, has low chances of success, but is grounded in the reason that each ‘good’ position in the Western countries attracts such high number of applications that

<table>
<thead>
<tr>
<th>Country of PhD Degree and Current Position type</th>
<th>Total</th>
<th>Permanent Position</th>
<th>Contract Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abroad</td>
<td>20</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Post-Soviet</td>
<td>18</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>USSR</td>
<td>24</td>
<td>19</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 9 Country of PhD Degree and Current Position type

Source: author
one has no choice but to gamble and submit many applications in hope that a small number would return an interview invitation.

A minority of researchers, in contrast, limited their choice to very few suitable organisations in the field during their job search. This **targeted application** strategy is usually based on very specific criteria, such as a certain location, or a certain reputational level of the organisation where they were prepared to start work. These scientists were willing to take extra steps, such as prolonging their contracts in previous organisations, or even moving on to work part time, rather than move to undesirable locations:

“I wanted as few perturbations as possible professionally, so I didn’t apply for many open positions. My strategy was to apply for those that really interested me, and I was accepted to every position I applied to. The share of rejections was very small. <...> I have a skill: for example, I can make boots. I am not saying that I can make shoes, and, eventually, the person who is interested in me making boots will be found. But also it is important to not say that I can’t do anything except for the boots” (Professor, UK).

Scientists who used this strategy usually submitted a very small number of applications with high chances of success.

**Professional network** is the most often-mentioned search strategy. It is transnational by nature and spans across countries and disciplines. Scientists who relied entirely on the word of mouth, personal correspondence, or on invitations from previous collaborators, all have been using their network to locate attractive positions and apply for jobs.

Along with search strategies, there are two significant migration enablers that have been discussed continuously throughout the interviews. These are termed “**Invitation**” and “**Funding Programme**”. These enablers are mutually exclusive. Whereas there are many cases around the world when scientists are invited to apply for a funding programme by a host organisation, in the context of this study this counts as an invitation for mobility.

When there is no previous connection or networked agreement between the scientist and the organisation and funding, often acquired independently from the third organisation, especially in countries like the UK, is the only enabler for mobility. Funding programme-enabled moves relate to the policy efforts to facilitate mobility, while invitation is a part of the grassroots professional network.

Professional network is the main search strategy of initial moves that entailed leaving the home country, for early career researchers. Arguably, initial moves are among the most
important in a researcher’s career. These moves have been predominantly carried out through scientists’ (or their supervisors’) network connections, including Russian and non-Russian network in equal measures.

Funding Programme is the dominant enabler of initial moves. Professional non-Russian network becomes more important during subsequent contract moves. At a later stage in the career institutional needs and commitments take precedence over networks and collaborations.

At the point where jobseeking scientists start looking for permanent places, there are fewer opportunities within the network, and a permanent offer requires institutional commitment and long-term thinking, as well as it may be aligned with collaborative projects of scientists in the network. Therefore, lottery application strategies were used in 14 (56%) tenure-track moves, along with by 4 targeted application moves.

In the country with the highest mobility, the USA, a third of all moves was enabled by research network, and another third – by lottery applications. Invitation was the easiest way to enter the system, however, funding resources are scarce and the labour market structure is rigid. Scientists often had to enable the widest scope of ‘lottery’ applications and move all around the country to be able to move to the next contract position or to secure a tenure-track job.

In contrast, Germany has a broad range of available funding programmes that enable scientists to receive research experience in the country without necessarily having pre-existing links with any German research organisation. This is why, besides the fact that professional networks are still very important, 16 moves to Germany (40%) were enabled by funding programmes. Professional network seems to be the most important search strategy to obtain positions in France: 5 out of 7 moves to France were found using the personal network, including coming to join a Russian-speaking professor who was opening a laboratory and an invitation to a professor who was looking to move back to France from the USA.

Permanent Positions
Receiving a permanent position is seen as a major step in the academic career that grants employment security, stability and is regarded as a desired minimum career development level by the majority of interview participants. However, getting a permanent position is hard. Most universities and public research organisations can be flexible in recruiting
doctoral students and postdocs, but the number of permanent positions is much smaller than the number of jobseekers, and the situation has been getting more asymmetrical in the recent years (Weert et al., 2002).

For the interviewees who succeeded in getting a permanent position abroad, it required subsequent mobility in the host country after moving there internationally. International migration to temporary positions was therefore a way to enter the system and subsequently settle in by getting a permanent position in a different organisation. A minority of interviewees received permanent positions as a result of international migration.

Labour markets of some countries have specific, sometimes unwritten, rules of getting permanent positions. Therefore, an initial period of adaptation there followed by relocation to different organisations within countries – is longer. For example, almost all researchers who entered national labour markets of the US and the UK changed one or several places of employment prior to getting a permanent position (see Figure 10). The majority had to adjust in one way or another after entering the national system and be mobile nationally post-international migration.

![Figure 10 Moves Resulted in Permanent Position](image)

Source: author

Some changed up to 5 countries during SMTs on the way to professorship. There are strong national differences. For example, among the interviewees who left as a part of the first ‘wave’ of migration, some spent time, but none stayed in the UK. UK-based researchers are
either the young generation of Russians speakers who did their doctorates in Russia in the early 2000s, or researchers who moved there to do a PhD in the UK.

It takes from 5 to 20 years to get a permanent position abroad. There is no strong link between scientists who obtained their doctorates home or abroad, with the exception of the initial ‘wave’ of mature researchers who generally secured permanent positions 8-9 years of migration abroad. It generally took longer for researchers who worked in multiple countries to achieve permanent positions that for those who only had subsequent national mobility (refer to Figure 11). The latter group of scientists is also more numerous.

Among the mobility enablers, lottery, targeted application procedures and network-enabled moves have equal importance. 4 researchers (10%) moved to their permanent positions due to the links with other Russian-speaking scientists abroad. Headhunting as mobility enabler is ever present in the top professorship-to-professorship moves and is negligible at medium to low academic career relocation levels.

![Image](image_url)

**Figure 11** average number of Years to get a Permanent Position, by the type of migration trajectory

Source: author

Professional network is the most prominent search strategy and selection strategy of permanent moves:

“Everyone in the community knows that there is an open position. After that we learn who is the candidate et cetera. And if I could have a real chance to get this, my friends would tell me: “Apply! You have a real chance!” If there is no real chance, there is no point in applying. At these positions, tenure positions, it never happens
that a candidate appears out of nowhere. <...> In my area of physics, if we want to hire a person with a big name then the list is very short” (Professor, USA).

Researchers learn about available positions through the network and only consider these opportunities if there was someone they knew employed there. It is, alter all, a safeguard for acceptable conditions in the new job, and against nasty surprises: as transaction costs in late-career migration are higher, scientists tend to be more risk-averse.

To conclude, the descriptive story of the interviewee SMTs elucidate some important aspects of scientific migration. First of all, scientific mobility is closely tied to academic career development, especially beyond the initial move from the home country. Second, there is significant subsequent national and international mobility: the first and the final destination countries are different for significant share of interviewees. Third, knowledge networks play an important role in the processes of search for positions internationally, and in enabling scientists to come for these positions. The next section of the chapter points to further scientific mobility patterns in the sample, before moving on to discuss scientific migration factors.

5.2.2 PATTERNS IN MIGRATION TRAJECTORIES
The average career path demonstrates evolutionary progress in academic career development with progressive growth from contractual positions to permanent positions. Mature researchers only changed position and moved only when more senior post (i.e. higher professorial grade or a directorship) was offered as a part of the package. Unlike for junior researchers, simply going to a more prestigious university, even to crème de la crème, would incur too much of a cost and disrupt ongoing research process.

Overall, the costs of migration, especially international migration, increase with seniority of a researcher. Most often, especially in the US context, mobility, or even international migration, occurred in those instances when researchers were seeking to ‘break out’ from contract-dependent soft money positions to switch on to a tenure-track job, or when scientists were forced to leave the research system that was not willing to accommodate them in their desire to have a permanent contract.

The researchers in this study differ in terms of age, gender, position, career stage at which they left their home countries, date and country where they received their doctoral qualification, and in their research areas. They also had very different SMTs that depended on the variety of factors, such as favourable environment, existing networks, previous strategies, or simply luck. However, there are patterns among groups of researchers that
make their SMTs similar. These are north-to-north migration; a link between national mobility incentives and further international migration; adjustment costs and multiple migrations; ‘forced’ mobility.

**North-to-North Migration**

The intermittent and final destinations for scientists who ended up working in the most popular choice countries, include mostly working in Northern Europe, Northern America and advanced Asian economies, such as Japan and South Korea. None of the participating researchers worked in a developing country, Eastern European or Southern European country, with the exception of two interviewees. This North-to-North migration pattern reflects trends of networks and connections among the most scientifically advanced countries and the exclusion of the developing countries from the competition for talent.

**National Mobility Incentives and Further International Migration**

Some countries have institutional incentives for academic mobility, which are considered a significant part of academic career. For example, the USA and the UK incentivise researchers within their national research systems to change employment at each significant stage of their career, and, in the UK specifically, even after getting tenure. For the globally mobile scientists, moving nationally is often not more difficult as moving internationally due to their recent arrival to the country.

Whereas national mobility may not incur same amount of cost as international migration, in many instances (selling/buying property or finding schooling for children) it may be just as big a decision as international migration. As there is a clear link between previous migration experience and subsequent likelihood of migration (Kou and Bailey, 2014), scientists who are incentivised to be mobile nationally, often consider wider, international options.

**Adjustment Costs and Multiple Migrations**

Previous studies suggested that it takes, on average, 2 or 3 years for migrants to make up their minds about staying in the country they moved to or to move on (Bijwaard, 2010). Among researchers with multiple migrations, this pattern was very vivid: most initial visits lasted no longer than 3 years (the duration of a fixed postdoctoral contract) after which scientists would leave for the next transit country, until they would find the work environment they would accept.

Short duration of visits was long enough time for researchers to understand whether they would like to stay in the country on a more permanent basis or whether it would be better
to move on. In some instances scientists considered building their entire careers in these new countries, after accepting attractive offers and having strategy to stay. But after getting an initial perception and the insider information about the life in the country and the working environment, they sometimes made a decision to move onward:

“I had an offer from Freiburg. I was waiting for my American visa there, and a professor offered me a 6-year contract to complete Habilitation. I asked him about what was going to happen after I finish the Habilitation, would I be able to find scientific job in Germany. He honestly replied that I wouldn’t. <...> It was a very difficult situation then, the Wall was just broken down then, they didn’t know how to unite with East Germany and the competition in science was crazy. <...> I know this now. Then, everybody was getting Humboldt scholarships and leaving abroad. Nobody stayed in Germany eventually, everybody left to the States” (Professor, USA)

Most ‘entry’ positions are contractual and do not last longer than 3 years. After working in a country for 3 years, scientists could decide whether building a long-term career in this country was possible, or the optimal professional development strategy necessitated onward migration. In this sense, the initial ‘entry’ positions serve as adjustment posts before émigré scientists embark on the search of more stable and secure employment.

Only 17 moves to take contractual positions resulted in getting a permanent place in the same organisation. Out of them only 1 – in the USA, and 6 each in the UK and Germany. National stepwise moves are prevalent, especially in the USA. The finding that experience of international migration facilitates further internal migration is more often met in refugee studies rather than in HSM studies (for example, see Weine et al., 2011). Some research organisations base their performance strategies on offering high numbers of temporary contracts and very low numbers of permanent positions, thereby making use of high quality human capital they cannot possibly retain.

“Forced” Mobility

Framework conditions for employment in many Western countries, especially in early stages of academic career, have been shifting towards fixed term contractual systems, sometimes with high institutional incentives for regular mobility. At the same time, researchers can be flexible with their employment globally. However, with foreign-born scientists, these arrangements have quite often ‘force’ their mobility, including international mobility, even in those cases when they would prefer to not leave their current region or even country of residence. This institutional incentive for mobility has affected a large share of scientists
who participated in the interviews and will be outlined in detail when the ‘push’ mobility factors are discussed below.

5.3 GLOBAL SCIENTIFIC MOBILITY FACTORS
This section of the chapter explores the capacities of spatial units (organisations, regions and nation states) to attract, extrude and retain globally mobile scientists. Factors that determine career strategies in the globalised ALMs appear to have individual as well as macro-level influences, and sometimes contain an element of spontaneity. Previously existing career plans get broken after changes in personal circumstances, or after national and international changes in technology, regulation, or even after political events, such as initiation or termination of programmes, or election of certain political parties. “National capital” of the receiving country, such as language and ethnicity, also plays an important part in the process. However, most often of all it was the institutional push - the logical development of one’s career - that stimulates global mobility of scientists.

While most scientific migration studies illustrate factors and incentives of increasing or decreasing mobility, this section provides deeper insight into importance of some of these factors in making actual mobility decisions. This section builds on previous research on drivers of scientific migration (conceptualised in the section 2.3), but also adds extra factors and shifts in importance among previously noted ones.

The results are visualised in Figure 13 for general factors, in Figure 14 for the pull factors, in Figure 15 for the push factors, and in Figure 16 for the hold factors.

5.3.1 ADDED MIGRATION FACTORS
Some scientific migration factors that feature prominently in the reasoning of migration among the interviewees are not mentioned in general studies on scientific migration and were thus added to the analysis as a result of thematic examination of fieldwork interviews (Table 10). The two most important themes here are mobility incentives and research topic.

Mobility incentives is an institutional parameter of each national research system that provides incentives for researchers to either change their place of work regularly. The Soviet Union is popularly known as a system with lifelong employment, where a scientist's career success depended on growing through the hierarchy within one research organisation. In the modern world research systems of countries, such as Germany and Japan are known for their low mobility rates and lifelong researcher employment (Arendes and Buchstein, 2004; Hill, 1995). In contrast, other countries developed research systems that incentivise regular
mobility of researchers between organisations. Such circulation, it has been argued, strengthens the links between organisations in the system, and facilitates inter-organisational cooperation. The US is an archetypal system in this respect, with similar arrangements existing in some European countries, such as the UK.

In the USA, as interview participants stress, mobility between organisation is encouraged at landmark points of academic career: after completing the doctorate, after taking several postdoctoral positions, and when getting a tenure-track position. There are no further mobility incentives after receiving tenure. Mobility incentives is a strong push factor for US scientists who have fixed-term contractual positions, as employing organisations are rare to extend these contracts. Even if the organisation satisfies the researcher otherwise, it extrudes non-permanent human resources, forcing the people to look for positions elsewhere. For foreign-born researchers this often may mean a termination of their work permit in a country and initiation of ‘forced’ onward migration.

If a scientist lingers in fixed-term contractual positions (called ‘soft money’ in the USA), the chances of winning the competition for tenure-track positions that eventually lead to tenure and offer more security decrease with time. Therefore, there is high incentive for mobility after the first ‘soft money’ contract finishes, even if the employing organisation offers to continue it, because of concerns to get locked out of chances to get tenure.

To sum up, institutional incentives for mobility range from ‘forcing’ scientists to be mobile almost against their will, to prompting international migration and positioning one’s multitude of international research experience as a valuable asset and a competitive advantage.

Similarly, research topic is an international migration factor highly specific to scientific profession. The ability to demonstrate a consistent track of (emerging) research results is a key sign of academic employability. At the same time, research topics are highly specific, with limited or no transferability to neighboring areas of research. With scientific migration, research topic can be a pull as well as a push factor.

Topic is a pull factor in those cases when a scientist is seeking employment (for the initial international migration, or as a result of institutional incentives) and has to be selective of organisations and research groups, because the individual research topic and the research topic of the group need to be as close as possible to ensure the continuity of outputs and cumulative reputation building within the same community.
In some cases such selectiveness becomes a strong international migration incentive, because the number of relevant research groups can be small and they are usually geographically dispersed. After getting to such group, it may limit any further mobility, because, the rare and narrow specialisation prevents a researcher from being mobile once the relevant group is found. Therefore, the choice is usually between staying (even on a non-leadership or non-permanent position) in the group, or going to another continent.

Alternatively, scientists sometimes actively seek mobility (or migration), because they see it beneficial for their personal research development to change the topic. In these cases research topic is a ‘push’ factor: a researcher starts selecting relevant groups, which have high reputation in the area of interest, and eventually makes the transition. The change of research topic in the course of academic career development is a risky decision and is usually associated with the acts of migration. In the words of a German professor, “one should change the topic after the completion of the PhD, or never at all”.

The connection between career development, research topic and scientific migration will be discussed in more detail in Chapter 6, there are other national, organisational, innovation and personal factors that were added to the list of relevant scientific migration factors. Most of them are organisational factors that relate to particularities of work routines in research organisations that employ researchers. Two relate to general characteristics of national research system, and three are non-professional: the ‘quality of life’, which reflects, mainly, the level of support available in the country (such as welfare) for all citizens. It proved to be most important to female researchers. Personal level factors – the 2 body problem and moving costs – have been discussed in the literature (Mason and Goulden, 2002), but are rarely brought up in complex decision making schemas.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Level</th>
<th>Description</th>
<th>Illustration</th>
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<tbody>
<tr>
<td>Quality of Life</td>
<td>National</td>
<td>Living standards, more specifically, general wellbeing and satisfaction with the standard of living in the country/region.</td>
<td>“We are planning a second child now – here, there are great conditions for this: after going on a child leave you maintain full salary for 14 months, and a temporary contract is automatically extended for the time period you are Elternzeit - on childcare leave” (PI, Germany)</td>
</tr>
<tr>
<td>Academic Support</td>
<td>Organisational</td>
<td>Support in grant applications, handling of paperwork, unburdening bureaucratic load on a researcher.</td>
<td>“good quality of academic support, good school for young professors” (Professor, UK)</td>
</tr>
<tr>
<td>Research Students</td>
<td>Organisational</td>
<td>Research students are the main labour force in any lab, especially in experimental science. Recruitment of good students often ensures good results received in research.</td>
<td>“I have access to very good students. Because of very good students my work is progressing much faster. This is something I couldn’t have been doing in Warwick or Bath. Over here the students are good and know much more, so leaving [here-MK] is very unadvisable” (Professor, UK)</td>
</tr>
<tr>
<td>Working Routines</td>
<td>Organisational</td>
<td>Established working routines can be a powerful hold factor for those scientists who do not wish to go through disruption and associated delays in research performance that mobility often entails.</td>
<td>“There is always some noise, some hindrance that make the life harder. &lt;...&gt; One needs to make effort to perform certain expected functions. This drains energy. When a person gets used to it, he doesn’t make as much effort, can concentrate on science and work well” (Professor, UK)</td>
</tr>
<tr>
<td>Research Group</td>
<td>Organisational</td>
<td>An internationally recognised research group as a reputational pull factor, but also own research group can be a powerful hold factor</td>
<td>“Once a person gets an academic position, it is rare that they keep moving around. In part it is because he gets his own research group, students, postdocs, equipment. Moving all this to a new place requires spending resources and time” (Professor, USA)</td>
</tr>
<tr>
<td>Brain Drain to country</td>
<td>Research System</td>
<td>Besides the first instance of brain drain from the late Soviet Union and Russia, a general tendency of brain drain to a certain country can be regarded as a career development trend.</td>
<td>“I noticed that the most successful people from Tel Aviv University were leaving to the USA. It was worth trying from the point of view of my career” (Professor, USA)</td>
</tr>
<tr>
<td>Employment Loyalty</td>
<td>Research System</td>
<td>&quot;Normally I wouldn’t leave Russia in my life. It also never occurred to me to change the workplace and move away from [here-MK]. I love [this place-MK], everything is familiar and is very dear” (Associate Industry Professor, USA)</td>
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<tr>
<td>Entrepreneurship</td>
<td>Innovation</td>
<td>&quot;The moving was made harder by the fact that 2 years ago we created a start-up company in the incubator. So I can’t and I don’t really want to leave Baden-Württemberg. So it turns out I am regionally bounded” (Group Leader, Germany)</td>
<td></td>
</tr>
<tr>
<td>2 Body Problem</td>
<td>Personal</td>
<td>&quot;I am not planning any moves. We are husband and wife together working at the department of Chemistry. Transferring us as a package will be much more difficult for any university than getting one person, the interested university should pay a lot of money” (Associate Professor, UK)</td>
<td></td>
</tr>
<tr>
<td>Moving Costs</td>
<td>Personal</td>
<td>(1)&quot;Moving is not an easy business! There are also all kinds of formalities; you need to understand the traditions and the culture. Also the issue of houses, bank accounts etc. etc.” (Professor, USA) (2) &quot;Each move throws you back. I want to develop as a researcher, as a tutor. It takes a lot of time to prepare for tutorials, but I like them a lot” (Professor, UK)</td>
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</table>

Table 10 Added Scientific Migration Factors

Source: author
The concentration of extra scientific migration factors offered for this analysis on the organisational and personal level highlights current focus of scientific migration literature on national-level analysis. Indeed, choosing a country to move to is a big part of any migration. However, for scientists operating on ALMs, the choice sometimes concerns more particular research organisations inside various countries, and the potential benefits that changing an organisation would bring them. In this sense, national borders are equally, or even less significant than research topics and groups, availability of good students, equipment and career development opportunities.

5.3.2 Overall Migration Factors Importance
Out of the total of over 450 mentions of various scientific migration factors, the participants of this study spoke much more about pull factors: the reasons of why certain places attracted them and thus motivated their migration decisions. Some of the most widely cited scientific migration factors, such as age of researcher, migration country, the reputation of a research organisation – are generally found important for all types of scientific migration.

In the discussion of individual motives and reasons of scientific migration choices a three-tiered thematic structure emerges (see Figure 12). The deliberation of reasons for scientific migration goes through three general tiers: contextualising the general circumstances of research career opportunities within various geographical locales; then deliberations of available career opportunities within this general institutional context, and, finally, in the third instance, deliberation of long-term potential to achieve significant research results in the chosen institutional environment.

The first and most often mentioned theme, which also indicates to its crucial place within the migration decision-making is usually ‘General’: a country’s choice for migration is discussed, and further mobility incentives within the country and internationally. Themes usually relate to general national factors, preferences of certain countries over others, and to opportunities to stay or move on within the labour market context of these countries. Another theme usually relates to individual professional reasons of staying or moving on. These are, primarily, professional research network, research topic and career development opportunities for a researcher.

The second thematic tier of migration reasons puts professional development to the forefront and builds individual career strategies within the context of general national factors.
Finally, the third and the most diverse thematic tier relates to reputation, quality of research and general perspectives of individual research agenda with the factors, such as ‘star scientists’, organisation’s reputation and research agenda. This reflects long-term thinking about opportunities to achieve successful research results and make important discoveries with the resources and the infrastructure of the current place of work, and the ongoing deliberation about whether it would be cost-effective to relocate to another organisation with more long-term benefits.

![Thematic Tiers of Scientific Migration Factors](image)

*Figure 12 Thematic Tiers of Scientific Migration Factors*

Source: author

### 5.3.3 Scientific Migration Factors Analysis by the Type of Factor

While migration factors of all three tiers seem to be important across various types of scientific migration, certain scientific migration factors act in a multiple capacity of pull, push and hold factors. Other types of scientific migration factors are only important for certain type of mobility.

Pull and push factor analysis is a conventional framework of looking at migration flows. In case of HSM, the main push factor is unemployment, and the main pull factor is job opportunities (for an example, see Sundari and Rukmani, 1998). With highly skilled professions the situation changes, because professionals, such as scientists, are rarely
unemployed and usually move from less attractive employment to more attractive employment (Garcia-Rodriguez et al., 2015).

Such differences exist not only between the home country and the ‘host’ country, but also, as in cases of multiple migrations, between several ‘host’ countries and even between ‘host' regions. As Figure 13 illustrates, the relative frequency of discussing organisational aspects of scientific migration choices is much more diverse than any other type of factor. The emphasis on organisational factors points to blurring of national borders and to much higher selectivity in terms of the type of organisation, and even the type of department or a lab when researchers make migration choices. Instead of migrating to a country, many scientists instead relocate to a certain organisation. As a way to illustrate:

“Out of all offers the Finnish one was the most attractive at that point. <...> I had an offer from University of Calgary, Canada, and I had an opportunity to stay, but then it would have been a temporary position in Calgary. But when a person chooses a position one needs to think about long-term career, and I wouldn’t be able to move beyond Calgary. There was something from the States, some third-tier university, I don’t even remember the name anymore. It was my first postdoc. I then had very few publications and citations.” (Scientist, USA)

For the now-US scientist, then based in Canada, there was a choice of three universities in three countries. However, the reasoning behind the eventual choice is entirely on the level of organisational characteristics of these three universities: the US offer was not considered due to reputational reasons, and staying in Canada, albeit having the smallest moving cost, had less long-term opportunities. An offer from Helsinki University was made based on the combination of Tier 1 factor (institutional push from the University in Canada), Tier 2 factor (proximity of research agendas, reputation) and Tier 3 factors (long-term career development opportunities). Tier 1 factor ‘pushed’ the interviewee into actively seeking a position, whilst Tier 2 and 3 factors were ‘pull’ factors that had impact on the eventual decision.

In terms of push-pull dichotomy, ‘pushing’ factors are usually the ones that initiate the search, while ‘pull’ factors determine the scope and selection. In this respect, the way the most Western research systems are organised – towards facilitating frequent academic mobility – is as big of a mobility incentive as the availability of global academic markets and ability of researchers to apply for positions globally.

The following paragraphs review particular roles of each of the three types of scientific migration factors that drive SMTs of researchers.
Figure 13 Scientific Migration Factors – General
Figure 14 Scientific Migration Factors – Pull
Source: author
Figure 15 Scientific Migration Factors – Push
Figure 16 Scientific Migration Factors – Hold
Source: author
Pull Factors
Pull factors of migration are more numerous and diverse than push factors. Organisational factors feature to the biggest extent among the pull factors for scientific mobility. Professional network seems to be the most important pull factor (see Figure 14). Navigating among options and selecting the right organisation is done using a variety of ways, but networks, along with the related factor of ‘star scientists’ are among the most commonly discussed. They act in concert with other organisational factors that relate to immediate research environment, such as research topic, research group and previous visits to the organisation. Mobility incentives and related career development opportunities are a strong pull factor for researchers, but is not as relevant as ‘push’ factor of the same instance.

National factors, such as regional positioning, point to the selection of offers from research organisations based on their perceived national benefits. For instance, for some researchers the large size of the US academic labour market, more relaxed labour legislation in comparison with other countries, and English as the main language of science, combined are a strong incentive to be ‘pulled’ to the country.

Equipment and facilities is a significant pull factor, on par with the hold factor. This reflects a journey of participating scientists who gravitated to megascience facilities throughout the course of their research career:

“It was a PhD in experimental physics. I did my experiments at Stanford. Most of the projects I worked on were done in Stanford Linear Accelerator (SLAC). In total I submitted 2 postdoc applications. I was already known at Caltech. Now, we are collaborating with the Lawrence Berkeley National Lab. I have good resources, and there is very good particle physics here” (Professor, USA).

This case demonstrates not only a continuous research career based on experiments conducted with the use of particle physics equipment pieces, but also how this equipment is a part of research network that involves people and institutions. By becoming a part of this network, the researcher was pulled into a participating institution and invited there by collaborating people. The ‘pull’ factors consist of geographic, infrastructure and personal elements of the network.

Push Factors
Push factors are to a large extent geographic and research system factors, rather than organisational factors (see Figure 15). The only time when organisational factors are decisive in ‘pushing’ researchers from a university is when these researchers, usually mature
professor, reach the top of career hierarchy and saturate research capacities of this university, and start looking elsewhere to expand and extend the scope of their activities.

“I came to a leading scientist, a ‘star’. I then received an offer to stay, we patented together. I ended up staying for 15 years. We did research on matrix polymers that could be used in diagnostics. There was medicine application. Eventually, we grew out of Cranfield. Started looking for alternatives, but not many universities could offer an option for the group” (Professor, UK)

For this mature professor, the applied nature of his research required expansion into the area where more opportunities for doing complex and interdisciplinary research was possible. Such complex need with the promise of big scientific discovery could not be accommodated in a small and specialised university he was working in at that moment.

Mobility incentives in the shape of either the need to find the next contract employment, or the intention to look for a permanent position globally, is the most frequently mentioned ‘push’ factor. In some instances, it is the only push factor.

For many Russian-speaking researchers the journey before settling somewhere resembled ‘tasting’ different countries, cultures and regions. A system of one or two year fixed term contracts allows foreign-born researchers to sample the life in various places around the world before choosing a region to settle in, to develop personal preferences for certain locales. For several researchers not being quite happy with the geographical location they ended up in was enough of an incentive to move onwards elsewhere in the same country or abroad, and was thus a strong ‘push’ factor.

Country tasting may prove unsuccessful for many reasons. Some researchers realised that learning a new language, such as French, was too much for them, even if the employing institution was of the highest quality. Others realised that they were treated more like ‘guests’ in a country and the society was not inclusive of outsiders (which was often mentioned in relation to Japan). In the aspect of a research system, academic career progression may have been organised in a way that gives preferential treatment to native-born researchers, and Russian-speaking scientists chose to not go against the tide and leave the country to seek fortune elsewhere.

Living in a certain country is a matter of personal choice for most researchers, and, being a part of scientific profession, it is possible to secure positions in public research organisations in most countries around the world. Scientists may have to initially compromise on the geographical preference aspect, or on the level of research organisation. The need to obtain
better, stronger students, or the need to find a research group with closer proximity to own research interests, may eventually ‘push’ scientists out to seek new employment.

Similarly, disliking the geographical location and cultural aspects of the current employment country can be an incentive to abandon otherwise prestigious and therefore attractive position. Push factors are to a large extent a combination of professional opportunities and personal preferences. Being a scientist, a person has more liberty to choose the desired geographic location for doing research. The only strong and unequivocal factor that forcefully ‘pushes’ researchers into mobility is fixed-term contractual position employment at early stages of academic career.

**Hold factors**

In the circumstances of high mobility of scientists, retaining the talent has become an increasingly important task. Therefore, ‘hold’ factors are discussed in this section in the context of systemic ability to retain mobile researchers. Retaining capacity of systems is found on all three levels – national, regional and organisational.

Childcare and schooling, working environment, regional positioning, and equipment and facilities are the three strongest ‘hold’ factors (Figure 16). Schooling for children reflects a long-term plan to educate the children within a certain environment, sometimes related to the education system in the country or unwillingness to break children’s education and friendship. Some researchers admitted that settling down and starting a family was a complete halt to any plans for further mobility, while others admitted that some mobility was still possible – but within certain boundaries, such as language.

Regional positioning as a factor reflects several motivations: on the one hand, it may be a country or a region that a researcher would not want to leave due to personal liking. Scientists with good work-life balance may have preference for being in a certain region with the easy access for resources and infrastructure. Alternatively, regional positioning may reflect a combination of geographical location, access to professional infrastructure, and a perfect intellectual environment that is unique and perfect for a particular researcher. This reasoning is closely connected with the other two significant retaining factors, equipment and working environment:

“Our main instrument is a synchrotron. There are only 2 in Europe – in Zurich and in Paris. We have easy access to each of them by train. This is why the position of this city is unique. There is also very high concentration of scientific thought here. There
In this particular example, being in Strasbourg has multiple beneficial elements to it for the interviewee: access to European research facilities, highly reputational research centre, and a stimulating intellectual environment, complemented, at a later stage, by international recognition and professorship.

Some scientists plan a career development strategy that maximises outputs of their return. This strategy may include multiple instances of mobility and relocation before the employment in the desired country, region or organisation is gained. In other instances, accumulation of human capital and necessary equipment makes it very difficult for a scientist to move onwards without significant costs to this migration.

Generally the variety of national (history and culture; immigration regulation; “migrant community”; quality of life) and personal (age; maintaining personal relationships; health insurance and pensions; moving costs) factors is higher in retaining capacity that in attracting or extruding scientists. This reflects the tendency that to tempt researchers with long-term stays, a good general environment should be available for them and their families in terms of non-academic community. For instance, many scientists who have experience working in European countries, such as Germany and Finland, and who transitioned on to the US, reflected about the value of “migrant society” and the merit of personal achievement in the USA. In contrast, some of those who chose to settle in Germany reflected on the welcoming character, acceptance and multiculturalism of German people. Russian-speaking diaspora did not feature in any of the interviews as a significant factor of host environment.

Professionally, hold factors reflect the satisfaction of researchers with the place they chose to settle in. It is usually a combination of research group and the agenda, good positioning from the point of view of professional network, solid career opportunities and long-term reputational benefits. Additionally, working routines are important retaining factors that reflect tacit organisational knowledge.

There are also factors that are not mentioned as frequently as some of the others that take precedence over in the circumstances when they emerge. These are, primarily, research clusters and own company. Being in a research cluster opens up opportunities for high intensity interdisciplinary collaborations, as well as to other opportunities, such as
commercialisation and access to higher level funding. For these reasons, researchers may not wish to leave clusters or compromise with staying in temporary or lower prestige jobs for the sake of being a part of the desired environment.

All academic entrepreneurs interviewed for this study did not see themselves experience any mobility beyond their current region of residence, because companies they owned require constant attention. Facilitating academic entrepreneurship is, therefore, a definitive way to retain talented researchers in the organisation or within the regional cluster.

One of the main findings of this chapter is that the capacity to attract or retain globally mobile scientists rests with factors not on the national, but on the organisational and, to a lesser extent, on the regional level. As scientific migration is a particular type of labour migration, working conditions in candidate employing organisations, opportunities and resources, are exceptionally important when the final decision is made. Similarly, good professional environment, routines on the one hand, and the embeddedness in clusters and innovation system on the other ensure that a scientist is retained in the system. The role of national-level factors in all three types of migration factors is mainly shaping – it outlines the scope of the general search rather than defines eventual mobility decisions. The role and image of countries in SMTs is described in detail in Appendix 5.

5.4 INSTITUTIONS OF THE GLOBAL SCIENTIFIC MOBILITY
This section discusses institutions that define and structure global scientific mobility. Among the variety of factors, patterns and trajectories outlined so far in the chapter, some come out strongly and consistently. First of all, scientists move between countries easily, to the extent that national-level factors become only marginal in their migration decisions. Second, scientists are incredibly mobile internationally, but permanent positions (and much sought-after job security) is only reached after some adjustment to national working environment.

These findings imply the existence of global institutions that structure global scientific mobility flows in one instance, and the existence of national institutions that regulate rewards and promotion of scientists (and where globally mobile researchers have a disadvantage) in the second instance. The two types of institutions of crucial importance for global scientific mobility – globalising ALMs and national academic career pathways – are discussed in detail in this section.

5.4.1 GLOBALISING ACADEMIC LABOUR MARKETS
Ongoing international mobility of scientists across countries, along with the selection moving down from national to organisational level, reflects the tendency towards globalisation of ALMs.

The rise of information technologies that allowed researchers to do intelligent real time search and selection of prospective places to work worldwide, intensifying rates of international research cooperation facilitate interconnectedness (Fontes et al., 2013; Jacob and Meek, 2013) and broad transnational research networks.

Additionally, in most cases scientists are not required to prove or retake their qualifications, as prestige is defined within the community, which leaves only a small number of barriers associated with finding employment and moving to different countries. Unlike for most other categories of internationally mobile persons, for scientists national entry barriers are low or nonexistent and, in some cases, countries adopt policies to attract globally mobile researchers in their bids to win the global competition for talent (Kuvik and Rath, 2015).

Globalisation is more often associated with opportunities for mobility. However, its effect on the academic labour market has been mixed. The most often discussed effect of globalisation – ‘brain drain’ – reveals negative consequences of increased mobility opportunities that deplete human capital from low-income or developing countries (Marfouk, 2008). At the same time, the competition for available positions in the international centres of excellence intensified manifold, which has led to the increase in the number of part-time and fixed-term contracts in some countries (Rogge, 2015) and in the rise of demands for mobility to and through these centres:

“There are few universities and a very large job market. Academia is producing a very large number of PhD graduates who are seeking to get a job in academia. So when there is an open position, which is not too bad, then the competition is nearing 1 to 70-80 in physics and mathematics. <...> When you apply you apply everywhere you can. Ivy League Universities, Liberal Arts Colleges, everywhere.” (Research Scientist, USA)

As scientific profession is less affected by deskilling, positions in the leading research organisations are open for applicants from around the world, and globalisation intensified competition for these positions manifold. This has led to the increase in the hierarchy of employing organisations in the globalising labour markets. Due to the high competition, ‘elite’ and ‘top’ organisations in many disciplinary areas are not directly accessible for applicants, especially for first-time migrants applying for home countries.
Many countries where it used to be acceptable to build an entire academic career in one research establishment, usually the one that awarded the Doctorate, now experience brain drain, as migration is becoming easier to perform, causing structural changes. At the same time, top performing organisations have the infrastructure, funding, collectives, students, and other resources for successful and ambitious research. Especially in the areas of ‘mega-science’ that require incredibly complex and expensive facilities for experimentation, access to these facilities may determine the outcome of research programmes. As these centres become more powerful and give more promise, more early career researchers yearn to work in these centres, and the more the competition for few available positions increases.

Spatial mobility does not have any observable hurdles, for as long as it happens within transnational academic community. Moreover, disregard of national borders and bodies has become an integral part of academic identity, as expressed by some researchers, especially of younger age:

“I think that scientists enjoy the international labour market, unlike managers and other professions. Borders are not as important in our case”. (tenure-track Professor, Germany)

English has become an official language of research in many laboratories, even those situated outside predominantly English speaking countries (BrachoRiquelme et al., 1997; Reguant and Casadella, 1994). These trends suggest that there is not much more to the act of international scientific migration than getting a work permit and physically relocating abroad: no extra costs, exams, evaluations. Even the language barrier is not as impenetrable as usually perceived.

While traditional strong centres, such as Oxbridge in the UK and the ‘Ivy League’ universities in the USA, remain important for particular networks of scientists, it becomes incredibly significant for researchers to be in the centre of an active research cluster, akin to the desire of IT companies to be in the centre of thematic clusters, such as the Silicon Valley (Bresnahan et al., 2001). The benefits of being immersed in a research cluster may outweigh disadvantages caused by being employed in a weak research organisation in the region:

“It is very convenient to work here: the physics are located nearby, and Harvard Medical School and computer science is literally the next building. My area – power grid stability, theoretical physics and aging – this is the only place where everything is so concentrated. <…> In Russia, if a theoretical physicist was getting interested in medical issues, it wouldn’t be possible to do research on it, where here is the leading edge. <…> People may say that we live in the age of technologies, which
tremendously ease the communication, but in fact it is personal communication that matters, when you can stand at the whiteboard with someone and discuss the topic you want to discuss without the limits of time or the bandwidth. ... I would definitely like to stay here. For me, MIT is number one. But the vicinity and any organisation in the area is definitely an option. There is Brandeis University, Northwestern, Rutgers is not too far away” (Scientist, USA)

As an effect of globalisation, prestigious research clusters sit on the intersection of spatial and reputational priorities of scientists and prove to be a new form of interaction of research organisations, which will have a significant effect on the structure of labour markets. The next section discusses other academic labour market institutions before analysing the interplay of geographic and reputational hierarchies in more detail.

Institutional Structure

A range of institutions structure career development strategies and eventual SMTs in the globalised academic labour market. They are classified as search enablers, mobility stimulators, mobility inhibitors, and mobility facilitators and include international fellowship programmes, supranational institutions, search engines, academic journals, academic conferences, headhunter companies, formal networks, and border agencies.

Search enablers are institutions that organise search for available positions in ALMs. They include networking events (conferences, workshops, circulation opportunities), online and offline mediums for job search (websites, journals) and professional/personal networks. Scientific communication facilitates circulation of researchers across research organisations. Therefore, networking events, such as workshops and conferences, that facilitate establishment of new links, are important enablers of academic job search. Academic conferences and other networked events on a smaller scale are a way to gain visibility in research and make initial contact with interested groups in the field, and are closely connected with formal networks of professional community of researchers, which may also have regular bulletins or a job posting web page. These also present opportunities to make reputational assessments of groups and researchers that will be a structuring element in job search and selection. Sometimes a job offer may arrive as a direct result of meeting someone at the conference, and is an opportunity for international migration:

“I did my PhD at Tel Aviv University. For a Post Doc I went to the University Urbana Champagne. I went there after I went to the APS conference and a Professor I met there offered me to come”. (Professor, Germany)
Networking events and professional networks are interconnected and reinforce each other. Professional networks, play increasingly important part as migration search tools and migration enabling institutions. Several interviewees admitted that they never considered applying to work at institutions where they had no previous networks and connections. Whilst this may indicate that these scientists were limiting their job search, it was at most times international, because in the globalised labour markets academic networks, especially of scientists with previous migration experience, are almost exclusively transnational.

Online and offline mediums for job search include, mainly, special job advertisement pages in field-specific academic journals and, more recently, tailored job searches on specialists websites. These are the most popular way for scientists to access the globalising job market in one instance, but also is a tool to limit their exposure to narrowly defined set of parameters. Limiting the job search to only one country, or several countries of the same language zone is a conscious framing decision in most instances, and is reinforced by the structure of ‘job alerts’ in electronic media.

Finally, some international fellowship programmes, such as the Humboldt fellowship, offer a combination of stimulation and a search: winning the scholarship enables the subsequent search and negotiation.

National and supranational fellowship programmes, circulation awards and visiting positions funding programmes are institutions that stimulate mobility in the academic labour market. Familiarity with a research organisation or with a country is a significant factor that may stimulate subsequent mobility. Existing research has demonstrated the importance of student exchange programmes, such as pan-European Erasmus programme, for subsequent EU mobility (Ackers and Gill, 2008). Previous mobility experience facilitated by such institutions, as university exchange partnerships, circulation awards (student and early career stages), or sabbatical and visiting researcher fellowships (mid- and late stage of career) are all mobility stimulator institutions. They not only provide personal experience with the location, but also facilitate networking and initial collaborations that then may be developed into long-term research partnerships.

Another type of institution that stimulates mobility is fellowships provided by research funding bodies that present an opportunity to initiate mobility in the labour market. Finally, institutional mobility incentives in public research organisations that take form of preferences of external candidates over internal ones during recruitment stimulate national mobility and, as discussed above, may stimulate international migration.
Proactive mobility facilitators, such as headhunter organisations, are only present in the academic labour market at high level of seniority and are virtually non-existent in early and mid-stages of academic careers. No intermediary organisations assisted with mobility of interview participants. Informal personal and professional networks are used to signal the availability of candidates for an open position; or available positions for a candidate, which does not leave much space for broker organisations who could act in this role.

Although there is advice and coaching available for academic job seekers, this market remains relatively unmediated by such actors, as recruitment agencies and other brokers. In many cases, scientists who are looking to relocate abroad search for opportunities themselves in the available platforms, select their options and submit applications.

Visa and citizenship are the institutions that have traditionally been perceived as mobility inhibitors (Werbner, 2002). Stringent visa restrictions may be the grounds of making a decision to not move, or, at the same time, waiting for the permanent residency can be a solid reason to not be mobile. While these institutions have the highest impact on the international scientific migration, they also restrict mobility in the labour market in the sense that foreign-born labour force is less secure about risking changing the job.

Disciplinary organisation of research groups in the field can inhibit mobility. The narrower the specialisation and the research topic of the scientist, the fewer laboratories or research groups can be a suitable place to work. As the recent trends in science are directed towards further specialisation, mobility options become more limited. In these circumstances a researcher has two general options: going to an organisation that wants to develop a certain area of science and starting a new laboratory there, with the risks of being cut off from networks and idea circulation, or staying with a research group that specialises in the area of interest. However, all mobility options are very limited in this case, simply because there are very few possible destinations.

Location/Reputation Hierarchies

A stream of literature on stepwise migration finds that getting to different countries can be more or less difficult for migrants, but these countries are also more or less desirable. For example, Paul (2011) gives an account of Filipino domestic workers who have to work in less desirable countries first before accumulating enough social and human capital to migrate to more desirable countries. This international migration pattern came to be called ‘stepwise migration’.
Stepwise migration studies reveal the discrepancy in opportunities of migrants and the available places they can move to. This reveals geographic hierarchy of desired destinations. Moving to countries that are higher up in the hierarchy was possible after migrants accumulated enough capital (financial, human, cultural) to make the next step and move to a more desired country.

The same problem stands for the globally mobile scientists. Having defined their priorities, many scientists then face a problem that the desired location or a desired research organisation may be inaccessible from within their home country. The inhibiting factors are varied, from the luck of funds and awareness to factors specific to the desired host research system, such as research work experience and a domestic doctorate degree.

The ease with which thousands of researchers from around the world can simultaneously apply for positions in a very small number of elite research organisations configures a hierarchy of desired destinations. With a lot of group and individual variations, the multitude of these hierarchies compose the atlas of mobility that prioritises certain areas over others as destinations of international scientific migration.

Unlike for the groups of low-skilled migrants that provide data for previous studies of stepwise migration, mobility of scientists in the globalised labour markets is structured by two main criteria - location and reputation – and where the former usually relates to a country or a region, the latter is used to outline the scope (or a reputational ‘tier’) of desired organisations.

As outlined in the first section of this chapter, for many interviewees going abroad from their home countries was limited by the breadth of their professional network, especially at early stages of their career. Mobility within professional network has less impediments and aids in adaptation in the new place (see Chapter 7 for the detailed discussion), so only few interviewees applied to positions randomly outside the network.

However, network also limits the scope of available countries and organisations of scientific mobility. Mobility incentives, especially powerful at early stages of one’s career, push scientists for further migration, sometimes to countries they were targeting as having higher priority. In other instances, available mobility enablers, such as funding programmes, facilitated the move to one country, but only because such enablers were not available for the desired country. The desired destination was reached in the subsequent move.
As an example, USA is well known for its larger academic labour market, high levels of funding distributed on the competitive basis and many strong areas of nanoscience. It is an attractive destination country for many scientists who are mobile on the globalising academic labour market. Entry costs to the USA are low as well due to high receptivity of foreign-born labour force and the general relaxed immigration towards skilled migrants. Many interviewees regard the USA as a desired country that offers opportunities not available in their current countries of residence.

For many interviewees ‘stepping stone’ hierarchies did not, or only partly, coincided with national borders. For instance, although the USA may have been the top country of choice, getting a postdoctoral position in one of prestigious European schools was more attractive for some participants than going to a tenure-track position at a provincial university in the USA.

Bearing in mind that any mobility to a new research organisation would incur costs, such as time spent for adjustment and establishment of new routines, preparing materials for teaching courses and other practicalities, moving to a different country can become no different than moving to a different region or a different city.

At the same time, some of the most important decision-making factors for international migration as well as internal mobility bear country-level significance. This entanglement of national, regional and local factors reflect reduced costs of international migration and in many instances put it on the same footing as regional mobility. Criteria for desired location include residence regimes and visa regulations; welfare benefits; average level of salaries; the prestige of scientific profession; infrastructure and proximity to core equipment, including mega-science facilities; community, reception and opportunities for integration and citizenship, and others.

Reputation is a sign of prestige and recognition in the academic community, which is ideally self-governed and is subordinated to a strict quality control. Whitley (2000) wrote about reputation as the most important aspect of recognition of achievement in science. Public research organisations, such as universities, are the largest employers of scientific personnel, and the fact that outputs of their work are a public asset imposes a system of peer recognition as a quality control mechanism.

While reputation is indubitably of utmost importance for selecting prospective places to work, the ways in which scientists assess reputation of a public research organisation vary in
scale and method. The recognition is stratified and divided in relation to particular research
groups, institutes, and regions (Jöns, 2010), so the assessment of the organisation as a
whole done, for example, on the basis of international rankings, may differ from the
assessment of the reputation of a region, which can be based on the overall concentration
of talent and, in turn, can also differ from an assessment of a reputation of a particular
research group, with the members of whom a scientist may be familiar on the basis of
shared network. The compound reputation assessment is based on a relative priority of one
of the factors, or on the combined value of all three, for each interviewee.

The sources of reputational assessment are not easy to determine. In most cases,
reputational values are presented in ‘accepted value’ statements that do not indicate where
the evaluation came from. It could reflect word-of-mouth assessments that are circulating in
the community that a researcher chose to internalise.

In the last year of the PhD I started looking for a postdoctoral position. I was only
ready to accept a postdoctoral position in a good place, because there is no point to
move on to do research in a bad place. […] My strategy was to select 10 best
universities and choose the groups that fitted my topic. It wasn’t the easiest in my
situation, because I have a very specific PhD topic. (Tenure-track Professor,
Germany)

In other cases, the assessment is done in the professional community – by reading works of
relevant research groups and making individual assessments of the quality of their work:

“I am a polymer physicist, I started off there. When I was in Germany I was still doing
research in this area. At the time there was no Internet – can you imagine? – so I just
went to the library and looked at who does what where. Well, some people I know of
because of my topic, it is very narrow. And I was also looking at other strong centres,
strong groups. There was a journal called Polymer News. I was looking through it,
choosing groups that made sense and was sending inquiries to those groups.”
(Professor, USA)

Hence, informal reputational assessments in the network are the core method of
reputational assessment of the organisation. Besides these, there are two distinctively ways
of assessing the reputation of a prospective place to work: its place in national and
international rankings, and the presence of ‘star’ scientists.

International university rankings are mainly used in those cases when a researcher wants to
make an informed selection of prospective places to work, but has very little information
about the choices, or the selection range is too wide. International rankings, albeit being
heavily criticised in the research community (Çakir et al., 2015; Taylor and Braddock, 2007),
are used widely by undergraduate students, postgraduate students and researchers alike to make selection decisions about prospective places of work and study. National and international rankings of the current or potential places of work are used to explain the overall quality of research during search and selection process:

(1) “The move of academics occurs in sync with REF [Research Excellence Framework – MK] in Britain. How to buy an academic: 1 – salary 2 – good lab 3 – REF score of the host university.” (Professor, UK)

(2) “This [current university – MK] is a good place, but not the top-10. Of course, I’d like to work in a top-10 university” (Assistant Professor, USA).

(3) “There is a selection system, the rankings, they mirror the reality” (Professor, UK).

“Star” scientists, on the other end, have long been regarded as one of the core factors that determines the reputation of organisation (Zucker and Darby, 1996). They are nodes of connection between various research organisations, and they also have high gravity, namely, they attract human and material resources to their affiliation, from new bright students, to industry contacts (Heinze et al., 2009). However, all internationally recognised researchers have such capabilities in attracting new talent to their research organisations, not only conventionally defined ‘stars’ with exceptional achievements. Among the participants of this study some degree of familiarity and personal recognition of a professor or head of the group in a target organisation was an indicator of its reputation.

**Stepwise Mobility and Multiple Moves**

For many researchers multiple migrations or onward migration (Newbold, 2001), has become an integral part of their profession. Scientists in general work their way up the hierarchy destinations until they manage to find the place that satisfies them from the point of view of location, as well as prestige. Factors, such as increased competition for open positions in top organisations, entry barriers to apply for jobs in certain countries, limit the agency of scientists on the labour market, especially at the early stages of their career. It is then often the case that scientists resort to available measures, such as fellowship opportunities, to move to a second choice countries or second choice research organisations, sometimes with a vision to accumulate social capital (e.g. produce significant research results and publish) and then make a move to a more desired locale. This onward migration is characteristic of labour migration in many social and ethnic groups (Aydemir and Robinson, 2008). The movements may be numerous and are sometimes spontaneous and are formed as personal circumstances change.
Scientists who look to commence an act of international migration, in most cases consider their country, or, more rarely, a research organisation in their home country, as a low priority. As the costs of migration are still high, the decision to leave is usually well weighed against possible returns. Unless the scientists belong to the ‘transnational elite’ group (Laudel, 2005), the available options for migration usually lie in going to a high priority country with limited availability to secure a position in a prestigious research organisation, or to a high reputation research organisation, but in a country that is not the best for that particular scientist.

Both location and reputation are equally important in determining subsequent decisions about staying or moving in the country. Low country priority locations with high reputation may indicate available positions in prestigious research centres that are located in countries associated with negative returns for a researcher. With an opportunity to get experience and international exposure, scientists may consider staying in the research centre before trying to make a move to a better country with better career prospects.

For instance, among post-Soviet researchers German labour market was easy to enter, due to good availability of research programmes, but at the same time it seemed to be unreceptive to foreign-born researchers and lacked permanent positions. Because of this, some scientists, who enjoyed the welfare system or the research culture, chose to compromise and remain there in contract-based jobs for a long time with a hope to eventually secure a permanent position. Others, even though they initially worked in strong German research centres, moved onwards to other countries, such as the USA, that are more receptive to foreign workforce and have good availability of tenured positions.

Among the onward migration strategies when researchers try to maximise the country and reputational outputs of their final workplace, a move from high ranked organisations in less desired countries to high ranked organisations in the desired countries is not often observed. Such moves are available to the elite scientists among the participants. Such trajectory can be explained by the fact that in the circumstances when a researcher works their way up the career hierarchy and gets increasing returns in the high ranked organisation in a less desired country, for the desired country this researcher is still only in a position to apply as an outsider to a research system. With all accumulated reputation, the available reputational range of research organisations would be unsatisfactory and incur loss of already accumulated benefits. In many cases, the move does not occur, even if it was initially planned.
The hierarchical structuring of academic labour market reflects the existing tendencies of uneven development of research clusters worldwide, and the skew towards favouring skilled migrations to the West. Some institutional configurations that soften this rigid hierarchy, such as networked engagement with the home country, will be discussed in Chapter 7.

National Barriers in Academic Labour Markets

Some countries have strong national boundaries of ALMs, which need to be mentioned here. While there is a general tendency towards globalisation and denationalisation of ALMs due to the reasons outlined above, national differences, rules and configurations still exist. For example, among the case study countries, the US research system stands apart from the UK and Germany as having an independent and even self-sufficient institutional setup.

The isolationist stance of the US science, even if it has foundations in the large size of the domestic community, in geographic distance and increased moving costs when communicating with, for example, Europe, contributes to the retaining capacity of the system. When researchers fall out of touch with procedures, techniques and discourses of other research systems they become less likely to consider moving there to develop their career. Opportunities for circulation and mobility therefore rest only with personal and professional networks, not with any other labour markets institutions:

“In Europe it was relatively easy to look. I looked at Exeter University, in England. But over there everything is organised slightly differently, so I didn’t even apply. Maybe mainly because I am not familiar with the European system, it’s information pollution. <...> Well and I know the system over here, which is probably why it is easier for me to search [for jobs – MK] in America. Europe is like some kind of black box from over here. There are so many different countries and all have different bureaucratic systems”. (Tenure-track professor, USA)

Different institutional setup fosters the development of different mediums where scientists source information about available positions in their field nationally and abroad. The following section focuses on persisting national features of ALMs, namely, academic career pathways, before it proceeds to outline academic career development strategies of interviewees in more detail.

5.4.2 ACADEMIC CAREER PATHWAYS

The previous section discusses transformative effects of globalising labour markets for the development of academic career. As mobility becomes more embedded in SMTs around the world, there are still some persisting differences in the configuration of ALMs, such as prestigious national networking events that incentivise US researchers to confine their
professional network to the US community, if not preventing but definitely limiting the rates of international scientific migration. While location/reputation hierarchies structure mobility flows, there is another structuring component of scientific migration, namely, academic career development. As was noted in the first section of this chapter, in most cases, scientific mobility continues until a scientist manages to secure a permanent position. This journey varies in duration and has national aspect to it.

Academic qualifications are uniform and to a large extent transferrable across countries. In general, academic career is initiated with the receipt of a doctoral degree. A scientist subsequently goes through one or several fixed-term contractual positions before eventually receiving a permanent position. At some point, an opportunity appears for a scientist to develop further, but not in a research capacity, but in a senior leadership capacity by developing an ‘administrative career’.

National differences of academic career development relate to the circumstances of transition between these core stages in terms of, for example, the number of postdocs, or mobility. Broader institutional differences also distinguish various countries in terms of academic career progression.

A core distinguishing principle is the existence of different types of permanent positions. A permanent position can’t be terminated without just cause, so this is the most secure position that enables greater freedom of research and riskier agenda setting. In this study they are termed ‘leadership’ and ‘non-leadership’ positions. Leadership positions are broadly classified as a type of permanent position that leads to professorship. This type of position gives scientist autonomy to develop an independent research agenda, apply for funding and build own laboratory.

Non-leadership positions, albeit guarantee job security, do not have the benefits of autonomy and cannot evolve into professorship. This type of position is nonexistent in the USA, but is popular in countries of continental Europe. This is due to the fact that professorial positions there are associated with a wider scope of authority and are much more limited in number.

Non-leadership permanent position holders work with professors as senior scientists as a part of big research groups. They have limited ability to supervise graduate students and apply for funding (depending on national specificities) and apply for research funding. They cannot have their own laboratories, but they can do independent individual work.
Scientists in the USA either have permanent professorial (leadership) positions, or can work for a long time in non-permanent contractual positions that have the overall name ‘soft money’ positions. These positions do not ensure consistent funding pipeline to enable research, and scientists in these positions have to either work for tenured professors, or continuously apply for new funding. The university only provides spaces and equipment in exchange for overheads. These researchers, who have to fund their life and work entirely on their own, which limits the scale of research, the size of their group and the number of graduate students they employ.

There is generally no transition available from one academic career path to the other, e.g. ‘soft money’ scientists in the US who exceeded the maximum length of contractual employment agreed on in the community have very small chances of getting tenure. Similarly, the career cap is set for the holders of non-leadership permanent positions in Germany and Switzerland, which can never exceed professorial authority.

Most national research systems in the developed economies are very competitive and have (1) low numbers of permanent positions and (2) low numbers of professorial leadership positions. With the increase in the volume in training graduate students along with much slower increase in the number of positions available, the competition increases greatly.

Some countries, such as the US, Canada and, more recently, Germany have a system of tenure-track positions, which are fixed in their duration, but after the examination held at the end of the contract the candidate may be admitted to a permanent place. Tenure-track is a type of transitional position from non-permanent to permanent (usually, leadership) employment.

The challenge for globally mobile scientists is in transitioning from one type of academic career progression to another one in a different country. Smooth transition requires in-depth insider knowledge of the institutional set-up of academic career development in the host country. In various national contexts, academic career opportunities change with mobility. Lack of mobility (lingering in one position or organisation) as well as excess of mobility (going to multiple countries) is regarded as an advantage in some systems and as a disadvantage and an impediment for promotion in others.

**Administrative Career**

While further gradations exist (for example, between different types of professorship positions in Germany), in general, interviewees regard reaching full professorship as the
pinnacle of academic career. Moving beyond professorship is widely regarded as a start of the building of a different career, administrative in nature, which often conflicts with research commitment.

There may be opportunities in moving beyond full professorship to administrative leadership positions, but many scientists choose to not make the move, as it incurs the reduction in time that can be allocated for research. Building an administrative career adheres to different rules than the academic career and is widely regarded as an unpopular choice among the academics.

For professors, developing an academic career requires tradeoff between research and administrative authority. Many are reluctant to give up scientific activities, because research is what they enjoy doing, and the amount of power and resources available at the pinnacle of research career give opportunities to do ambitious and far-reaching projects. On the other end of the scale lie opportunities to influence wider agenda setting processes within the employing organisation and nationally. As academia is almost everywhere self-governing, academic leadership, consisting of researchers with vision about priorities in future development of science and technology, can have profound implications for research groups and laboratories working ‘on the ground’.

Moving beyond a purely scientific career and starting to act in an administrative capacity is a choice that some senior scientists make. Advancement in the administrative career, however, is determined by factors that go beyond academic achievement and recognition in academic community. Researcher’s ability to influence policymaking, this elevating the profile of his institution, or collaborate with industry, thus bringing in extra funding, is appreciated more at this stage. National differences are stronger at this point.

For senior professors who do not wish to give up their research, there is global mobility opportunity in the way of connecting with other countries and developing geographically distributed scientific practice. Many globally mobile scientists choose their home country to pursue this endeavor. This is a viable strategy to increase resources, networks and reputation in the community and is often encouraged by the employing organisation, because it raises its international profile (Anand et al., 2009). For some Russian-speaking professors developing an extra laboratory with more research projects looks much more interesting than advancing to senior leadership and building administrative careers:
“I intend to work at the same position as right now. ‘What is a career development?’ – I am a professor, a scientist, I don’t really need much more. Being a head of a massive institute is not really my thing. If I start growing in a direction I have – then it is towards being an institute director. <…> There is a lot of collaboration [with Russia – MK] and it is a very important part of our work here. I regularly go to Moscow or St Petersburg, we receive joint funding for research projects.” (Professor, Germany)

Such multiple roles scientists vary in the degree of engagement with their home countries, but are invariably regarded as strategically important brokers that facilitate knowledge and technology transfer the development of cooperation networks and, ultimately, reversing ‘brain drain’ in the source countries. Sometimes such researchers become strategically important actors in the innovative development of their home regions (Saxenian, 2007). For scientists themselves, such engagement opportunities can be a strategy to develop an ‘alternative’ reputational capacity.

The outline of the structure and operation of ALMs, as well as career progression pathways sets the stage for discussing strategies developed in response to challenges and opportunities of ALMs, factors that determine these strategies, and resources used to enable these strategies. The next section of this chapter outlines initial data on national and international migration moves of researchers, before moving on to discuss patterns in SMTs and factors that influence them.

5.5 ACADEMIC CAREER DEVELOPMENT STRATEGIES
Several previous studies noted that an individual migration project, even if it involves many years and several countries, rarely forms a rational and coherent strategy (Pásztor, 2015; Ryan and Mulholland, 2014). However, the nature of global scientific mobility is in most cases sequential. While only a very small minority of interviewees had a long-term strategic migration plan, usually involving multiple ‘steps’ upward the location/reputation hierarchy, the majority had a vague idea of where they wanted to be at the beginning of their global migration projects, but also were prepared to take chances as they were coming along.

Additionally, personal and professional circumstances of scientists change with time. Global events, such as marriage, may change desired career development pathway and incur further mobility, while the desire to trade administrative career for another laboratory in Russia at an advanced stage of career development is usually not planned 30 years in advance either.
Therefore, the term ‘strategy’ in this sub-section relates not to a coherent premade plan, but to a cumulative result of choices made throughout one’s career. Strategy may change during the course one academic career. In this sense, the section below offers ideal typical ‘career development strategies’ in the circumstances of globalising ALMs.

This study cannot offer the description of ‘finished’ global mobility projects for the same reasons. It was previously found that individuals may go on the move again after decades of living in a place and after even they considered themselves settled. The findings of this research suggest the same pattern among Russian-speaking scientists.

Overall, career development strategies reflect the ways in which researchers cope with the challenges of building an academic career outside of their home country, including the hurdles and opportunities of globalisation. These narratives are called ‘strategies’ because there is a clearly defined priority or a principle according to which researchers developed their careers (see Table 11 for the summary).

The strategies differ in relation to preference of national or international migration; in terms of factors that incentivise mobility (such as ‘forceful’ mobility incentive, or an attractive offer, or a desire to work in a more prestigious university), in terms of the ways migration decisions are made: prevalent criteria, selection and framing criteria. Finally, there are differences in terms of what types of migration factors are important in building these various migration strategies, in terms of long-term planning and job security. In contrast, factors that distinguish scientists greatly and discussed in detail above, such as the ‘wave’ of migration, place of PhD award, academic age, or a discipline, do not really determine or make a difference in building an academic career development strategy.

Four major types of academic career development strategies are distinguished: career output maximisation strategy; networking strategy; lifestyle [non]migration strategy, and global trotting strategy. Career output maximisation strategy is an aggregate term for three sub-types of strategies based on taking the most from career-based opportunities of global mobility. Stepwise development, capability adjustment, ‘loopy’ migration and the ‘greener field’ development all reflect circumstances that may appear at different stages of academic career development, and how global mobility can be enacted to get the most out of the situation.

This section outlines each of the strategies with illustrations presented in the forms of a career biography narrative, selected from representative interviews.
<table>
<thead>
<tr>
<th><strong>Networked strategy</strong></th>
<th><strong>Career Output Maximisation Strategy</strong></th>
<th><strong>Lifestyle [non] migration</strong></th>
<th><strong>Global Trotting Strategy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
<td>Only consider moving if there is a link</td>
<td>Next move must be to a better place than the previous</td>
<td>Leave the top priority organisation/ location with the purpose to return</td>
</tr>
<tr>
<td><strong>International Mobility</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>National Mobility</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Dominant Selection criterion</strong></td>
<td>Reputation within Network</td>
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</tr>
<tr>
<td><strong>Search Strategy</strong></td>
<td>Network</td>
<td>Lottery; Network; Targeted Appl.; Targeted Application; Lottery</td>
<td>Targeted application; Network; Lottery</td>
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<tr>
<td><strong>Framing and selection Options</strong></td>
<td>Network, Location</td>
<td>Open-minded</td>
<td>within the same country</td>
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<tr>
<td><strong>Important Migration Factor Type</strong></td>
<td>Organisational</td>
<td>Organisational; Research System; Regional</td>
<td>Organisational</td>
</tr>
<tr>
<td><strong>Long-term planning</strong></td>
<td>Some</td>
<td>Coherent Strategy</td>
<td>post-move strategy</td>
</tr>
<tr>
<td><strong>Required Job Security</strong></td>
<td>not so important</td>
<td>important at later career stages</td>
<td>important at later career stages</td>
</tr>
</tbody>
</table>

**Table 11 Career Development Strategies Summary**

Source: author
5.5.1 Career Output Maximisation Strategy

Career output maximisation strategy is, first of all, characterised by a coherent long-term plan, sometimes made by a researcher even before leaving the home country. Scientists who adopt these strategies, especially at early stages of their careers, their chances of getting a position in a desired country or organisation and measure this up against their existing network and other opportunities. A solution is usually made to work their way up the geographical and reputational hierarchy, starting with less desired destinations.

These researchers are usually flexible towards moving to various countries as well as moving within one country, if there are more attractive organisations that a scientist can move to. They are keen to learn about institutional settings of various research organisations and the ‘rules of the game’ in national job markets.

Below is a biographical narrative of a scientist who is currently an Associate professor in a top engineering university in the USA. He worked his way up national and reputational hierarchies and received a permanent position after 18 years of global mobility.

“[Israel] it is a very small country. There are very few positions in universities. There are many people who came from the former Soviet Union and it is hard to find a position. In fact, you are made to wait, to brew by yourself for several years, to wait. But you don’t want that – the time passes and you don’t even know whether there will be a position or not, nobody knows. <…>

‘In principle, I wanted to do a postdoc in the USA, but I didn’t find anything at that point. The problem was I didn’t know how to look, there were internal rules, and it is often a chance. I knew a girl from Technion in Germany, she was looking for someone then, and she said: “Come!”’. <…>

‘In truth, it is almost impossible to get a permanent position in Germany. There are some very precarious positions, but they are not very clear. Over there all faculty are the professor and his secretary. All others are temporary and are changing all the time. <…>

‘I still wanted to go to the USA, I wasn’t particularly keen on going back home. <…>

‘I started looking in the USA, I was applying to different positions in different universities. There was an interesting woman in Pittsburgh, very energetic. She always has positions. I
worked for some time there and decided to move on to something new. I thought that I could apply somewhere. <...>

‘I will tell you so many worldly wisdoms now! The purpose of a postdoc is to learn something new. You can learn everything you need in 2 years and you need to move on. When you apply to new positions they look that if a person sat for too long on postdoc positions, it becomes strange. There are completely strange and obscure rules that vary from discipline to discipline! This is why when a person lives in Europe he doesn’t know this. This is why to get a good position here from Europe is almost impossible, because people don’t know the expectations. <...>

‘After I spent 2 years there [in Pittsburgh – MK] I started looking at who does what where and started applying to various places. Again, I was late to apply to some places [because of 2 postdocs – MK], but how could I know? People who worked in the same group as me were looking for positions as well, so I learned how the application should look like, what to write, which keywords to insert to make it noticeable. This is a very experimental science. And yes, I applied a lot to many places. I got somewhere around five interviews. These guys were the first to offer me a position. [This university] is a good place, so I agreed. Happy” (Associate Professor, USA)

The Professor’s narrative reveals an initial target as a good, permanent position in the USA. However, the USA was unthinkable of from Russia, and not really reachable from Israel. A postdoc in Germany became a stepping-stone on the way there: he never planned to stay in the country permanently. However, unexpectedly, it was not easy to get a good permanent position in the USA from Germany either, mainly because the Professor had no tacit knowledge of the American job application procedures. It took him another contractual position to learn the rules of the game and to eventually find a position he was satisfied with.

The reputation of the employing organisation, job security (permanent position) and professional network are very significant factors in the narrative. With primary drivers of finding a good research environment to produce optimum research results, career output maximisation strategy follows the combination of geographical and reputational hierarchies in the most straightforward way, detailed as ‘stepwise development’ in Table 11.
With some variation on this, there are three sub-types of career output maximisation strategy. They reflect stages in academic career development, rather than a long-term career development strategy. Capability adjustment and loopy migration are used at early stages of researcher careers, loopy migration done specifically to achieve a permanent position. The ‘greener field’ migration is a late-stage mobility strategy.

**Capability Adjustment**

It is often the case, and certainly was before the Internet became popular, that talented people grab the first opportunity to go abroad, and, to ensure the success, choose risk aversion strategy when it comes to the first move abroad. It was certainly the case around the breakup of the Soviet Union, when very small number of Soviet scientists had experience of communicating with the outside world, and for aspiring students everywhere outside of Russia was pretty much unchartered land.

In these circumstances, the first move abroad had to be very safe. However, after the initial migration, some researchers realised, they could be more competitive internationally than they previously thought, and more mobility followed. This mobility is predominantly national, and it happens along reputational hierarchies. The account of an assistant professor who left a provincial town in Russia in the middle of 1990s to do a PhD in a provincial university in the USA, is illustrative.

"We were very naïve back then. I was the second person who left Saratov, I know it. Of course, we knew that Berkeley and Harvard existed, but we did not date to apply to such places. We should have, to be honest. With our grades we would have probably been accepted. But what comes after Harvard and Berkeley, we had no idea. So in one of the countless brochures I looked through who caught my eye was professor Boldyrev, who is an émigré from Russia himself. His background made sense for me, because he became a Doctor of Science at the age of 34, which is unthinkable, and he taught at MPTI, and I liked his science very much. He was at Utah State University, in the middle of nowhere, in a small city. I had no idea what Logan, Utah, was. I wrote to him whether he wanted a new PhD student. After all, we come from the same environment, and we speak the same language, although our correspondence was in English from the start. And he said: “Yes, I will accept you”. <...>"

‘I never regretted it. I wrote a PhD thesis with him, we published a lot. After that all doors were open for a postdoc to me. The university was rubbish, to be honest. But I had awards on
a national level and publications, and this was the main thing. I went to Yale for a postdoc. After that I started applying for professorship positions”. <...>

‘I applied to many universities, probably, I submitted over a hundred applications during the three years I was job hunting. I had interviews every year, but I didn’t really like places I was getting. <...>

‘These were 3rd tier universities, like Utah State. I have nothing against them, one can prosper there. But after all... At the same time I had interviews in places like MIT and Stanford, where I wasn’t accepter, but I realised what it was like to be among people like that, how tasty it could be every day. <...>

‘So I did not accept any offers I had and moved to a different laboratory [in Yale] for a year. It was a very short postdoc. <...>

‘... and during this time I got myself a husband, anf then I had a baby, and I had a 2 body problem to solve, which is why it took so long. But then, after a perfect storm, I am here. I came here in 2010” (Assistant Professor, USA)

For this Assistant Professor, moving abroad was something like a leap of faith. Being in the information void, she didn’t have any access to information about research organisations abroad, nor networks connecting here with the USA. Therefore, she took a very safe step by going to work with a Russian-speaking supervisor who was well-known in Russia. The reputation of the university was of much less importance than the opportunity to move to the USA. After receiving the doctorate and adapting, she was able to move upwards along the reputational hierarchy in a streamlined career development path.

Having already moved upward to the top of the reputational hierarchy (having adjusted her capability to that of employing organisations’), she was only prepared to move horizontally to other top US universities with the purpose of securing a permanent position. Instead of taking the downward mobility opportunity, she decided to attain an extra temporary position and prolong the postdoctoral career stage.

The new supply of researchers who were willing to accept positions in the US universities was a new pool of talent and expertise that European and the US scientists were able to tap into. With the high demand of post-Soviet scientists seeking positions in the US, some medium-tier universities adopted active recruitment strategies to capture these talented
people and level up their research. It was a win-win situation for lower tiered universities who usually lost the battle for talented domestic students, and for the aspiring foreign-born PhD students and postdocs looking to launch a career in the USA.

**Loopy Migration**

In the US context, it is often expected for a scientist to work in at least one postdoctoral position after completing the doctorate before applying for tenure-track positions. However, there are no strict stipulations about doing the postdoc abroad. While it may be difficult to re-enter the labour market after leaving it, in some cases making a loop – going abroad to take a position in a more prestigious university with the purpose to come back – is a type of stepwise migration strategy that pays off. It occurs mostly at the stage when researchers are looking for permanent positions, initially unsuccessfully in desired countries:

“*I got married in the process of my PhD, and finding employment for the two of us, you know, is always more difficult. My husband was in the same department. We started looking for work together and we found together postdocs in Paris. Me at a university of Pierre and Marie Curie and he in a national laboratory 1 hour drive away. <...>*

‘*during these two years we had the general goal to become professors and find positions in a university. We were constantly applying for positions [in the US – MK], and eventually I received an offer from Colorado university and my husband found a position in Chicago. <...>*

‘*My supervisor forwarded me an email from someone in Paris who was looking for a postdoc. I thought it was very interesting, because it was in Paris and an interesting topic. Literally the next day he sent me an email saying I was accepted. I then mentioned my husband, and he told me that he could circulate his CV, because my husband had absolutely no leads in Paris. After some time he received an email saying that some people received his CV and were very interested. I didn’t really want to go, because it’s a different country, I like living in America, my green card was in the process of making. It wasn’t easy to leave. But he got really enthusiastic about this, he said he needed international experience. So we left. Had there not been this chance, I wouldn’t have looked outside the US. <...>*

‘*In France we had very big problems with the language. Because you really need the language, especially to teach. We also tried to extend positions and so on, but in the end we were applying for next positions in the US” (Assistant Professor, USA)
For this assistant professor, the 2 body problem was a pressing issue in looking for a job after completing a doctorate in the USA. Not separating the family defined her mobility priorities, and drastically limited the scope of organisations she could accept offers from to those that were situated in large cities or research clusters. With this priority structure, she forfeited the desired country of residence – the USA – where she was only receiving offers from remote isolated universities – and moved to Paris, where there were many employment opportunities for both herself and her husband. This mobility was enabled entirely by the professional network.

After spending some time in France, the couple made a loop – and returned to the USA with increased chances to find employment in a more desired location. Doing research in a prestigious school in Paris and getting good research results gave this academic couple a competitive edge and contributed to their chances of receiving permanent positions together back in the USA. International migration, therefore, was used as a strategic tool to gain a better footing in the preferred country of residence, to be able to secure a position in a better research organisation.

‘Greener Field’ Career Development

Finally, there is mobility at mature stages of career development. They appear in different circumstances and for different reasons, but there is a group of scientists who never stop building career development plans that involve national or even international mobility.

It is often the case that after reaching certain stage in the career development, a scientist does not have any further incentives for mobility. For instance, the number of migration moves is reduced drastically after receiving a permanent position. As there is no push for further mobility, many scientists settle down and work in one research organisation for years, and even decades. However, as in any other profession, all researchers reflect about ongoing opportunities, in the words of a prominent UK professor, ‘think about greener fields’:

“Here the science system is very peculiar: it is advisable to change the places of work frequently. Because of RAE [Research Assessment Exercise – MK] universities are trying to improve their scientific ratings by luring scientists over. So for a scientist there is always temptation, always thinking about greener fields.” (Professor, UK)

Thinking about greener fields can be expressed in a variety of ways. First of all, there are always better universities with more resources and better infrastructures. In the UK,
initiatives, such as the Research Assessment Exercise, gives incentives to research performing organisations to continuously keep trying to recruit high quality scientists to enhance research performance indicators. For scientists themselves this often means that many attractive offers are laid on the table, sometimes from organisations you can't say “no” to. They may provide enough mobility incentives for scientists to consider moving on somewhere.

The ‘greener field’ career development strategy is different from the career output maximisation by its intention. In the case with the ‘greener field’ thinking there is often no intention to move for a scientist beyond some considerations. In some cases, mature scientists apply for organisations abroad with the purpose to negotiate promotion in their current organisation. However, being foreign-born and having previous mobility experience, they may be more likely to actually move should the offer be attractive enough.

5.5.2 NETWORKED MIGRATION
Using a network as a primary source and enabler of global scientific mobility. Social network is a source of specific type of ‘migrant capital’, and, as researchers who work in organisations far away from home initially have narrower networks than their domestic competitors, ties with other post-Soviet scientists and alumni is often used in a capacity to search for further opportunities. The two instances of network migration – using solely professional networks and relying on networks of Russian-speaking scientists abroad – are intertwined and are sometimes difficult to distinguish. However, the networked strategy of academic career development, irrespectively of the type of network enabled for career advancement, is a major phenomenon.

Previous narratives in this section already contained examples of using both Russian and not specifically Russian networks for career advancement by the means of mobility. But in fact, a significant share of researchers relied solely on professional networks for advancing their career. Having a network contact was, to some extent, an overriding principle of job search and selection over location or reputation. An illustration of this is a career development narrative of currently Maître des Conférences in France:

“I did my PhD in Moscow. <...> After that I got a job on a postdoctoral project in Germany. It was a big project and I worked for 4 years there from 2001 until 2004. It was a research centre in the town called Julich, quite famous. After that I returned to Russia and I worked for 4 years in Novosibirsk, in the Catalysis Institute. After which – it was from 2005 until 2007 –
and in 2007 I came here. I am here since 2007, in 2009 I received a permanent position, called in French Maître des Conférences. Since then I am here. <…>

'I started looking for positions before I finished my PhD. <…> I met a professor at a conference who later offered me to come to him for a postdoc project. We wrote an application with him together for a programme, maybe you know, it’s a Humboldt programme. I worked on that for 2 years, as a Humboldt fellow, and for 2 more years on local projects. Why Germany? I wanted to work in Germany specifically. Because the research system in general, and people from England told me, is appreciated by its pedanticity and fundamental approach to research. Another strong personal factor was – that the professor who offered me the job, my Moscow supervisor knew him and told me that he was a serious and interesting person who is great to work with. So 2 factors: scientific school and the person. <…>

'When I was starting work I was thinking about coming back to Russia. It was the time to think about some permanent work. I had a chance to go for another postdoc, but I was leaning towards getting a permanent job. When I was thinking about finding work in Russia I of course thought about MSU as a place to go back to, but there was an option at the Catalysis institute, because I knew my former boss, we crossed paths at conferences and we had a joint project when I was in Moscow, and my Moscow boss recommended her. So I went there to work. <…>

‘In 2007 I got married. My wife had a job in Stuttgart, so I started looking for work near Stuttgart. The most viable option was [here]. <…>

‘I haven’t mentioned – a big role was played by the fact that firstly my boss from Novosibirsk came here. She came here in 2006, in think, received a position here in 2007. She started assembling a new electrochemical group here, and when I told her that I am looking for a position close to Western Germany she told me that there is an opportunity to work here with her and then maybe to stay here on a teaching position. And then it happened in the way it did” (Maître de Conférence, France)

The underlying reasons for mobility of this France-based scientist were a mixture of professional and personal reasons. At earlier stages he was more interested in getting work experience abroad and was looking for opportunities to come to Germany, without any specific long-term plans. Later, an opportunity at home became more attractive and he
returned. Personal factors later ‘pushed’ him to search employment abroad once again, but it was the professional network that enabled the move. This somewhat spontaneous career development enabled entirely by professional network, has yielded the desired result for this Maître des Conférences, who intends to grow professionally within the French research system.

5.5.3 LIFESTYLE [NON]MIGRATION
Personal reasons and motivations can be a deciding factor in migration decisions, as illustrated earlier. The [non]migration strategy defines researchers for whom non-professional reasons became the prevalent reason of their career choices throughout their career histories. Usually personal and family reasons are attributed to factors inhibiting mobility: there are accounts, pensions, schooling, spouse’s job and other issues that affect the degree to which a person is mobile. Sometimes personal factors can ‘push’ mobility, as illustrated above.

Predictably, family factor quickly becomes a big demotivation for further onward migration once the permanent position for both spouses in one locale is found. The reason why this strategy is called [non]migration is because lifestyle is as often a factor preventing further mobility as it is not. Lifestyle is a factor that may have a structuring influence on the entire career path of a researcher.

“I came here as a postdoc in January 1991. I considered myself a Visiting scientist. I spent 1,5 years here, we were writing a very big review. Then we came back to Moscow because we were patriots and we thought: “No, we are not going to desert our country”. But in 1992 we came back [here – MK] again. <..>

‘I came here and we wrote me down as a ‘postdoc’ for the migration services, e.g. as someone who came here to study. After a couple of years, around 1998, I received a permanent position, akin to ‘senior scientist’. In 2003 I became Privat Dozent, which is the next stage. It is quite a funny position, because it is like a person from the side, an external person, who can teach at the university. <...>

‘At some point I had offers to move, firstly to Caltech, and also to Grenoble. <...>

“I was looking for positions, about 15 years ago. But I have somehow grown roots over here and I haven’t been looking for many years now. When the question was topical, there were a lot of difference factors, including family reasons, and many of them were lifestyle, not
connected with [my current employing organisation – MK]. For example, there are mountains here. I do a lot of mountain climbing, it is an important part of my life. There are also mountains in Grenoble, possibly better ones as well, but [here] pays better, more than anywhere else. I have a good salary for my position. I know everyone over here, but over there are new and unknown people. And if I do move I will be in a comparable position of “research scientist”. I also speak the language” (Privat Dozent, Switzerland - reconstructed from notes)

Privatdozent is a non-leadership permanent position. This researcher went through years of precarious positions in a top Swiss university, but the lifestyle made it all worth it. Eventually, maximisation of career outputs did not matter to him as much, because otherwise he would have to move onwards and abandon the living environment he valued to a very high standard. In this example, country priority overrides reputation priority and becomes the driving force of scientific [non]migration.

Despite all complications, this scientist could still be a part of an international highly professional research group in a university with very good reputation. At the same time he was able to have great work-life balance and dedicate a lot of time to a favorite hobby.

5.5.4 GLOBAL TROTTING STRATEGY
‘Global Trotters’ are lifestyle migrants whose rise has been noted along with the rise of inherently mobile cosmopolitan elites, creative professions, and the new nomads (Inkson and Thorn, 2010). Academic profession, just like any other career that eases mobility, is an opportunity for some researchers to satisfy the natural curiosity about living and working in multiple countries, especially at early stages of their career development.

In contrast with career output maximisation strategy and a networking strategy that can also incur high intensity of international migration, personal lifestyle choices are put to the forefront of career-based decision-making. Most of the ‘global trotters’ eventually settle down after a while and manage to find permanent positions, but they tend to be among those scientists who spend the longest before eventually securing a tenure-track route in a respectable US university. Such is the example of the current associate professor employed in a 2nd Tier university in the USA who visited 5 countries in the course of his career:

“I graduated from the Moscow Institute of Physics and Technology in 1991. This was my first step. Then I did a PhD in Moscow in the Institute of Theoretical Physics. After that I entered a
graduate programme of the University of Utah Salt Lake City, I studied there for 2 years, I think. In 1995 I got my PhD from Utah University. After that I went back to Moscow and worked there for about half a year, I think. After that I worked in Kharkov in the Physics and Technology Institute. Officially I worked there until 2000, from 1996 until 2000. After that I worked for 2 months in India, no, 3 months. Institute of Mathematical Sciences in Chennai. My next official job was – I was invited to England for a year to the University of Exeter. After that there were small invitations in Germany – I was a visitor for a couple of months. Then I went back to America and got a job at the University of Utah Salt Lake City. I worked there until 2004, and in 2004 I found this assistant professorship position, I am here now. <…>

‘I will be staying here until my children grow up and finish school. Moving with family has big limitations. After that, maybe, I will move again’ (Associate Professor, USA)

This case study is unique among the researchers, firstly, because nobody else went to work to the post-Soviet country other than the ‘home’ country. Secondly, this is the only scientist among the 66 interviewed who went to another developing country to work. And although he had to leave India after a couple of months of bad climate and alien culture, the motivation of personal curiosity is dominant in his career development strategy. Global mobility opportunities of scientific profession enables the satisfaction of this curiosity.

5.6 CONCLUSIONS
Scientific mobility is happening on a global scale. Globalisation of ALMs sees routinization of scientific mobility and incorporation of mobility elements by scientists looking to advance their careers, enhance their employability, or resolve personal and professional dilemmas. For most participants of this study, mobility has become an invaluable part of their identity and career development.

The core finding of this chapter relates to the role of national borders in SMTs. As this research builds on the push-pull migration factor analysis, it confirms the general importance of previously named factors for scientific migration. However, the need to add extra factors on the organisational level reveals the shift in relative importance of these factors for different types of moves. Mobility incentives of research organisations become a powerful push factor that stimulates not only national mobility, but, in foreign-born scientists, also international migration. SMTs are aligned with plans of host research organisations to attract and manage talent.
Global mobility flows are supported by a variety of institutions, some of which are non-national, but others are nationally bounded. Institutions of scientific mobility in each country are integrated in the general institutional configurations that govern academic community, many of which are of crucial importance for building a successful academic career, but are not a part of the mobility framework. Globally mobile scientists come to these national systems with prior limited knowledge and understanding of the system and face the challenge of adaptation.

Ultimately, they may be global trotting and ‘try’ various academic systems, but the majority makes their moves to countries that they perceive as being either familiar to their previous experiences, or the ones that they perceive would be possible to adjust to. The next chapter of the thesis discusses the proximity of academic cultures in case study countries compared to the Soviet Union/Russia and outlines adaptation issues in more detail.
CHAPTER 6 ACADEMIC PRACTICE

6.1 INTRODUCTION
This chapter assumes the micro-level focus and analyses the relationship between academic practice and global scientific mobility. More specifically, it uses the concept of ‘academic culture’ to label differences in the rules of social membership of geographically dispersed academic communities. The chapter sets off by outlining the commonalities and differences of academic cultures in the Soviet Union and post-Soviet countries, comparing them with academic cultures of the USA, UK and Germany. It proceeds to outline the problem of changing academic culture for scientists who experience scientific mobility.

The second part of this chapter focuses on effects of degrees of adaptation to the domestic academic culture among interviewees. This is framed as a problem of adapting culture for practice, or practice for culture, when the two clash. While there are three main options for resolving this clash – conservation of domestic identity, development of plural identities and shift of identity – these are enacted in a number of academic practice strategies. The chapter is concluded with implications of the resulting strategies.

6.2 VARIETIES OF ACADEMIC CULTURES
Relativist epistemologies suggest that knowledge is circumstantial and depends on many social aspects, such as the time, the society or culture (Lin and Law, 2014). In more extreme views, the existence and the truth of knowledge is defined in social interaction, and facts are constructed among the participants of the process, and are redefined in further iterations, sometimes with changes in meaning (Latour, 1987). There are shared features specific to the scientific profession. For natural sciences, they include general self-governance of research institutions in terms of agenda-setting, construction of scientific facts based on evidence accepted in the research community, and particular ways in which research results are communicated and disseminated. However, variations exist among institutional arrangements of scientific research, science management approaches, especially in terms of allocating and handling research funding, and cultural norms.

National academic cultures that exemplify ‘cultural bias’ of academic research prescribe specific patterns of behaviour for achieving success in the social community that is academia. Academic culture is seen to have two functions: first, it delineates the boundaries of academic activities, which provides the scope for the development of academic identity.
Second, norms of academic culture provide the rules of social membership in academic community, which determine prestige and recognition of individual members of the community. As there is limited understanding of how different national academic cultures are structured, this section develops a comparison framework based on the interview data. It analyses academic cultures on the national level, as the data is scarce to provide regional and organisational differences.

Soviet/Russian academic culture is presented as the backbone of the analysis and is then compared, in the experiences of the interviewees, with other academic cultures. Articulations of academic culture in host countries were not as common for the interview participants. However, it is possible to distinguish some traits across the case study countries that combine aspects of practice, institutes and norms of national academic cultures. The list of these parameters is not conclusive and is used to highlight the differences with the Russian research culture that may indicate greater or lesser adaptation challenge.

Table 12 integrates the elements of national academic cultures related to the research context and to the research process. The following part of the section, first, outlined general features of academic cultures. Then the discussion centres on boundaries of academic practice, which forms one element of academic culture of special interest in this research. The Research Compass Card model is used as a general classification.

6.2.1 General Scope
General features of national academic culture are closely related to the institutional organisation of scientific research in a country, and to the rewards and incentives system. The following pages discuss academic career structures, hierarchisation, mobility expectations, funding principles of national academic communities and the corresponding elements of national academic cultures. These form contextual and ‘social’ elements of research process.

Institutional and social set-up of academic community in the Soviet Union differs from the set-up of countries of Western Europe and the USA. Interviewees were less keen to report on commonalities, usually giving a statement that “[i]t is easy to adapt to good things” (Assistant Professor, USA) without further elaboration. It is fair to suggest that the differences in academic cultures are the cause of behaviour change of Russian-speaking scientists.
<table>
<thead>
<tr>
<th>Type</th>
<th>Elements</th>
<th>USSR</th>
<th>USA</th>
<th>UK</th>
<th>Germany</th>
</tr>
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<tr>
<td>General</td>
<td>Academic Career Structure</td>
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<td>1-step</td>
<td>1-step</td>
<td>2-step</td>
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<td>flat</td>
<td>mixed</td>
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<td></td>
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<td>competitive-NSF, DPD, DE</td>
<td>competitive -RCUK</td>
<td>bloc/competitive</td>
<td></td>
</tr>
<tr>
<td>Certified</td>
<td>Goals of Science</td>
<td>Science for the sake of</td>
<td>Mixed</td>
<td>Public Good</td>
<td>Mixed</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Research Focus</td>
<td>One topic for life</td>
<td>responding to policy</td>
<td>regular shifts, with mobility</td>
<td>mixed</td>
</tr>
<tr>
<td>In-group</td>
<td>Communication</td>
<td>Hierarchy - prestige</td>
<td>Individual responsibility</td>
<td>relative autonomy</td>
<td>relative autonomy</td>
</tr>
<tr>
<td>Community Networks</td>
<td>Strict Organisational and Disciplinary Divisions</td>
<td>Inter-organisation and inter-disciplinary networks</td>
<td>Inter-organisation and inter-disciplinary networks</td>
<td>Some divisions into research Societies (MPI, HZ, FI)</td>
<td></td>
</tr>
<tr>
<td>Division of Labour</td>
<td>&quot;Jack of all trades&quot;</td>
<td>Admin and technicians</td>
<td>Admin and technicians</td>
<td>Admin and technicians</td>
<td></td>
</tr>
<tr>
<td>Publication Intensity</td>
<td>low intensity-high precision</td>
<td>high intensity</td>
<td>high intensity</td>
<td>high intensity</td>
<td></td>
</tr>
<tr>
<td>Between-Group Communication</td>
<td>Independent Work</td>
<td>High</td>
<td>High</td>
<td>Independent Work</td>
<td></td>
</tr>
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<td>PG only</td>
<td>UG and PG</td>
<td>UG ad PG</td>
<td>Varied depending on organisation</td>
</tr>
<tr>
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<td>Broad and Fundamental</td>
<td>self-selected</td>
<td>self-selected</td>
<td>Broad</td>
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</tr>
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<td>Public Science</td>
<td>Only Elite, 'ivory tower'</td>
<td>Policy Debate; Deliberation</td>
<td>popular and heterogeneous</td>
<td>Mainly informing</td>
</tr>
<tr>
<td>Proprietary Knowledge</td>
<td>Proprietary Knowledge</td>
<td>weak protection, not preferred strategy</td>
<td>IP Offices, assistance</td>
<td>IP Offices, assistance</td>
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</tr>
<tr>
<td>Commercialisation</td>
<td>Glorification of theoretical 'non-applicable science'</td>
<td>Highly dependent on an institution, popular</td>
<td>popular</td>
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<td>&quot;Good&quot; Technologies</td>
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<td>core</td>
<td>core</td>
<td>desirable</td>
</tr>
<tr>
<td>Science Advisory</td>
<td>very top only</td>
<td>available</td>
<td>popular</td>
<td>segregated</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 Varieties of Research Cultures and Practices

Source: author
Academic career structure relates to the inclusion of new members in the academic community. In the USA and the UK it is a 1-step structure, where the receipt of a PhD is the only qualification that needs to be obtained and recognised by peers in order for a researcher to launch a career in science. In contrast, Germany and the USSR/Russia have a two-step system, where an additional ‘second doctorate’ is required for scientists to obtain autonomy and independence. The ‘second doctorate’ is acquired as a sign of maturity and accomplishment in academic career of a scientist. It may take over a decade to complete the process.

Post-Soviet academic communities are still distinguished by high rates of hierarchisation. Not only were research and administrative careers fused in the context of scientific career, reaching their pinnacle at the position of an ‘academician’, but also the management of property and funding was distributed vertically in the Soviet Union, and, to some extent, in the modern Russia as well (Graham, 1998). Among implications of this system are low levels of personal autonomy in research and low rates of the participation of scientists in the political system. Due to its closed and hierarchical nature, the conversion of symbolic capital of scientists into the status in the political field was extremely limited.

Another aspect of hierarchisation is the degree of autonomy among middle-rank scientists to select their own projects, rather that work as a part of larger groups. While the British system is somewhat stricter than the US system, in Germany there are two pathways available for academic career, whereby the acquisition of the ‘second doctorate’ greatly increases autonomy, but not taking this path greatly restricts the autonomy as well as the prospects to obtain it.

The issue of mobility expectations relates to existing institutional incentives of academic mobility. The Soviet Union was a country that rewarded lifelong employment of scientific personnel. It was expected that a scientist would continue working in the same laboratory starting from doing undergraduate projects and up to the retirement. This practice cultivated loyalty not only to the employing organisation, but also to the set of methods, approaches and hypotheses that came to be called ‘scientific schools’.

Among interviewees of this study, some maintained negative attitude to mobility after relocating to systems with high mobility incentives (see Chapter 5), and their career development was eventually delayed or hindered. Other interviewees exploited this trait of
academic culture by recruiting post-Soviet graduate students, who were less likely to change supervisors or move elsewhere.

Finally, Soviet and post-Soviet funding allocation system has been distributive: funds are allocated to various organisations by the government and are distributed within these organisations according to the needs of research collectives. Case study countries demonstrate an alternative approach, which is competitive funding. In this system, scientists write proposals of research projects and compete with their peers. The German system is more complementary to the Soviet/Russian system, because it is the only major European country, where certain types of public research organisations receive bloc funding. In the US and the UK the funding system is highly competitive.

Moving from a system of distributive funding to a system with the competitive funding structure reveals the lack of a core skill of proposal writing in the post-Soviet scientists:

“The main organisational problem of scientific activity that everybody has to tackle is learning how to write proposals that get funded. <...> We in the Soviet Union got used that we are just given money and are not asked what we spend the money on. Here, there is state funding, and we need to fight to increase it” (Associate Professor, USA)

While writing successful research proposals is a challenge, for many interviewees it also is a time wasted that could be spent on doing research. Several interviewees chose to pursue academic career options where funding proposal writing was not essential.

6.2.2 PRODUCTION OF CERTIFIED KNOWLEDGE
The elements of academic practice and culture that are included in the group ‘certified knowledge’ relate to the contents of the research process that is compared across the countries. Features of academic cultures that relate to the research process start with the Goals of Science – the source and the purpose of research in the society. Research focus reflects cross-disciplinary mobility of scientists and the willingness to take up new topics and venture into new research areas. Patterns of scientific communication are reflected in the In-group communication and between-group communication aspects of academic culture, as well as in expected publication intensity. Finally, community networks and the division of labour among scientists are discussed.

First of all, the drivers for the Goals of Science are different in research cultures. In the UK there is a strong drive from the policy and the public to inform and influence academic
research both in terms of the criteria of funding applications controlled by Research Councils, and in terms of local communities, artists and social scientists (Boden et al., 2004). The US and German systems are mixed, and the goals of science in terms of the purpose of research results and the drivers of research agendas are varied depending on the region and on the type of organisation, and even depending on the type of source the funding is sought from (Wang and Shapira, 2015). The Soviet Union/Russia is yet again an extreme case of a country, where science is informed by previous research and is done for the sake of science.

Soviet and post-Soviet scientists not only focused on research, but the focus of their research was informed by exclusively previous research to a large degree. As science funding was distributed centrally from the top of the Academic hierarchy, there was never need for the majority of scientists to justify their research agenda to public funders. Low intra-institutional mobility and lifelong employment in the same organisation prompted rigidity in research agendas.

Not only had the scientists to be loyal to their employing organisations and ‘scientific school’ research traditions, but continue to incrementally build up their own contributions within these traditions. New research emerged on the basis of previously received results within the ‘scientific school’ and its results looped back into the development of the same school. There was rarely any impact on the world outside of the ivory tower. Research ‘for its own sake’ was praised (David-Fox, 1998).

These social circumstances have engendered a specific pathway in which new topics were selected and developed within the Soviet and post-Soviet research process. In the first instance, there is a hierarchy of disciplines and a hierarchy of research topics. Theoretical disciplines, especially physics and mathematics, held dominance at the top of the research pyramid, and more applied disciplines, even sub-disciplines within physics, are much less prestigious and are, therefore, uninteresting:

When I moved to Israel [in 1993 - MK] I switched to soft matter physics, which was quite a big change of my topic. In Moscow it was thought about as a very marginal science: very few people did it. This is polymers, liquid crystals. <…> The school of theoretical physics was focused on electric properties since the times of Landau [Soviet theoretical physicist, 1962 Nobel Prize Laureate – MK]. This is why everything that concerned non-quantum effects was very marginalised. <…> I remember [my Professor’s] commentary after a seminar on liquid crystals: “It is surprising to know that one can do something serious in this area!” (Staff Scientist, USA)
The perception of some areas of science as ‘marginal’ by senior researchers who managed finances in research institutes of the Soviet Academy of sciences resulted in uneven distribution of funding across research areas and topics. The most prestigious research areas attracted the most talented young people, many of whom eventually shifted to other topics and even disciplines, after they relocated abroad and found themselves in research areas oversaturated with post-Soviet scientists. While in Russia scientists tend to maintain continuity of research topics with a strict hierarchy, in other countries scientists’ agendas are much more responsive to the changes in the political and social context, to the point of adopting ‘hopping’ strategies of changing research agendas frequently and doing research where many funding opportunities are available.

Various types of communication are at play in the organisation of the research practice, among which in-group communication is distinguished: distances between senior and junior researchers, research hierarchies, and communication between theoretical and experimental scientists. Among the Soviet scientists these distances tend to be longer, in accordance with hierarchies based on prestige and qualifications of researchers. Often contrasted with the British ‘culture of praise’, Russian peer-to-peer scientific communication has often been described as one-directional, critical and uncompromising. The US context maintains individual responsibility of scientists for the results of their research, and shorter communication distance. The UK and the German context maintain relative autonomy of researchers with longer distances between professorial-level scientists and middle and junior level scientists.

When it comes to the communication with external groups and different disciplines, the US and the UK context demonstrate high effort in integrating different disciplines and fields of natural sciences and fostering interdisciplinary research. There is significant policy effort in both countries. In Germany research is organised in research societies, who have limited communication among each other, and more barriers exist. The Soviet/Russian academic culture demonstrates the development of strict disciplinary divisions. Competing scientific schools refused to compromise their vision of ‘truth’ and admit the existence of other centres of excellence, and communication between different disciplines was not rewarded by the institutional structure of Soviet research.

The Russian science is still highly isolated in terms of communications with external research groups and disciplines. Communication within one area of research highlights the preference
of Soviet and Russian scientists and collectives towards independent work: multiple previous studies have highlighted the leaning toward lower rates of between-group collaboration in Russia (Karaulova et al., 2015; Oleinik, 2012). Similar trends are observed in Germany, while the British and the US research cultures lean towards more joint and collaborative projects between groups and organisations.

As a result, academic community in the Soviet Union and, partly, contemporary Russia, has developed to look like an agglomeration of very loosely connected research organisations that converge and communicate only in the top level. Circulation of scientists among research-performing organisations was low; there were very few interdisciplinary and inter- organisational links. Concurrently, many skills that a scientist has in Western Europe and the USA, such as presentation and self-presentation or communicating research to lay audiences, were not required and therefore virtually nonexistent among the Soviet and post-Soviet researchers.

**Low publication intensity** and the **limited division of academic labour** stand out as particular characteristics of the Soviet system. In the circumstances of low intra-institutional mobility or collaboration, there was no significant need for the Soviet researchers to communicate their results outside of their immediate research group. Therefore, publications were only produced if a significant discovery was made, which could be as rare as once in several years. Additionally, the style of oral and written presentation of research accounts had come to differ as well:

> “Science results in the USSR were communicated by the mediums of papers and conference presentations. The papers were usually concise, whereas the presentations were lengthy and detailed. In the US the situation is the other way round: the papers are detailed, but are also written in a style that is easy to comprehend. Conference presentations here are crème de la crème, only the best results are presented in a concise manner” (Professor, USA)

Finally, the practices of fundamental training and carrying out thorough and detailed research inform specific practices in how post-Soviet scientists produced **public accounts** of their research activity. American and Western European labour markets are distinguished by high mobility and high competition. In recent years, more and more research organisations employ ‘publish or perish’ approach (Fanelli, 2010) that enacts strict research performance assessment criteria, the top one being regular publication activity. In this approach, journal publications essentially become a merit of research productivity (Leahey, 2007). Frequent
publication of research results is therefore encouraged for all researchers. These outputs have the impact on promotion and tenure, employment of junior researchers, and on the overall performance of research organisations, that are ranked nationally and internationally. This pattern of publication of research results has its inverse side (Rogers, 1999), which manifests in practices, such as ‘salami slicing’ (thinning out research results to multiple publications) and ‘shotgunning’ (applying to multiple journals with the same article in hopes that one will publish it).

In all three case study countries high-level public research organisations, and some medium- and low-level ones offer a spectrum of administrative support to researchers, from secretarial workers who manage research expenses, purchasing samples and new equipment for the laboratory, to technical staff who operate and maintain the equipment, assist in proposal writing, and other activities that do not require unique scientific expertise. Post-Soviet scientists remain ‘the jack of all trades’ in terms of devising experiments, operating the equipment, and analysing the results.

**Scientific Discovery and Creativity**

This context of research does not facilitate creativity in the sense that’s become conventional in among social studies of science recently (Florida, 2005) in the sense of diversity and heterogeneity that facilitate new combinations and ‘outside of the box’ thinking. The Soviet ‘recipe’ to scientific creativity was, first, coming out of the broad training and thorough investigation of a very narrow research area for a prolonged period of time. This broad knowledge was a key to uncovering previously unseen underlying mechanisms and rules in systems under examination.

Another side of the Soviet and post-Soviet creativity comes from the over-bureaucratisation of research activity in the Soviet Union and post-Soviet lack of resources and funding. Post-Soviet calamity of underfunded institutes, outdated equipment and cut state funding of science have led the scientists to be **inventive** with their experiments. Overcoming bureaucratic hurdles and lack of resources in unconventional ways sometimes results in receiving unpredicted and curious results.

Preparing for conducting thorough research throughout the whole duration of one’s career is something that requires **broad and fundamental training** in the discipline. The breadth of academic knowledge of Russian-speaking scientists is a great advantage on the globalising
academic labour market, and is recognised of mature researchers as an advantage in student graduates of a selected pool of elite Russian universities to date.

6.2.3 Broader Academic Activities
A dividing line between academic cultures of post-Soviet countries and academic cultures of countries of Europe and the USA is drawn around the boundaries of the scope of academic activities. The Soviet and, partly, Russian academic culture limits the acceptable range of academic activities to straightforward scientific research only and does not routinely include any forms of teaching, outreach or collaboration with industry (for details refer back to Chapter 4). The type of academic identity that includes multiple types of activities is inherently alien to post-Soviet scientists.

For example, researchers in laboratories only encountered students at the stage of postgraduate Master-level training, which was attended to as a form of tutoring. Professional educators, not active scientists, have been doing teaching in universities. Most of the other countries in the world put some teaching responsibility on professorial staff. In the US and British universities most of research staff also perform undergraduate as well as postgraduate teaching, and it is institutionalised within the scope of professorial responsibility. In Germany, the teaching is divided. In the words of a Scientist employed in a Max-Planck institute, “there aren’t many incentives” for them to collaborate with the nearby university (a leading technical university in Germany), or to communicate with students specifically. Only university staff engages with undergraduate and postgraduate students, and this is not an obligation, but rather a choice for scientists employed in permanent non-leadership positions.

In terms of training of the students, numerous interviewees compared the education of American and British students negatively with the fundamental and broad training of post-Soviet students. The practice of narrowed curriculum and self-selection of subjects to study within the US and British systems is distinguished from the German system, where there is also gradation of students by the ability, but with more class hours and compulsory subjects, the German system gives more fundamental training.

There still is no accurate or established translation of ‘engagement and outreach’ into Russian. The Soviet and the post-Soviet science had a very narrow mode of contacting the wider audience, which was almost entirely about publishing popular science books and journals, hereby informing the public about advancements of science.
As it is a relatively recent initiative in many countries, this aspect of the academic compass card is still strongly driven by policy and public funding sources in countries, such as USA and the UK. Other countries, such as Germany, do not implement hard power tools to influence researcher practice profiles. Therefore, while the communication between scientists and the public is multi-level and heterogeneous in the UK, the German way of communication mainly takes the shape of informing the public about research results.

**Links with industry** – project-based, consulting and institutionalised forms, when a company, for example, co-funds a research laboratory – are very widespread across the USA, UK and Germany. Large and specialised universities have technology transfer offices, IP protection offices and other core infrastructure to assist scientists who work with industry partners. This is in contrast with the widely reported weak IP protection in Russia and other post-soviet countries and IP conflicts between scientists and employing universities. Furthermore, science in Russia is still highly theoretical, and, in the post-Soviet tradition, applied or commercialisable research is looked down upon.

The same general trend is observed in the relationship between the science system and the political system of the countries. ‘Good’ technologies – the ones that benefit society and are prioritised by the policy – are often at the core of research in the US and the UK. It is partly due to the high level of embeddedness of science in the societal issues and discourse, and partly due to close links between science and industry. Some German institutions, such as Helmholtz Society institutes, do not necessarily follow changing priorities of policy and industry, whereas others, such as Fraunhofer Institutes, must follow them closely.

Finally, with regard to science advisory functions, where the Soviet/Russian research hierarchies only converge in the top, the academics play active role in the policy development at all levels, up to incorporating societal concerns in daily reflectivity (Upham and Dendler, 2015).

**Varieties of Research Cultures and Scientific Mobility**

When a globally mobile scientist decides to relocate to a different country and has a selection of offers from developed economies with excellent legacy of scientific research, where the living conditions are high as well, the choice of eventual location depends on minor things, such as the type of research contract, the topic, the type of position, or, indeed, the similarity of research cultures between the home and the host countries.
Moving to a place with a similar research culture brings less adaptation challenges, and, therefore, less hurdles and costs less in terms of advancing the research.

Overall, there seems to be more similarity between the Soviet/Russian and the German research cultures and practices than with the US or British systems in terms of the hierarchies and the structure of scientific community; the variety of practices that constitute academic identity, and other core parameters, such as the existence of organisations that do not require proposal writing skills. There is a historic background to this similarity, because the institutional structure of research, along with the idea of the Academy of Sciences, was borrowed by Peter the Great from Germany in the XVIII century (Lipski, 1953). German-born scientists constituted large part of research community in the Imperial Russia throughout its existence, until the Revolution of 1918. Similarities between the two countries remain, and when Russian scientists relocate to Germany, there are fewer ‘alien’ elements to the academic practice that they have to cope with.

Coping with unfamiliar research environment may become a serious cultural challenge. For instance, several scientists who held positions in Japan complained about the local culture and the norms in the laboratory environment, from walking in socks to working incredibly long hours. One senior Professor, now working in the USA, left Japan after only 5 weeks, because the culture shock was too great and was impeding his research. He finds that “America is indeed different from the Soviet Union as well, but it is similar in some ways”.

Incidentally, Russian nanoscientists in Russia collaborate with German scientists more than with scientists from any other country in the world (Karaulova et al., 2015), but the science diaspora is the most numerous in the USA, as highlighted in Chapter 5 of this work. A similarity of research cultures may be an indicator of possibly converging interests and aligned goals of science, which can be points of contact between nationally dispersed scientific communities. With the global mobility of researchers, there are other factors at play, and similar culture is far from being a decisive factor of mobility to the country. After relocation, however, the issue of coping with differences in research cultures, by adapting to the local context, or by preserving own familiar ways, becomes nascent.

The varieties of academic cultures reflect changes in values, expectations and attitudes between various approaches to research process and the accompanying norms and institutions. Conflicts between elements of domestic academic culture and academic culture
of host countries and organisations are seen as the core of the identity-practice conflict, examined further in the chapter.

6.2.4 Changing Research Culture After Relocation

Depending on the academic culture parameters of various countries, it can be easier or more difficult for scientists to adapt to the local environment. An inverse relationship with that would be the incentive to adapt, e.g. the more similar the environment is, the less need a scientist feels to change the research culture.

There are multiple factors that may be significant in the eventual change of academic culture and shift towards adaptation to the new environment. Among them are academic age – the career stage at which relocation occurs; available diaspora knowledge networks; career development ambitions; and the existence of particular orientation of host research organisation.

The choice of the strategy depends on the variety of factors, but mainly on the ‘academic age’ of the researcher at the time of migration, on the degree level with which a researcher left the country of origin, and on the research collective in which the researcher is working abroad. Completely adapting to the new academic culture by assuming a new academic identity is more likely to happen with younger scientists who moved abroad. As they are in the process of learning how to be a member of scientific community, they learn some of the research practices and attitudes from scratch and assume as their own.

When the challenge of coping with the new environment is present, especially in the circumstances where the local research culture is unfamiliar, but international competition for permanent positions in research organisation is high, the role of diaspora knowledge networks, both in the host country and globally, becomes important for adaptation. Some of the more prominent cases of ‘scientific diaspora’ when scientists constructed spaces that were comfortable for them to operate in, and rejected norms and values of the host research systems, occurred at times when entire laboratories, research groups moved abroad in the beginning of the 1990s. In these cases professors had the privilege of reconstruction of practices they were favouring in the USSR with the same group of researchers, but in the environment of better finding and equipment.

Career development ambitions is another powerful driver of adaptation. In most academic communities, it was possible for scientists to preserve their preferred way of work in terms
of the contents as well as context of research. However, recognition within academic community by means of receiving awards, or promotion in the career ladder, happens when the broader membership rules are fulfilled, and the foreign-born scientist demonstrates the ability to integrate in the new environment. In this sense, career development opportunities become an incentive for adaptation, and certain tradeoff exists between adaptation to the host academic culture and career development in the host country. However, the process if more complex and will be discussed in detail below.

Finally, university orientation plays an important role in adaptation. University orientation refers to a stated focus of the employing public university towards the production of certain type of knowledge. Therefore, organisational policies of this university prompt scientists to broaden the scope of their academic activities towards commercialisation and technology transfer (entrepreneurial universities), teaching, or towards becoming public intellectuals. The impact of this orientation was expressed in interviews, when study participants named university guidelines as the reason why they were taking part in certain type of activity, making it clear that otherwise this would not be the case.

Post-Mobility Adaptation

For many post-Soviet researchers international migration and the new academic practice became a serious challenge. They faced the task to not only acquire the necessary competence to reach high level of social membership in the host organisation’s and country’s scientific community, but also possibly amend their academic research practices (focus, topic selection and change, communication of research results and producing public accounts, and others) to achieve this desire standing.

A seemingly simple problem of assimilation or conservation therefore becomes a core one, because foreign researchers have imbalanced set of competences: their knowledge and network connections of the local environment are lacking, but their knowledge and networks of the environment they left exceeds the level of an average researcher in the host country. Leveraging this ‘migrant capital’ (Erel, 2010) can be a way to accelerate professional development and career progression of internationally mobile researchers.

Adapting and completely changing the way in which scientists do research may seem like an easy way to acquire social membership in the new scientific community, but it may not be as straightforward. While some knowledge of the local research culture is required to enter the scientific community and secure social membership by, for instance, receiving a permanent
position, diversity and heterogeneity of approaches are celebrated within the community (Van Noorden, 2012). Therefore, maintaining some of the Soviet or Russian research culture after relocation abroad may be beneficial for a researcher and can be regarded as a competitive edge over other scientists.

Academic culture is fluid. There is much diversity in local research cultures within the Soviet Union, as there is diversity in research cultures across regions and types of organisations in all other countries, and also across time. However, the general rules of broader membership in the scientific community stand, have national specificities, and pose a challenge to the newcomers. The following section investigates these issues but, first, outlining the types of academic identities of globally mobile researchers, and second, by looking at the link between the type of identity and the scope of academic activity of the researcher in the practice profile.

6.3 ACADEMIC IDENTITIES AND PRACTICE PROFILES
This section moves on to discuss the tacit assets that globally mobile scientists bring with them when they relocate to a new country or organisation. I classify these assets as ‘academic identities’, which identify mobile scientists as carriers of a particular type of academic culture. Identity and culture are linked inextricably with each other, but there is room for adaptation and change. In this chapter, I focus on the type of change that occurs within academic activities of scientists as described in practice profiles. The previous section highlighted an extremely narrow scope of activities classified as ‘academic’ within the Soviet culture, in contrast with much broader scope in academic cultures of fieldwork countries.

6.3.1 ACADEMIC IDENTITIES
The majority of the study participants chose to adapt for their new roles in one respect or another, with either maintaining most of the familiar ways, or bringing in their heritage of scientific upbringing into the practice of host organisations.

A minority of scientists chose to either adopt a completely new academic identity post-migration, embracing the values and practices of the host research system and organisation, or decided to not change anything, remaining true to their previous way of life, sometimes even being aware that such behaviour was not the best for the career development or research performance.

The three types of adaptation for coping with conflicting academic identities are depicted in Figure 17. These types are Conservation, Plural Identities and the Identity Shift. The concept
of identity, discussed in detail in the Conceptual Framework development (Chapter 2), is used explicitly here to outline the discrepancies between self-perception of globally mobile researchers and their resulting practices and strategies.

The core difference between the three groups is the attitude to the background and training, as well as to their ‘native’ research culture. The differences in these three modal types of identities affect the ways in which researchers approach and organised their work, as well as the roles they adopt and the corresponding practice profiles they exhibit. These identities are constructed individually by each scientist as a result of their life-course history and are influenced by their established individual work identities (Walsh and Gordon, 2008), as well as their cultural identities (Chew, 2014).

Maintaining elements of this domestic ‘research culture’ and, therefore, elements of this particular occupational identity, does not equal maintaining affiliations and links with the home country. In transnational research communities links can be maintained between overseas diaspora members or the identity may be maintained in the form of following the norms and values of the domestic research culture, even is a researcher is out of touch with other Russian-speaking scientists.

Figure 17 Academic Identity Adaptation Types

Source: author

Maintaining the domestic research identity is termed here as ‘Conserved Identities’. This academic identity describes the type of behaviour when scientists maintain practices and strategies of their domestic research cultures in their routine academic work. These may relate, broadly, to self-identification as a ‘Soviet’ scientist, to the norms and values of the Soviet training and research practice, or to the practical employment of activities outlined in the previous section. As a way of illustration, the following opinions of a research professor currently residing in the USA, demonstrate this type of identity:
(responding to a question about commercialising own technology) “We are, after all, from the Soviet Union. Business is an exploitation of other people’s labour, psychologically. We have a different upbringing. I grew up during the times when ‘business’ was a swearword. I maintain psychological deterrence from this activity. University is a non-for-profit organisation, so, from the communist point of view, there are no rule violations”. <…> “America is a free country. Here people with all kinds of religions can live comfortably, including the communist religion”. <…> “One needs to go by the rules taught to him in the childhood, otherwise it is easy to go crazy!” – “I felt that it is not for me, changing something, it is an issue of self-preservation” (Research Professor, USA – reconstructed from notes).

Following familiar rules and patterns was an issue of self-preservation for this interviewee, a way to maintain his own identity after relocation to another country. In the environment where he found ways to continue following his ‘communist religion’, he did not see the pressing need to change completely to fit in. He eventually found a place where he was not pushed to move (teaching-oriented college, no mobility incentives), or to write funding proposals, therefore confining himself to highly theoretical research areas that did not require research group work or substantial financial resources.

The most evident consequence of disconnect of values is disengagement. If teaching, training, outreach, and commercialisation were seen as something that is improper, or undesired, a researcher would tend to try and minimise this element from his or her academic practice.

A complete change of academic identity and the choice to refute the Soviet training is conceptualised as the ‘Shifted Identities’. These scientists choose to completely integrate into the new research system, usually nationally bounded one, and to develop behaviour patterns indistinguishable from native-born scientists.

“My Russian Style [of scientific research – MK] had to be brutally murdered in the very beginning. It’s too rusty. Actually, the Russian style is about detailed and systematic approach to scientific research and when you do something it will only be interesting to 2 or 3 people besides yourself. <…> This style doesn’t work here. Here people are so busy that they are only interested in the end result. Unless you present your results in an east-to-understand style, no one will read them”. (Professor, USA)

For many scientists who relocated abroad at a relatively mature age, stripping off old identities and assuming new ones was a way to ensure career success and full integration. This was often, but not always, a conscious decision. For others, it was a product of, in the words of a German Professor, an ‘evolutionary development’, when, gradually, post-Soviet
countries and their links wane from the field in which a scientist operates, and eventually the home country becomes one of many options for this researchers, who assume neutral attitude to their home countries and their representatives (students and former colleagues). This does not mean that these scientists completely shun contact and collaboration, but it only interests them in the context of their own professional development.

While identity shift may occur with some researchers, the majority combined elements of the host and the home research cultures in one form or the other, in their routine academic activities. This type of academic identity is conceptualised as ‘Plural Identities’. The concept of plural identities is most often used in sociology and cultural anthropology in the context of social integration and diverse environment research. The broad concept of cultural pluralism acknowledges the “structural and cultural persistence of ethnic groups in the society” (Kivisto, 2001, p. 7). In the context of academic identity and practice academic pluralism, similarly, can be defined as the persistence of culturally diverse groups in the scientific community. These groups are characterised by holding particular codes of conduct and value systems that are invoked in their daily practical activities. Bickford (1999) overviews pluralism in the context of identity and stresses the fluid and multi-faceted nature of plural identities as they are invoked in different contexts. She also stresses the performative nature of identity. These features hold for plural academic identities.

It would be wrong to assume that plural identities arise from a combination of the home country research culture norms being fused with the research culture of the host countries. In the globalised labour markets, where scientists spend substantial amount of time during their careers in multiple countries, plural identities may also refer to the combination of elements of all research cultures experienced by a researcher into a unique academic practice style. Some of the interview participants specifically aimed at getting research experience in multiple countries to experience German ‘Ordnung’ (Assistant Professor, USA) or Italian ‘socialism’ (Professor, USA). A minority of interview participants explicitly expressed a particular type of denationalised identity, which they framed in terms of the globalisation and cosmopolitanism discourse – science has not only become a global profession, but mobility and networks spanning across continents and countries are integral to academic practice. This is not to say that academic practice is homogenising across nation states, but rather relates to the awareness of plural identity researchers of their multiple migration moves and the impact of these moves on their current academic practice and culture. This awareness allows them to regard further, temporary mobility, and the ‘suitcase
lifestyle’ (Professor, UK) as their unique advantage in terms of developing and successfully managing their multi-sited cross-cultural research, teaching and engagement activities.

When senior scientists employ nationally diverse staff at the laboratories, they expect them, on the one hand, to adhere to the rules and practices of the employing organisation by, for instance, producing a steady publication record and partaking in teaching and service duties. At the same time, there will be expectation that the diverse environment of the multi-ethnic laboratory or a department will produce synergies that will lead to original groundbreaking research results. Therefore, with recruitment of international research staff, there is, on most occasions, an expectation of plural identities, which will be enacted in a particular way, whereby the contextual academic behaviour of globally mobile scientists will conform to the expected norm, but the research process-related behaviour will be deviant and therefore original.

Needless to say, there is rarely such clear distinction between the process and the outcome of research activity, as well as there is almost never such a clear distinction between the aspects of multiple identities. To outline the scope of effects of the change in identity on academic practice, first, the types of academic practice of interview participants based on the Research Compass Card will be outlined. Then, the comparison with employing organisations’ orientations and types of identities will provide insight into the interplay of research culture and the resulting practice.

6.3.2 Academic Practice Profiles
In terms of the distribution of time between various types of activities, a variety of factors, including the type of position and the national context, have an (external) impact on the practice profile of scientists.

The clustering of activities of each particular group of researchers in one of the fields of researcher activity profiles can indicate general disposition towards certain types of activity within population.

However, there are multiple other factors that may have decisive impact on how scientists distribute their time between different types of academic activities, such as country of residence, type of position, gender, and the type of employing organisation. These are analysed prior to moving on to discuss the impact of research culture on academic practice.
The factors are examined during the preliminary faculty workweek time allocation questions. Details about the scope and adaptation of the framework to the type of data collected can be found in Appendix 7. Only results are reported in the section below.

**Workweek Time Allocation**

Faculty time allocation studies focus on tradeoffs between teaching, research and service among full-time faculty in universities. On average researchers spent 58% of their time on research. Therefore, about 40% of their work time is spent doing other activities, which vary greatly depending on each of the categories under examination (see Figure 18).

![Figure 18 Workweek Activity Distribution Patterns Among Participants](image)

Source: author

There is a difference between permanent position holders in workweek allocation. Leadership (professorial) position holders have more diverse profile, the share of research activities among non-leadership permanent position holders is higher, and the share of time spent teaching or on service is lower by 10 percentage points each. In this instance, the pattern is consistent with other reports indicating that research time allocation decreases with the age of a scientist (Bentley and Kyvik, 2013). Additionally, avoiding leadership positions indicates a strategy towards preferring for research over other activities.
Tenure-track and contractual-level researchers tend to spend larger share of their time doing academic research and producing good quality publications. Researchers employed in fixed-term contractual positions, which are more insecure, spend the largest share of their time on research. The fixed-term nature of their job does not require deep commitment to the university in terms of teaching or service.

US and German Russian-speaking scientists employed in fixed-term research positions are often funded by research projects and have zero teaching loads, as teaching duties in these countries start from either receiving a tenure-track post (US), or undergoing habilitation (Germany). The UK researchers demonstrate the highest teaching loads among the participants – 40% on average, regardless of the position type.

The results of the initial survey of activity profiles of Russian-speaking scientists employed in public research organisations indicate that general allocations of time between various types of research activities in their academic practice broadly correspond with findings from the broader faculty time allocation body of literature. Additionally, career stage and job security have possible influence on how scientists distribute time among their activities. However, the limitation of the workweek time allocation framework does not reflect the broad scope of academic activities of study participants. Therefore, a broader ‘practice profile’ framework is needed. The subsequent analysis of academic practice profiles takes these findings into account, and substantiates these ‘external’ structuring elements of academic practice as constitutive blocks of corresponding profiles.

**Academic Practice Profiles**

The analysis of practice profiles of academic researchers was coded in accordance with the amount of time interview participants spend doing a certain kind of activity, and according to the perceived importance of this activity relative to other ones. The codes range in the interval [0; 5] and are outlined in detail in Table 13 below.
Research is the main orientation among the majority of scientists: this is an implication of the type of profession, also driven by the sampling methodology, where journal publications were the main indicator of visibility of scientists. Research results and performance have been the main enabling reason of leaving post-Soviet countries for these scientists, and many of them stay true to the initial career paths.

Alongside with scientific research, interview participants have demonstrated a variety of practice profiles, and these profiles can be divided into Broad and Narrow type of practice profile. Broad profiles indicate a variety of activities, when researchers regularly engage in at least three of the practices in the Research Compass Card. Narrow profiles indicate much less diversity in the type of activities that researchers demonstrate, and these scientists only engage in one or two types of practices regularly. Scientists with narrow practice profiles constitute the majority of interviewees. A minority of interview participants demonstrated focused practice orientations: 2 focused on education, 4 – on innovation, and 1 – on the public goals. Each type of profile will be outlined briefly in the following section, before moving on to discuss the relationship between academic identity change and the development of certain type of practice profile.

**Broad Profiles**

The majority of researchers with broad profiles have permanent professorial positions: two scientists with broad profiles have tenure-track positions and one is employed in a contractual position. Broad profiles indicate relative liberty to distribute the workweek time as scientists see appropriate, without external pressure to demonstrate exceptional results.
in one certain area, such as research for tenure-track scientists. While the position
distribution is more homogenous across this group, there is overrepresentation of female
scientists (30%) and UK scientists: more than a half of scientists interviewed in the UK have
broad profiles. Scientists from different countries also demonstrate different specialties in
terms of academic practice in the Research Compass Card (see Figure 19).

Scientists with broader profiles demonstrate the breadth of activities in the areas of certified
knowledge (academic research), education and proprietary goods. Engagement and
community outreach, along with Public Goals activities occupy much less space in the
academic practice of researchers with the broad profiles. This can be interpreted in the
sense that an average scientist with a broad profile spends significant amount of time
producing certified knowledge, but is also aware of the public benefit and applicability of
scientific outputs. This scientist considers teaching an important part of academic identity,
and engages in education. Finally, this scientist has regular contacts and links with industry,
but they are not of core significance to the research, e.g. industry-collaborated research is
not regular, or is collateral to the production of certified knowledge.

However, UK scientists demonstrate more awareness of the public benefit of their research,
partake in science advisory activities more often, and, communicate more with the general
public about their research. The two French researchers in the group, on the other hand,
have very close and regular links with the industry – both have small businesses that they
supervise – but also are actively developing the teaching part of their academic activities by
either working on the introduction of their own courses to the development of a new
Masters programme. Broad profiles of the German scientists are leaning much more heavily
towards industry, as industry links, funding and otherwise collaboration are very pervasive in
the system. The US scientists have the ‘narrowest’ broad profiles without any particular
focus. This should be interpreted not in terms of numbers (the broadest and the narrowest
profiles cancel each other out), but in terms of the extreme focus of the US universities on
the production of research outputs and on the facilitation and development of focused,
rather than narrow, profiles in the organisations interviews were conducted. No scientists in
Switzerland have broad practice profile patterns.

**Narrow Profiles**
Scientists with narrow profiles are predominantly focused on straightforward academic
research. In this large group, average indicators of the practices distribution coincide with
the overall average measures (see Figure 19 left). On average, scientists with narrow profiles
focus exclusively on research. They either teach irregularly, or do not assign much importance to their regular teaching, seeing it more as a burden than as a core academic activity. They have interest or even some experience in dealing with industry by patenting or have jointly funded projects. However, they do not clarify the public benefit of their research, and have very little interest in engaging with the general public.

Most noticeably, researchers in early stages of their career path have very narrow profiles focused exclusively on research (Figure 19 middle). Among all opportunities, scientists employed on the contractual basis prefer setting and maintaining links with corporate actors, possibly with the view to move over to the research in industry should the career development plans not succeed.
Figure 19: Broad Practice Profiles Radar Maps

Source: author
Figure 20 Narrow Practice Profiles Radar Maps

Source: author
In the national systems where early career researchers have teaching responsibilities, such as tenure-track positions in the US and the UK, there is also an element of participation in education. Such narrow focus on research, with the element of externally imposed ‘teaching’ is pervasive among interview participants with low job security. Many listed their interest in further developing industry links, or putting more effort into teaching or outreach, but the precariousness of their position and their intention to secure tenure were the main obstacles, or the reasons for not following up with their intentions:

“For [this university] research is the main thing. Other things may help you, but they will not save you. So to say, if you teach students badly, they may give you a reprimand, but it’s not too bad. But if you teach students very well, but do bad research, then nothing will help you. We do some rubbish with students: youtube videos and such. Students get happy and shut up.” (Assistant Professor, USA)

Take tenure-track interviewees: over several years of occupying the position, they must demonstrate their capabilities as researchers and academics, building up research portfolio, networking, but also participating in the ‘social’ life of the employing organisation (usually a university) by sitting on committees and teaching courses. These are all formally required activities that eventually lead to securing tenure. As this is the ultimate goal, scientists in tenure-track positions invest significantly in research and education, but demonstrate no more than interest in other activities depicted on the Research Compass Card.

Above described tenure-track model is pervasive in the USA and was recently transferred to other countries with the missing ‘middle link’ in the academic system. Therefore, the double emphasis on research and teaching among scientists with narrow profiles is most indicative of the US practice profiles (Figure 20 right). UK researchers have much smaller base teaching load, which can be more flexible than in the USA and can be minimised “when research is going well” (Senior Lecturer, UK). Therefore, non-research activities in which UK academics with narrow profiles engage relate more to working with the industry or communicating the public good of their science. Swiss and German scientists have the biggest opportunity to dedicate their entire time exclusively to scientific research. This is usually achieved by settling in a position that presents an optimum compromise for the desired practice profile:

“Another part of the decision [to not proceed with Habilitation or relocate to another research organisation – MK] is that I don’t really like teaching. So if one chooses to develop the career traditionally, then teaching and bureaucratic responsibilities pile up for a person. In due time I was reflecting about Habilitation. However, I thought that it was too much effort for something I don’t really enjoy. You also have to prove
In the example above, this senior researcher wanted to maintain permanent research position, but evade teaching responsibility, which he disliked. As a solution, he chose to not do Habilitation, which on the one hand opens up the way to professorship, but on the other hand would impose a teaching duty. Settling in a non-leadership research position with limited access to funds, but bigger freedom to do independent theoretical work and, at times (unsuccessfully) communicate with companies.

In terms of disciplinary divisions, the difference between the type of practice profile (as well as the type of workweek loads allocation) tends to draw the line not between, but across disciplines. Scientists engaged in theoretical research in physics tend to need less collaboration or even publication activity than experimental physicists, who have high needs in equipment and competent teams to operate it. Another difference lies in drawing the line between fundamental and applied research, especially in terms of commercialisability of research results and the extent of collaboration with the industry. These divisions exist between scientists, but are not examined in this chapter closely. Instead, it assumes the focus of the career stage and practice profile, as well as academic culture.

**Focused Profiles**

While scientific profession indicates the dominance of the production of certified knowledge as a primary activity, the broadening of the scope of academic identity has led to the emergence of various types of focused academic practice profiles. The majority of narrow practice profiles are indeed focused on research, but among the interview participants a minority have profiles focused strongly on teaching, production of proprietary knowledge, or on public goals. A small group of scientists are focused on producing proprietary knowledge by either closely working with industry, or because they have companies they are actively developing and therefore were spending significant amount of time, comparable with their research activities, on working in these companies in the entrepreneurship capacity, rather than in the research capacity. One participating researcher was actively engaged in science advisory activities and therefore his practice profile has strong focus on the Public Goods and Policymaking. Focused profiles can be broad or narrow – but they are distinguished by the focus and the particular importance of that type of activity for the researcher (Figure 21).
The two scientists with education-focused practice profiles are at very different stages of their career. One is a mature US professor with proven research record who was helping to launch a new Masters programme in the university and was engaged in the curriculum development and administrative work alike. After the launch and the initial first years he was planning to return to full-time research. The other scientist was still at the beginning of his career path and held a tenure-track position at a French university. For him, a career with a focus on teaching was a preferable professional development path, and he was planning to grow within the teaching, rather than research, pathway. He was initially recruited to work in a research laboratory, but he was gradually reducing the amount of time spent on research and focusing on immersing into teaching, which, in the French system, was demanding in terms of the language, qualifications and many small culturally sensitive details.

One interview participant has a practice profile focused on meeting public goals. In his case, his time was split evenly between the work in his research university and the work in a funding agency in the USA. This has had impact on the rest of his profile: he reports that before he took up the post, he was regularly consulting companies and taking part in the development of his department, but having a dual role of a public official and a researcher...
imposed certain limitations on the range of activities he could partake in, limiting his practice profile to these two main elements, but leaving him interested in broadening it up once again.

There are three academic entrepreneurs among the participants of this research, all of whom intended to take their companies to the competitive level. These companies have been organised using different sources and were at different stages of maturity: a Swiss senior scientist had to recently put his company in an “artificially induced coma” due to poor performance, but was developing three alternative ideas for new start-up ventures; a US-based associate professor set up a high-technology company in California and was flying there regularly from the East Coast to do negotiations with the investors and partners; and another US scientist raised funds from various sources, including the Small Business Innovation Research (SBIR), Department of Energy and local university funds, to set up a long-running small company, which he used in a dual capacity as a profit-making enterprise and at the same time as an additional laboratory space to conduct and publish applied research. Finally, a scientist took up the role of a technology transfer intermediary in his university, transitioning from a research-focused position to a ‘research professorship’ position that is a type of post specifically designed for specialist who can establish and maintain links between the university and industry.

Focused practice profiles should be discussed in conjunction with the relative drop in the significance of research in the scientists’ activities. Initially, all scientists with currently focused profiles were recruited to their respective employing organisations for their research capabilities on research-performing posts. The factors that have led them into shifting their priorities to other activities in the practice profile are all career related.

In one instance, mature scientists with big track record of published research who reached the top level of their research careers were trying out alternatives, like setting up a company or developing new courses and education programmes, as possible ways to develop professionally. For other scientists, developing a focused profile presented an opportunity to get out of a career deadlock. For instance, the US research professor did not initially manage to secure a permanent position, or to move ahead in a conventional academic career ladder. For him, having his own research laboratory was an unrealistic prospect, especially after experiencing a conflict within the university. Setting up a business and turning it into an applied research laboratory, located in the university yet independent from it, allowed him
to gain recognition and academic freedom to carry out research and set his own goals, be less dependent on the teaching load.

Finally, for a young US entrepreneur professor with a company in California, setting up a business was a practice that was encouraged in his employing university, as well as among his fellow faculty. In that environment being an academic entrepreneur was something normal and expected, and other interview participants had companies as well. However, for that researcher being “one step in science and one step in business” was something of a way of life: his business agenda informed his research, and his academic profile had added resources and benefits from the company.

6.3.3 Synthesis: Research Identity and Practice

Broadly speaking, there is a connection between the domestic academic culture and the variety of activities in which a researcher engages, the breadth and focus of practice profiles, and particular career development paths. In this study, the change in academic culture is conceptualised using the medium of ‘identity’ of a researcher, and the Research Compass Card is used to describe the variety of practices that broadly delineate the scope of activities within scientific profession in the countries of the Western Europe and the USA. After relocating to a new country, each scientist brings over acquired norms and practices (‘academic culture’ manifested in a particular ‘identity’ enacted through a particular set of activities) and is confronted with the expectation of a ‘proper’ academic practice profile in the new employment.

Scientists moving to new countries from any other country have essentially two basic options: to either adjust to the local expectations (written and unwritten), or to seek options for employment in positions that would not necessarily mean straightforward academic promotion, but could suit preferences of scientists in terms of preferred practice profiles. Due to the very narrow ‘ivory tower’ understanding of the role of academia in the society, the Soviet academic culture facilitates training of scientists with very narrow academic practice profiles. After moving abroad scientists with these narrow profiles were usually confronted with much wider expectations towards societal participation, and had to face the challenge of meeting these expectations, or adapting to avoid them.

Indeed, all scientists who have ‘conserved’ identities also have narrow practice profiles (Figure 22). Moreover, while for some narrow profiles two elements of practice could be important (typically, research and teaching, or research and innovation); all researchers with
‘conserved’ identities only reported research as a significant element of their practice, and all other elements as irregular or insignificant. Some of them outright exclude innovation or outreach from the scope of activities they consider belonging to the ‘academic’ scope. Others just note that this is not what they could see themselves doing.

Figure 22 Practice Profiles of Researchers with Different Identity Types

Source: author

Overall, scientists with ‘shifted’ identities demonstrate the broadest practice profiles. The majority of these researchers have permanent positions, which some of them regard as a result of assimilation and complete integration in the new society. Others discard the issue of culture as completely irrelevant, stressing the universal and global nature of scientific profession. Over a half of all broad practice profiles are held by researchers with the shift in academic identity.

Multiple identities profile holders stand in the middle between the two groups. While the overall activity score is smaller for multiple identity researchers, they engage in innovation activities to a bigger degree than researchers with shifted identities, and all but one focused academic practice profiles belong to scientists with multiple identities.

There are several issues with adaptation issues of globally mobile scientists, which are not directly related to academic culture and must be mentioned before proceeding further. One
of such issues is the general position of an ‘outsider’ in the new ‘host’ society. The recruitment is usually proceeds with the research capabilities of researcher, but tenure, promotion and reputation may involve other elements of the practice profile. Some interview participants realised these requirements, and attempted to satisfy them, but their position as outsiders – not to the research system, but to the country in general – prevented them from fully realising their potential. Public engagement and outreach is one of the most characteristic practices where this might occur:

“Yes, my university is actively participating in these [Public Engagement – MK] programmes. We have a programme in my department when we go to middle schools and high schools and we speak with the pupils about being a scientist and experiments that we make in the lab. But if I were to go, what can I tell them? I come from a different country! I have very strong accent and I don’t speak the language very well. So I do not participate. Let someone else do it” (Professor, Germany)

Same concerns may arise in teaching, when in non-English speaking countries research laboratories are international and English speaking, but teaching is done in the native language of the country, which is not a requirement for research. Similarly, language proficiency and understanding of the tacit culture are required for continuously interacting with the business partners. In the words of a researcher employed in the Fraunhofer Institute in Germany, a ‘huge investment’ of time and effort is needed to reach the level where stable industry relations can be maintained, but there still is a top mark that a migrant scientist cannot surpass.

In this respect, it is easier to broaden one’s academic profile in cultures and societies that are generally receptive to globally mobile people, where the diversity is high and where globally mobile researchers would not feel excluded from the general debate and discussion of ongoing problems. Without the feeling of belonging, there is no contribution to the wider discussions and broader outreach, as these require strong motivation.

Another issue is the multi-level nature and the complexity of academic practice and the boundaries of academic identity. This study aims to show the existence of one effect, but the actual social reality is often more complex, and no clear boundaries exist. For example, globally mobile researchers may feel estranged in the new societies and organisations abroad and they sometimes can use the coping mechanism that all other migrants use: become embedded in transnational migration networks, rather than aim to integrate in local
societies. These networks may be enacted in research and non-research activities of scientists.

Among interview participants, in two cases otherwise pure research-oriented scientists either engaged in, or considered developing their practice profiles towards working with the industry. However, the initial links with the industry came from within other Russian-speaking diaspora members, scientists and businessmen. Such activities constitute the core of innovation-focused scientist, who provides technology transfer services for Russians in America and for Americans in Russia. Therefore, while this study makes a case that scientists with conserved identities often have very narrow practice profiles, conserved identity may also manifest (very rarely) in, for example, industry links with other diaspora members.

Identity-Practice Configurations

There is a multitude of configurations of choices and strategies of adaptation to the host institutional system that can be distilled back to the initial three options for reconciliation of tacit knowledge and competences with the requirements of the new environment: shift, conservation, and multiplicity. The variety of these configurations can be broadly classified into strategies that adapt norms and expectations to the environment, and the strategies that seek a niche in the new environment that allows maintaining part or the full set of norms, expectations and other elements of the domestic research culture.

As such global change in one’s professional outlook does not happen overnight, there is a variety of configurations of the ways identity and practice are enacted, with the resulting career development strategies and practice profiles. The variety of identity-practice configurations is depicted on Figure 23 and is outlined in detail below, starting with conserved identities strategy and moving gradually up to the normative shift strategy. The concluding part of this section discusses broader implications of the existence of these configurations.
Conserved identities are characterised by the general desire of scientists to not undergo any transformative changes in doing scientific research, as well as in the values and norms of this scientific research. This can be expressed in a variety of ways, from academic research...
strategies that express explicitly the refusal to conform to the local rules and requirements, to strategies towards not partaking in activities that seem undesirable or undeserving.

**Reconstruction.** The most conservative type of academic practice is when scientists who move abroad reconstruct the space they are used to operating in their domestic environment, with all appendant norms and expectations. For instance, a senior Soviet Professor, who left the Soviet Union in the 1991, moved his entire laboratory to a university in the United States, including senior and junior researchers and students. In the two decades that followed, the laboratory remained in the university, but its personnel changed multiple times.

When this Professor was negotiating his new position, he did have to compromise: for example, he agreed to teach, but only after some “arm-twisting” on part of the university management. In return, he negotiated the privilege to do the science his way, in the way he is used to. The ‘conserved identity’ of the entire laboratory and satellite research collectives around it, composed of former scientists and graduates, is best highlighted by the fact that students from Russia and the Soviet Union were still more welcome there than American students:

“When students from Russia were coming here in the 1990s, I could demand things from them, in a sense that they were used to doing what they were told. Here, students come to you voluntarily, they do not depend on you. You have to work with the local students in a way of soft advice, being kind, building their self-esteem” (Professor, USA).

The contrast between dutiful Russian students and independent (in a negative sense) American students reveals the hierarchical and uncompromising manner of work that the Professor prefers, much like the best of the Soviet scientists, who valued subordination, loyalty, dependence and strict vertical hierarchy in their research institutes. Science spaces like this US laboratory are still predominantly populated by post-Soviet scientists and graduate students, and are in a way reconstructed spaces of the system that is long gone.

**Position that suits identity.** Many globally mobile researchers with conserved identities do not have the resources to move the entire laboratory, or move as a part of the entire laboratory. In many instances, the spaces of science they end up in are diverse, and they face the dilemma of adaptation or exclusion. In some of these cases, scientists search for the place that is best suited for their current research identity and that will require as little compromise as possible. These scientists seek research positions that may not fit in with the
usual research hierarchies or grant the best output or funding opportunities, but instead provide comfortable space for work and boundaries of academic practice that coincide with their ideas of academic culture. In case of post-Soviet researchers, these perceptions would be of narrow practice profiles, opportunities of independent research, freedom to investigate the same topic area for prolonged period of time, and as little external influence on the scientific process as possible.

There are two kinds of scientists who enact this strategy: the first type is professors who made important discoveries, or had high reputations in the Soviet Union, and who were invited to tenured positions in the United States or Europe. These scientists are valued for their original and fundamental approach to science, and were a great asset to university departments that aimed at developing a certain area of physics or chemistry. However, they face multiple obstacles on the way of continuing their research in the new organisation, mainly because of the national organisation of science. Writing successful funding applications is one of such frequently cited problem:

“Funding is very hard to obtain. I was ‘sitting’ on the Department of Energy grants. I also received funding from BSF (America-Israel foundation). But I do refuse to change my topic. It is a very narrow specialisation. I can’t get funding but I refuse to change my topic and follow fashions” (Professor, USA).

The consequences of this situation are the following. First, this US Professor is unable to purchase experimental equipment to advance his research. His traditionally isolationist position prevented him from using shared user facilities in other high-level universities in the area, confining him to simple experiments and Soviet-style theoretical developments. Additionally, he did not have enough funds to recruit graduate students to work in the laboratory, so he had to set significant share of experiments himself. While he is proud of ‘working with his hands’, this is also a Soviet practice, because, as several other interviewees explicitly confirmed, senior professors in the USA and Europe alike delegate these basic activities to their research students and technicians. This unfortunately leads to believe that the research outputs received by this scientist are less than they could be if he was operating in a more comfortable environment where his values and approach to research was rewarded accordingly to his talent, not to his ability to change research area.

The other type of researcher who seeks positions that suit the practice is a ‘soft money’ scientist in the USA, a non-leadership permanent position scientist in Germany or Switzerland, and a scientist working on contractual position in Max-Planck society or
Helmholtz Society institutes in Germany. These positions in respective countries give opportunity for scientists to do research full time, without the duty to teach, or the public duty to engage with industry research, outreach and other activities. This is a way to compromise: a researcher discards ambitions to get professorship and associated benefits, but in return there is no pressure to significantly adapt their practice to the requirements of the local system.

Practice profiles of these scientists are very narrow, focused predominantly on research, with marginal elements of other obligatory activities, such as teaching. Some of the senior interview participants who chose this strategy to find their place abroad reflected about it with a sense of a missed opportunity:

“I am a theoretician and I’ve done fundamental science all my life. To my regret – and I really regret this – my education and my aspirations were different. We were led to think that fundamental science is the highest class. And applied science – is for the people of the next class. I was brought up with this outlook, and I have lived with it for quite a long time. This is a big obstacle in my life, I would like, I have a couple of patents, but I don’t think they are commercialisable” (Professor, USA)

For this US Professor, broadening up his practice profile and moving on to becoming an academic entrepreneur was something he maybe thought about doing, but was eventually constrained by his research culture, by deeply-rooted normative perceptions of what constitutes science, and by the Soviet hierarchies of types of research. This constraining effect of research culture on research practice goes beyond scientists with conserved identities and is a popular phenomenon, as will be highlighted further.

**Value for Culture.** In some cases, particular research culture was has enabled the international migration of scientists: foreign organisations were looking for researchers with fundamental and broad expertise, proficient in theoretical research, and original in the interpretation of research results. In these cases, these particular traits of the national research culture are what distinguishes scientists and motivates them to ‘conserve’ their identity, because national identity becomes their competitive advantage. These researchers, who are valued for their culture, have little or no motivation to modify their behaviour or to adapt significantly to the new academic environment.

Scientists who maintain their national research culture as their main competence may not be motivated in significantly changing their practice or adapting to the new environment. However, working abroad and being exposed to a variety of alternative outlooks to culture
and practice may broaden up their horizons and cause a gradual shift towards adopting new elements of academic activities in their overall profile. This can take the form of moderate teaching, consideration of the broader value of their highly theoretical research, or considerations of commercialisation, or even moving to the industry. Alternatively, they may maintain close links with their home countries for decades, and develop in a research capacity bi-nationally.

A trait that distinguishes scientists with plural identities is a combination (or co-existence) of elements of both domestic and host national academic cultures in the profile of their activities, both practically and normatively. Plural identity scientists in general are not ready to undergo a complete transformation of identity: they acknowledge and value their background and training, they are highly sensitive to spoken and unspoken ‘rules of the game’, but they are also critical of the local research environment and usually find one or two Soviet research culture elements that they preferred, and sometimes even implement them in their research practice abroad. There is a great diversity of how these plural identities are enacted, depending on the personal story, multiple contextual factors, the embeddedness in the diaspora knowledge networks, and personal aspirations.

**Experience Layering.** The most conservative strategy of plural identities researchers is ‘experience layering’. Scientists who exhibit this strategy do not actively express, or verbalise the type of identity they see themselves holding, and they also do not explicitly give a preference to their domestic of the new host research culture and associated norms, practices and activities. Instead, these (mostly early career) scientists accumulate new experiences and venture out to explore various alternative configurations of academic practice elements.

In this sense, their overall activity profile is structured by the requirements of their employing organisation: industry links and ‘good technologies’ in a research university in Germany, writing potential technology applications in proposals without the intention to follow up on them in a research university in the UK. These scientists do not exhibit a strong lean towards any particular type of practice profile configuration, nor do any of them have broad or focused profiles. Instead, they understand the norms of the academic environment in the countries they work in, but do not necessarily follow up on those that go beyond pure research.
**Skills Recombination.** Scientists may initiate more active ‘culture work’ by revisiting the skills and competences they brought from the home countries, assessing their value in the new context, and setting out to acquire new skills that would complement the set required for successful academic work in the new environment. Erel (2010) notes that “[t]he notion of skill is historically and geographically specific” (p.643), but validation of the skills migrants have occurs at some point after migration. The skillset that the globally mobile scientists coming to the countries of Western Europe and the USA possess was initially specific to the academic practice of the Soviet Union and post-Soviet countries. Validating the skills – seeing which ones of them provide advantage or disadvantage in maximising research performance and career outputs – is a stage that most migrant scientists have gone through.

Usually validation occurs after an initial failure, or underperformance. A scientist who spent too much time than usually approved of in a contractual position in a top US university and, as a result, only managed to secure a tenure-track position in a second-tier university, reflected about his potential and missed opportunities, noting that he was not aware of the ‘eternal postdoc’ threat to academic career development. As a result, his long-term career development prospects were now in jeopardy. As a solution, he sought to establish links with his home country using alumni networks, to leverage resources and ideas to produce excellent research that had the potential to propel him out of the second-tier institution, which was characterised by systemic lagging in the quality of equipment, staff and students.

Another example of skills recombination is move to the industry. A scientist in Switzerland dropped out of the conventional promotion and career development ladder and was seeking unconventional ways to advance his career. Here, he revalued his skills in mathematics, which is a part of a fundamental and broad Soviet training in physics, and found part-time employment in a private company, as well as maintaining part-time position in a physics research institute. This strategy – revaluing one’s social capital, identifying potential development areas and saturating the skill set – is one of the success stories of plural identity scientists.

**Knowledge Moderation.** Leveraging home country links and resources to advance one’s career abroad is one of popular strategies of globally mobile professors, which will be discussed in detail in Chapter 7. In relation to the network structure, plural identity researchers enact different identities (with the communication style, pace and thematic areas of discussion) when working with different types of researchers. As the post-Soviet
research culture has particular unspoken rules and characteristics, Russian-speaking scientists abroad become cultural mediators and manage the internationalising post-Soviet research collaborations:

“Without doubt, in my opinion the main skill you can learn in Russia is to work with Russians. Working with Russians is a very special story. It is like working with Americans in America or in Japan with Japanese. <...> If you mean whether the ‘Russian style’ is preserved, then it is preserved in some places and is not preserved in others. If there are 3 Russian professors in the department, they continue working in the ‘Russian Style’ they are used to. But if there is only one Russian professor, then he changes. A person works like others who surround him” (Research Scientist, USA)

This is not a unique phenomenon: Tang and Shapira (2012) found that Chinese scientists who had collaborations inside and outside China – knowledge moderators – increased returns of international collaboration in terms of spillover in China and diffusion. Authors note (pp.105-106) that many of these scientists with transnational networks are in fact returnees and had extensive time in their careers spent outside of their home country.

Russian-speaking scientists act in a similar capacity by enacting plural identities: for them, communicating with other Russian-speaking colleagues not only means communication in the mother tongue, but also a plethora of unspoken rules and expectations. Being researchers with an established career abroad, they leverage extra resources from their Russian-speaking networks, but these are not the only collaboration networks they are embedded in.

What distinguishes a plural identities researcher from a conserved identity researcher here is the ability to understand what is ‘in’ and what is ‘out’ of character in the context of various research cultures, and act accordingly with different segments of their professional networks, mediating and moderating intercultural communication, where appropriate.

Mimicry. The vast majority of scientists with plural identities incorporate in conventional academic career structures in various countries, and aim to reach professorial positions that grant research autonomy, own resources in terms of laboratory space and staff, and enable to apply for extra funding from various organisations. There are several strategies that Russian-speaking scientists employ to reconcile the differences that initially arise between their expectations dictated by the domestic research culture and the actual demands of the host research community. The safest strategy is a straightforward mimicry. Employing this strategy for a researcher means adoption of the practices and patterns of behaviour
expected by the research environment in terms of publication activity and intensity, mobility and other elements of academic practice. However, very few of these expectations are internalised, and the researcher remains critical, sometimes preferring domestic culture norms:

“In the Soviet Union, you had one topic for life. You research 1 molecule for 40 years but you know absolutely everything about it. You can even afford to not publish actively. PhD can take 10-20 years until you are awarded “the Doctor of Sciences”. All this time you should be researching 1 topic and it will bring you respect from the community. Here, you change the topic every 10 years. Usually it is connected with changing your job. It is also a system of this kind: to move around and not to ‘linger’. <...> There are good and not so good parts about this system. Sometimes I just want to step away from multitasking and do ‘pure science’ for some time. <...> I have my Soviet mentality still: I love to study a phenomenon in-and-out” (Professor, UK).

The UK Professor who is the author of the quote above has a broad practice profile: he is doing active research, manages a separate science and technology center, working with resident companies there, participates in engagement and outreach, and extremely values teaching, which is, in his opinion, “contributes to professional development” and is therefore a core of academic identity. In part, he is excited about each of the activities in his broad profile, but at the same time he admits the benefit of uninterrupted research, fundamental inquiry into one narrow task throughout one’s career, much like his own supervisor in the Soviet Union did.

Hybrid Practice. The general critical attitude towards the host system (or systems) and comparative assessment on the part of Russian-speaking researchers can contribute to institutional change and the development of fused, hybrid research environments. Plural identity scientists put different ‘glasses’ on when they assess the status quo, values and norms in their workplaces, and, if they have enough autonomy and freedom, integrate the two research cultures, selecting the best practices of the two worlds. This leads to the emergence of a truly hybrid local research culture:

“When I was doing my PhD I had a micro chef. There were senior PhD students who managed and supervised younger students who worked in the same group. I am trying to implement such a system here, because step-wise system worked very well then” (Professor, UK – reconstructed from notes)

The scientist who enacted ‘microchefs’ system in his laboratory artificially increased the hierarchical structure by adding an extra level, much in the way mentoring was organised in
his academic institute during his own training. Teaching is an area where the most examples of such ‘fusion’ come from, primarily because the main strength of the Soviet research culture comes from its broad and fundamental training.

Hybrid research practice includes maintaining, or reinforcing elements of the domestic academic culture, where they do not interrupt main requirements and expectations of the local environment. Reaching the optimal configuration of practices requires high cultural sensitivity and high understanding of spoken and unspoken rules that determine prestige in academia.

In other cases, scientists transfer their Soviet and Post-Soviet experiences onto demands and practices of the new environment. They compare their research organisations with “the Union in the 70s” (Research Professor, USA) or with the military applied research institutes of the Soviet Union (Scientist, USA), and transfer their experience of problem-solving and mediation onto the new context, acquiring recognition and reputation.

**Celebrating Difference.** The awareness of being different can be a powerful and competitive tool for many researchers. In case of Russian-speaking scientists, their native research culture and its particular traits is one, but not the only difference. They are also globally mobile researchers, with experience of mobility, adaptation and intercultural mediation. Some of the plural identities scientists emphasise these traits by choosing to adapt to the local research culture only to a limited degree. Many US-based interview participants stressed the fact that USA is a country of migrants and, therefore, the local culture (research culture, but also in general) does not impose strict requirements to completely assimilate, but instead encourages difference. Researchers with these orientations can be found not only in the USA, but they are invariably drawn to locations where being different is rewarded institutionally.

*The shift in identity* is usually characterised by internalisation of the new normative outlook on academic identity. Scientists with shifted identities communicate with domestic researchers from the positions of an outsider, on par with any other scientist from the foreign country. Some researchers with shifted identities have links with other Russian-speaking scientists, but the nature and the history of these links are drastically different from the ones maintained by scientists with conserved or plural identities. At the same time, scientists with shifted identities do not necessarily adopt another national identity, but may become denationalised. These configurations are explored below.
**Tribute to the Motherland.** The first group of researchers with shifted identities is composed of those who acknowledge their background in the Soviet Union and post-Soviet countries, and their transition from a typical post-Soviet researcher towards assuming a new approach to the organisation of academic work. Most of researchers in this group communicate with domestic scientists in Russia or post-Soviet countries, but approach them from an outsider perspective: collaboration with Russian scientists for them is just one of multiple sustained international collaborations, or it is an old and established collaboration lasting through decades.

Scientists in this group demonstrate a wide diversity of activities in their practice profiles. They acknowledge adaptation issues they encountered at early stages of their career development, such as proposal writing, or permanent positions application submission process. These researchers recall conscious big effort to adapt to the local environment: they usually invested heavily in understanding the local norms and culture, the ‘establishment’ and the language. This awareness of their background as ‘outsiders’ and their current position as ‘insiders’ puts them among the highest-achieving researchers among interview participants in terms of their career development.

While the roots of their identity are acknowledged, these researchers express views and opinions typical of their country of residence, and have typical academic practice profiles for these various countries, and for research organisations that employ them. As an example, a scientist who left to the UK from the Soviet Union, found employment in a university with very applied commercial orientation. He adapted his practice and identity completely for this university, patenting actively and growing to be a full Professor. The next career step for him was to move towards more publicly important applied research, as it is rewarded more in the UK system, which is geared towards public accountability. The next strategic move of this scientist was to move to a new university with more fundamental research approach, bringing in his applied research portfolio and the team of junior scientists. He then proceeded to initiate new research agenda, the results of which have potential applications in medicine in terms of research findings, as well as drug discovery. Throughout the career history, as this scientist reminisces, he was aware of the needs of the establishment – within his employing universities as well as in Research Councils and the Royal Society – about the type and the amount of outputs expected from someone of his standing and type of science. He was able to not only understand the existence of these expectations, but also internalise
them, directing his entire career towards meeting them, thus developing it successfully and moving to a leading research university at the mature stage.

**Polar Shift.** For some scientists, assuming a new identity means forcefully discarding the old one. These scientists make a division between “us” – those who adapted to the new environment – and “them” – those who did not, or scientists in the home country. Researchers of this group adopt very particular strategies of adaptation and research practice in terms of collaboration management: they invest heavily in assimilation in the new context, learning the rules thoroughly and adjusting their own norms and expectations. Sometimes they shun Russian-speaking collaborations not only with the home country, but also with other emigres, wary that this may set them back, especially in the eyes of the research community they are trying to integrate in. In those cases where there are links with other post-Soviet scientists, it is for the particular purposes, usually instrumental and related to resources than to the proximity of research topics or other reasons.

All scientists who expressed polar shift views had to go through tough competition for permanent positions after international migration. They regard their immigrant status as a disadvantage, rather than an asset, and complete integration in the national research culture for them is a way to overcome this advantage. Their practice profiles are broad or focused, with particular attention to the priorities of the employing organisation and of the general science and technology priorities in the country of residence.

**Global Outlook.** Other scientists with the shift in identities do not see the need to conform to the requirements and expectations of one particular research culture, because they regard themselves as a new generation of researchers, denationalised in the globalising world. They build their strategies accordingly to these views: they develop highly geographically dispersed collaborations network, have a career history of moving between elite research organisations globally, and problematise their research within global problems and challenges that may or may not coincide with national research priorities and agendas.

Scientists who belong to this group challenged interview questions frequently, regarding them as formulated within old frameworks. For example, wording “stay in a country” or “go back to a country” was perceived outdated, because for the globally mobile scientists there is no staying, because there is constant short-term mobility, and there is also no “going back”, because the country of origin is not particularly different from any other country in the world. One scientist, a company owner, perceived questions about commercialisation...
with skepticism, understanding that the Soviet research culture implies detachment from industry, but refusing to see himself as an exception, but, rather, as a representative of the new entrepreneurial generation.

Scientists in this group are highly performing and highly mobile. Some of them have links with Russia, mainly within the framework of recent science diaspora initiatives (institutionalised collaborations, rather than personal network of collaborations). However, they only take part in these initiatives if there is a direct benefit for their global research career: for example, when collaboration with Skolkovo includes spending some time at MIT. Practice profiles of these scientists are either focused (entrepreneurial), or concentrated around research, with elements of other academic activities.

**Normative Shift** is the final strategy of scientists with shifted identities. It is distinguished by a complete internalisation of the norms and values of the local research culture and environment. This group of researchers is diverse in the variety of ways in which internalisation is expressed: for instance, a US Associate Professor constantly emphasises the importance of doing things “the right way” – in the laboratory and in the scientific community. For him, the right way was ultimately the American way.

Other scientists went abroad as doctoral students, and their research identities formed during their doctoral training (not necessarily in the country of further employment). For them the research culture dilemma had entirely different dimension – that of reconciling the German and the French approaches to research and teaching. These scientists did not particularly distinguish the Soviet Union or Russia in any other way but the place they were born in. They did not seek research collaborations with other Russian-speaking researchers, nor did they rely on Russian-speaking transnational networks in their search for positions. Scientists from Russia initiated some contact with some of these scientists, in a word of a UK Professor, after she achieved a certain level of pedigree. However, these researchers needed certain environment to initiate collaboration with Russia:

> “In order for me to establish collaboration links with Ukraine, I require some degree of transparency. The system must be organised in a transparent way. I should be learning new things, and it should be a professionally comfortable system” (Associate Professor, USA).

These requirements – transparency, certain conditions under which collaboration can be possible – indicate that in order for these researchers to initiate collaboration with Russia,
Russian scientists need to adapt to the non-Russian research culture and approach to science, which will pervade the collaboration. Scientists with normative shift in their identities are not ready to put the Russian ‘hat’ on when they communicate with other Russian researchers, but instead require their conditions to be met.

Most of these scientists also change research topics and areas, moving from more “traditional” schools and approaches they were educated in to advanced and interdisciplinary “modern” areas of scientific research. This is another reason why there is little in common between them and domestic Russian scientists, mainly because of the divergence in the type of science they do.

The majority of scientists with the normative identity shift have very broad practice profiles. They work in the areas, such as solar batteries and alternative energy, prosthetic implants, fluid mechanics in airplanes, coatings and spray dispersal techniques. The (overlapping) majority stated that they take teaching very seriously, indicating that it is an activity inseparable for research. About a half does regular outreach, varying from MOOCs to encouraging female higher education in STEM professions. Industry links are pervasive to a smaller extent within this group.

6.4 BROADER IMPLICATIONS
The influence of culture on academic practice can have enabling or constraining effect. Scientists with hybrid shifted identities, or knowledge moderators with plural identities demonstrate the ways in which the social capital of the domestic academic culture can be translated into the new context, validated and used to benefit the end result of academic practice.

For one interviewee, enacting different identities and working with different networks was a strategy to overcome local barriers to immigrant scientists in peripheral USA. He used his Russian-speaking network to overcome prejudice in the initial research organisation he moved to from the Soviet Union. Later, after the Internet bubble burst in the Silicon Valley and companies were experiencing difficulties, he temporarily moved back to Russia, using his social capital as an American Professor, to become a Chair in a research university. When the situation in California improved, he moved back there by enacting old professional contacts, and brought several Russian graduate students along. His unique transnational position and working in different networks in different circumstances became the enabling factor that maximised his career returns.
The constraining effect of academic culture is seen among conserved identity researchers, scientists undergoing the process of skills recombination, or scientists who resort to mimicry. They either miss opportunities to broaden the scope of their academic activities, or to maximise research outputs by getting competitive funding and resources. An example of the constraining effect is found in the interview with a UK professor, when technology commercialisation opportunities were discussed:

“I had very fundamental upbringing that lacked applied courses, such as design.”
<...> “Collaboration with a factory or a plant was to undermine one’s dignity” (Professor, UK)

For this professor, opportunities were missed because he was lacking in design skills, but also because of the deeply engrained industry adverse Soviet training.

Interviewees generally reported constraining effect of their academic culture and upbringing on their ability to engage with the production of codified knowledge, attributed either to the lack of training, or, as shown above, to low affinity with this type of activity. Among several entrepreneurial scientists who participated in this study, more mature researchers were among Soviet entrepreneurs and prided themselves as exceptions. Others were brought up in the post-Soviet context, where the divisions between science and industry were not as strong.

Public engagement and popular science is one element that falls out of the priorities of researchers in the practice profiles. Only one scientist reported doing outreach regularly and attributing high significance to it, while many others dismissed it as a formalist requirement.

In these dismissive statements, public engagement is seen as a remote and externally imposed activity, not an integral part of academic activity. Among other communities, public engagement was misinterpreted and misunderstood as ‘public relations’, where special offices should deal with it. Other scientists expressed more traditional perspective about popular science and public communication:

“Scientists themselves don’t know where science is headed! What are you talking about! What kind of relationship does it have to people? Give us money – an we will sort this out among ourselves. How can you, for example, predict a breakthrough? It will happen by chance. And in the beginning only very few people will comprehend it. After some time, all this, of course – it will grow and there will be public outreach. <...> But it is stupid. Recognition should be coming from within scientific community. Scientific community has special journals that highlight papers. These people usually
publish papers on papers. And some part of them does media relations, it is their job. An ordinary scientist shouldn’t go anywhere. When they finally realise they discovered something important, they will understand and will start telling everybody. The main thing – is for them to understand. In other words, it will take time – for them to understand. <…> Science is a business, and like in any business there is a public relations department. This department publishes a lot, but it does not employ scientists. I have nothing to do with outreach. My job is to generate something that will become outreach in 10 years. This is how I see myself” (Research Scientist, USA)

For this scientist, research community is represented primarily as a social group, and research discoveries do not attain value instantly, but rather with time. Discovering something first and then taking time to understand what was discovered, the pace of diffusion of this understanding – all these are important factors. The view that a discovery first must be assessed and interpreted within the expert community and then be presented to the public, already with an evaluation and interpretation, is an attitude from self-governed research community, where non-experts have no vote in judging the benefits of a discovery. Arguably, public engagement is the area of the Research Compass Card most affected by the academic culture of globally mobile scientists.

Role of the Environment
Academic environment and organisational policies perform the shaping role in scientists’ academic culture and identity change.

Most participants of this study adapted to the new environment in some way, and all found reference groups in their immediate environment. For those émigré scientists who are willing to assimilate and conform to the norms of the new research culture, this culture is learned in the first instance from academic activities in which other members of the department engage:

“Being here, I did not intend to do any business activities. <…> There is just nearby [a colleague], he is not Russian, but he is from Sri Lanka. He has a successful company, maybe not even one but two. He is doing photo detectors and applies for industry funding. And so he enticed me - come on, set up your own company too, maybe something will work out. And so I tried…” (Associate Professor, USA)

In the quote above the US professor was not going to requalify as an entrepreneur. For him, founding a company was a step that would help to bring more funding to his research. However, it is essentially a new type of activity, which he ventured to engage in, because there was a positive example in his immediate environment.
If other members of the department are also Russian-speaking researchers, there are fewer opportunities for adaptation, and therefore largest share of the domestic research culture is maintained. As will be shown in Chapter 7, in some cases scientists with shifted identities may be drawn into the diaspora space.

The orientation of the employing university has a crucial role in adaptation to the expected norms of the local academic culture. There were often cases when scientists were thinking about setting up a start-up because this was a normal practice in their employing organisation. Research organisations also impose rules of receiving tenure and staying in current positions for scientists they employ, which is a high shaping influence on the scope of academic activities.

The link between academic practice profiles, academic identities, academic cultures, and the existence of multiple ways to enact plural identities to reconcile different norms and expectations have multiple implications for scientists themselves, for employing organisations, and for sending and receiving countries.

6.4.1 IMPLICATIONS FOR ACADEMIC ACTIVITIES

Overall, interview participants managed to find an agreeable balance between their own perceptions of the ‘proper’ academic practice profile and the external requirements and expectations in their countries and research organisations. By changing either their outlook on research culture and assuming broader normative understanding of academic practice, or by adapting the practice profile to their original research practice using a variety of ways, the majority of interviewees did not plan any further changes to their established activity profiles. Some scientists with plural and shifted identities intended to broaden their existing practice profiles, usually upon reaching a certain career milestone, such as receiving tenure. Some researchers intended to narrow their activities, mainly referring to the excessive teaching in the first years of the employment in a new research organisation.

There were instances when interviewees were critical about the configuration of their research practice, thought it was unfair, or there was too many non-research elements in their activities. This was a result of a compromise with their employing organisation, some obligatory activities in exchange for tenure and an opportunity to do relevant scientific research. Attitudes of rejection were expressed when scientists did not believe that certain activities were integral part of academic identity and practice. A young tenure-track researcher in Switzerland called his service “administrative silly things”. Just to illustrate the
contrast, another professor who left to the USA in the beginning of the 1990s, described his service activities with a sense of importance and responsibility, pointing out that it is very important, “because we can influence the way in which the university is going to be developing”.

Attitudes towards applied research and commercialisation of research provide the most vivid illustration to the core differences in academic value systems of the former Soviet Union and case study Western countries. Another strict hierarchy of the Soviet and the post-Soviet science relates to theoretical, non-applied research, which had the highest value. Hence, any collaboration with the industry was, as an interviewee put it, “below human dignity”. This attitude featured prominently in the interviews and is in some sense a dividing line between those researchers who chose to adapt and those who remained adamant in contraposing ‘science’ and ‘money’.

The opinions of interview participants about teaching activities ranged from stating that it is undesirable and is pushed on junior and less successful researchers, to the opinions that participation in education is inseparable from participation in research, because the basics of science in teaching and the cutting edge science in research as in fact two sides of the same coin. After leaving their home countries early as well as late-career scientists often faced requirements to commit up to 50% of their working time to teaching duties. However, this academic activity was also not in the traditional scope of their training and practice: In post-Soviet systems, graduate students, early and late-career researchers are not involved in teaching unless they explicitly make effort to transfer from Academic institutes and research laboratories to university departments. Therefore, attitudes to teaching caused some ‘academic culture shock’ and required rethinking on part of émigré scientists.

For instance, a scientist employed on a ‘soft money’ position in the top US university, explained it in the following way:

“I don’t really like teaching, and I don’t really see much sense in service. But I think it’s more of my disadvantage. With regard to teaching – this is how it’s come to be. I’ve always done research and I’d rather just do research. <..> But again, the Americans who’ve worked all their lives here keep telling me that this perspective is likely wrong, that teaching is an important part of one’s career.”

This scientist had some experience of teaching when he did his first postdoc in Canada, and that left him disappointed: his English was not that good, the curriculum was unfamiliar, other challenges of the initial adaptation period were stressful. Eventually, he chose to
remain in contractual positions to be able to dedicate all his time to doing research, instead of conforming to the peer pressure and expanding his practice profile to teaching.

6.4.2 IMPLICATIONS FOR ACADEMIC SKILLS AND CAREER DEVELOPMENT

Skills Gap and Career Delay

As mentioned above, the broad fundamental training traditional for Russia and other post-Soviet countries may be greatly advantageous in some cases. However, this training lacks some core skills for scientific practice. These include presentation and communication skills, funding applications writing skills, skills that require positioning one’s research in a broader social context, skills of communicating research to non-specialists and to the industry. These relate to straightforward presentation deliveries at conferences, but it also relates to the ability to present, or self-present, networking and gaining informal ‘prestige’ among not only scientific, but also policy community, especially funders.

Finally, there is a big problem with technical specialisation skills, and with health and safety skills. This gap is seen in mature scientists who experienced delays and interruptions in their careers because of inadequate presentation, but also to new generations of postgraduate students coming from Russia and post-Soviet countries:

“The level is falling, of course. I remember myself, I remember that laboratory work was important and we were trained to use all instrumentaries, we could work with them. But it is always very costly. I understand this, but the level is falling. Well, for example, I interview a couple of candidates from Russia, Ukraine and I admit a very small percentage. So I ask them about chemistry. In chemistry there are many standard methods, and I ask: “Do you know this?” – “I do” – “have you tried to do this with your hands?” – “No, I haven’t” – “Why?” -“We don’t have the equipment” – “Ok. Have you done this?” – “We had a lecture” – “Have you done? Do you know?” – “No” – “Why?” – “We don’t have any opportunities”. And this is a completely idiotic situation. And on the other hand I have Americans who come from top universities and know everything very well, and even top Chinese graduates, they also have normal level” (Professor, USA)

For some interview participants, acquiring technical skills and expertise with experimental equipment was a much smaller challenge than harnessing the skills related to self-presentation. In the words of a UK professor, “you get used to good things very quickly”, so getting used to the new equipment, available resources and funding went without hassle in most cases.
In contrast, ‘selling science’ is something that goes against deep values of the Soviet scientocratic culture (Durant and Ibrahim, 2011; Graham, 1998), where science on its own had worth and merit, did not need to be promoted and sold to prove its value. Taking part in funding competitions, networking and learning to present their research in the best light for post-Soviet scientists was to admit that different science not only has different value, but this value also has a price tag.

While this fundamental issue on the level of values can only be resolved by adaptation and assuming the new framework of coordinates on the part of scientists, it had fundamental impact on the career development of several interviewees.

Long-lasting implications of refusing, or even being reluctant to engage in an activity that constitutes a part of the academic citizenship, may prove detrimental to career progression of a researcher, or even potential scope of research organisations where they may get their next job.

“If I’d known better how science is organised in universities, maybe I would’ve done better in the [previous] university, maybe I could stand a chance of getting tenure there. It’s just in many cases over here you need if not shout out loudly, but definitely be energetic in communicating all of your successes and achievements, so that everybody knows what you are doing and know about you. This is what is called self-promotion. I do it quite badly and it is my problem. It is indeed Russian psychology: if you want to do science, you should sit quietly so that people do not interrupt you, and you do your science” (Assistant Professor, USA).

The criteria of academic citizenship become more formalised in some countries. For example, departments in the UK universities are ranked regularly as a part of the Research Excellence Framework (REF, formerly RAE). In 2014 REF included research impact assessment for the first time, which can include outreach, work with industry, or any other societally significant activity of a research collective. The university system in the USA, on the other hand, incentivises and assesses each researcher by their ability to bring money to the university, and such ability, be it research grants from the National Science Foundation, the industry, or commercialisation or consulting income, is appraised.

In this environment researchers who may not be overall familiar with these sometimes not so formal requirements may be confused about what ought to be done to fit in with the system. They may choose to persist in their perception of what a ‘true’ researcher should be like, despite being aware of their long-term disadvantaged position.
Not only is the inequality structural and relates to the career development options, but crossing the boundary that divides straightforward research from other academic activities can be a challenge for scientists. For example, if a scientist who only speaks English moves to a university with a strong public engagement mission in a non-English country, even though he is recruited for his research capabilities, should the employing organisation have a strong mission towards outreach and engagement, this scientist will most likely remain excluded from this activity. This may result in various outcomes, ranging from the ‘imposter syndrome’ to self-depreciation.

Other scientists undervalue their existing cultural and human capital by thinking that their existing non-research expertise cannot be translated to other academic activities outside straightforward research, therefore depreciating some of their existing skills as non-transferable. In these cases, some technical and administrative assistance could help them cope with the problem. It can include filing patents, writing business plans, or pitching ideas. This was the decisive factor of why a professor in a top UK university, did not go ahead with his start-up idea:

“My proposal was about the laboratory method of roentgen equipment. When I was pitching this to the committee they were asking all kinds of questions and I was thinking: "Why are you asking me about market size and the demand for this technology?" – "I think that we all have inherited some traits from the Soviet Union, but there also are individual particularities". – "I grew up in a family with an idealistic attitude to science" (From Interview Notes)

In those cases where such assistance is unavailable, scientists narrow down their practice profiles, focusing on what they do best, being unaware of potentially detrimental effects that this narrowing may have on their career development at later, mature, stages.

**Career Cap**

Highly performing scientists are not simply scientists who produce consistently excellent research results, but also have broader academic practice profiles that include multiple activities, have diverse networks stretching beyond academic community into industry and policy communities. These exceptional researchers, in accordance with the new rules of the transformed academia, will be the first candidates for upward scientific mobility, where they can take up positions in more prestigious research organisations. They also will have better opportunities for moving up the administrative career to take up senior management roles.
in their research organisations. Scientists with more straightforward academic profiles, in contrast, are more likely to maintain their current positions.

Scientists with narrow practice profiles run at a higher risk of having a career cap: they reach the point where no further career development within the academic system is possible. Some scientists with conserved identities choose career development paths with a lower career cap, such as non-professorial permanent research positions. Others find a career cap at the level of research professorship, where a different type of practice profile and associated networks is required to progress further.

Albeit straightforward publication and patent outputs and their citation rates remain the main indicator of success of one’s scientific career, it is increasingly important that profiles of academics who run for senior posts in academia and beyond, or even for prestigious professorships, contain evidence of successful income generation, generating business connections and partnerships, the ability to promote sustainable and responsible research, to transfer knowledge from research to innovation (Allan, 2014). This situation generates structural inequalities within academic departments that push otherwise excellent researchers to technical roles and positions: non-tenured “research professors” in the US, Privatdozent positions in Switzerland without any prospects of promotion to a professor and the necessity to be a part of someone else’s lab, or to temporary positions in German academia, which are automatically terminated after a certain number of years. Staying in such non-threatening and non-ambitious position may help scientists with migration experience evade many of the academic duties they may not like or disapprove of, but it also significantly limits their academic potential, sometimes irrevocably so, after growing out of the “early career researcher” category.

Under these circumstances, globally mobile scientists have a systemic disadvantage in their career development options. When some make effort to understand the local research culture and the local norms, others assume, especially in the first years after migration, that evidence based research process is uniform across countries and continents. These scientists may have academic career aspirations, looking to become members of the elite scientific community due to their exceptional contributions to scientific discovery. However, varying understandings of academic identity on the one part, and devaluing own social and cultural capital, confining them to straightforward research only on the other part, and the lack of assistance in adaptation and support in the host organisation may lead to
miscommunication of these highly performing researchers and the clash of expectations with the employing research organisation. This experience may leave both parties frustrated, but it also signals that this hazard is quite specific to those scientists who did not receive their training in the host system.

**Unique Skills**

Finally, there are some skills that are unique for the globally mobile scientists. In one instance, their academic practice profiles have very international outlook. The degree of this international network is not related to the type of identity, therefore it is a unique skill of all globally mobile scientists. As highlighted above, international migration still has costs in terms of maintaining research networks, therefore, the value of the international networks of the globally mobile scientists is increased.

The skill of maintaining, and even expanding, a transnational network of research collaborations is a valuable skill in the age of research mobility. This skill extends to the ability to manage and mediate geographically dispersed research collectives, design and execute geographically dispersed research projects. The unique position of globally mobile scientists administers the competence of knowledge moderation and cultural mediation to them in the collaboration with their home countries. However, cultural mediation skills and the ability to manage geographically distributed projects is a transferrable skill that can be expanded and applied in various contexts.

For example, a UK scientist with a shift in her identity not only has the ability to be mobile almost constantly – she positions mobility as central to her identity as a scientist and as a citizen – but also expand her research competence to regional centers that do relevant research, and engage them using this mobility skill. She maintained collaborative links with German universities she worked previously, has a long-standing ongoing collaboration with Russia and is developing a new long-term collaboration in Spain at the moment.

Managing geographically distributed teams and dividing research process into geographically specific locations is the globalisation research practice that will be gaining intensity in the future. There are already cases where certain countries and regions acquire science and technology specialisations due to more liberal legislation and the culture of acceptance. So far, these are contentious areas that involve manipulation with the human DNA, experiments that involve animals, or assistive reproduction technologies (Whittaker and Speier, 2010). In recent decades, the emergence of global value chains of research,
where experiments are designed in one country, executed in another country, and the results are analysed in the third country, has been noted. Modern communication technologies enable coordination and timely communication between geographically dispersed teams, and transport systems enable constant circulation and mobility. In these circumstances, the skills of the globally mobile scientists as cultural mediators and coordinators, indispensable for this type of project, may become integral for the entire scientific profession in the future.

6.4.3 Implications for Institutional Management

Russian-speaking researchers tend to concentrate solely on the production of codified knowledge when not stimulated to adapt to the new science system after relocation. This is asymmetrically reflected in their profiles. The final configuration of academic activities of each scientist is usually reached as a result of negotiation with the institutional management. Typically, in the variety of positions available, there is internal differentiation in terms of specialisation. Researchers with conserved identities pressed to work with industry may attempt to negotiate redistribution of academic activities towards, for instance, increased teaching, or take responsibility for the development of the international profile of the organisation by connecting it with post-Soviet countries.

Recruiting globally mobile researchers to work in a research organisation will invariably increase the international profile of this organisation in the field these scientists work in. Due to the fact that national collaboration networks of the internationally mobile researchers are limited, they compensate this by maintaining collaborations with their home country and other countries of employment. Sometimes developing and maintaining geographically diverse collaboration network becomes a personal strategy for some of these researchers. These networks may become institutionalised as they involve more people, artefacts and ideas circulating around. This may manifest in international events, visitors from other countries, circulation of doctoral and post-doctoral scientists.

Issues with adaptation and underperformance outlined above become less overt with subsequent migration moves. Interview participants noted that the first migration is usually the most difficult experience, while subsequent moves cause less stress, and in general interviewees reported getting used to moving frequently. With getting exposure to multiple research cultures and environments researchers get a chance to develop and mature, adapt their expectations and norms or, if they do not see the need, develop the set of practices
that confirm to the expectations and norms, which allow them to compromise in cases of conflict, and negotiate mutually beneficial employment agreements.

6.4.4 COUNTRY-LEVEL IMPLICATIONS
Interviewees, who left their home countries during the economic crisis of the early 1990s, mainly did so to stay in the scientific profession and work as researchers in public research organisations. Many did not regard alternative forms of employment, even if this was a research position in industry. However, scientists from the subsequent generations did not have these black and white views anymore. Several interviewees who were going through the phase of skills recombination caused by the career disruption or delay, seriously considered, or even found employment in high-technology research-intensive companies. This is an embodied knowledge spillover effect that occurs naturally with STEM graduates, and even with doctorate holders and contributes to the development of university satellite firms and regional innovation systems (Lin, 2015; Trippl, 2013a). Cases where émigré scientists move to work in industry is different, because of the difference in immigration legislation for scientists and for other skilled professions. For example, in the UK obtaining a work permit to do scientific research is insurmountably easier than obtaining the permit for work in the private sector, even if the type of position and the salary are comparable. Most research universities in the UK are Certified Sponsors and can sponsor non-EU workers, while less than 1% of high-tech companies are (Coadec, 2015). Therefore, universities may act as Charon and enable scientists to come over the Channel to the UK. After obtaining the Indefinite Leave to Remain, these scientists may leave the academic system and boost applied research and innovation.

Public engagement and outreach activity seems to be working in two ways. Some researchers established, or attempted to establish, outreach and engagement events in Russia jointly with the local participating organisations. Among those reported are workshops, summer schools, and summer internships for students. Whilst discussing his interaction with local German journalists, which he regarded as a nuisance, a professor with a mega-grant in Russia also mentioned outreach activities he went through there, such as interviews and radio shows. Going back to the issue of identity and belonging, some researchers such focus of the societal mission of researchers who tend to adopt diaspora behaviour suggests not the rejection of the idea of service as something that does not relate to science, but rather targeting the society where such activities may have an impact.
Remembering the fact that some researchers prefer to do outreach in their home countries rather than in the current countries of residence, it is important to understand changes in academic identity. This does not only relate to the researchers with the experience of migration, but also more generally to scientists employed in public universities: changing, or, rather, reverting set of practices that are expected from academics (Martin, 2012) is a serious challenge (Billot, 2010; Henkel, 2005). However, the choice of researchers to place their activities abroad, to commit to the development of another country, even if it is their home country, may be a signal of disbalance between their sense of being in one community, but belonging to another – which becomes the end beneficiary of their service.

This is an indication of important discrepancies in the societies of the receiving countries not only in the academic community, but also in the society in general. Dividing people into polar “us” and “them” categories, limiting mobility and access may result in the situation when foreign-born citizens, even if they receive full rights in the home country, are still confined to outsider positions in the public discourse.

6.5 CONCLUSION

Scientific research is the main asset and competence of the majority of scientists interviewed for this study. All of these researchers at various times during their career faced the dilemma of broadening up the scope of their academic activities towards bigger participation in the production of proprietary knowledge, education, outreach, and contribute to discussions in the policy community. These activities, albeit not remote from the main competence of interviewees, could be perceived as alien to their view of academic identity and the normative perception of the dividing line between a scientist and a businessman, a scientist and a TV presenter, a scientist and a politician. For some interviewees, crossing these lines was not acceptable, despite potential rewards of doing so, and potential punishment of not doing so. For others the attempt to act in a new capacity was a challenge in itself. This, latter, issue is uniform for all research workers in public research organisations who face the plethora of opportunities to enact their research competence in a new context.

Russian-speaking scientists occupy many positions in scientific communities of their respective countries, and fulfill various system functions, from doing highly theoretical research in ‘traditional’ physics and mathematics, to being knowledge moderators between their home and host countries, to developing broad academic identities and practice profiles
by engaging not only in research, but also in teaching, developing applications for their research, and advising policymakers on the advancement of science and technology, to developing unique interdisciplinary capabilities and research agendas, being on the frontier of nanotechnology.

As there is a multitude of roles in academia, scientists with different values, preferences and experiences fill in the roles they see themselves suited for. Processes that ease international migration, such as globalisation and its components, make it easier for scientists to move around, develop new kinds of ‘global’ academic identities and unique practice profiles. Eventually, there are more opportunities for those researchers who left their home countries, but did not find local research cultures to their liking. With the increased specialisations and heterogeneity among the components of scientific profession, there are plenty of opportunities for scientists to enact one or multiple strategies that reconcile their research culture with available practice profiles, and maximise research outputs. However, this heterogeneity also has pitfalls and constraints – both for scientists and for the organisations that employ them.

The next chapter outlines one of the transnational coping strategies that scientists use to advance their research and career development. Engaging in scientific diaspora activity, along with others outlined here, becomes a coping strategy that allows to find a compromise between own perspective on academic identity and institutional requirements. As this element is often overlooked during orientation for migrant scientists, inconsistencies may arise, e.g. scientists with migrant background who came from the former Soviet Union, would be less likely to engage in consultancy projects at a receiving university that has an entrepreneurial orientation. Moreover, in case consulting services are formalised and jobs are passed on to scientists from the central university-wide office, doing such jobs may lead to dissatisfaction. The strategy to form, or become a part of scientific diaspora, seems to be the only alternative to the adaptation to the rules and requirements of the host research system that may lead to a successful academic career.
CHAPTER 7 SCIENCE DIASPORA NETWORKS

7.1 INTRODUCTION
Science diaspora network is a specific type of network that only globally mobile scientists have. Chapters 4, 5 and 6 mentioned science diaspora networks, and it is a unique concept that relates to the macro-level picture of scientific migration; is an enabling mechanism of international scientific migration, as well as a knowledge and resource sharing tool; and it is also a strategy of reconciliation between academic culture and externally expected practice. Science diaspora networks is a concept that integrates findings from previous chapters together.

At the same time, science diaspora networks, along with the boundaries of academic practice examined in the previous chapter, is a part of the broader academic collaboration network that reflects post-migration coping strategy of globally mobile scientists. Scientific diaspora networks can have many configurations and are used by scientists with all identity types (conserved, multiple and shifted) for their specific purposes. Science diaspora networks affect, improve and mediate career development opportunities of researchers.

This chapter focuses on these, and other functions of science diaspora networks. As conceptualised in Chapter 2, current research on science diasporas is lacking in sophistication, and even the definition of science diaspora was refined in the section 2.3. This chapter develops science diaspora theory by, first, presenting the social field perspective on research networks and applying this to the concept of diaspora knowledge networks. It then proceeds to outline boundaries of science diaspora for various types of interview participants, and outline the variety of situations when scientists become engaged in diaspora networks. I use the concepts of being and belonging to distinguish various degrees of diaspora engagement. The second half of the chapter develops the notion of transnational diaspora spaces by applying the concept of transnational academic spaces to science diaspora networks, and discusses implications for research collectives, employing organisations and the home countries.

7.2 A SOCIAL FIELD PERSPECTIVE OF RESEARCH NETWORKS
The importance of professional network was highlighted previously, when it transpired that this is one of the most popular strategies for building a global career for Russian-speaking researchers. However, the importance of professional network stretches beyond enabling
mobility and providing channels for migration. Professional networks of scientists invariably extend beyond their employing organisations and, in many cases, internationally. Some studies make a claim that scientists work and operate within transnational spaces driven by ideas, artefacts and people being circulated through the network (Jöns, 2009). In basic science and in megascience, projects often are carried out by large teams of researchers belonging to different research organisations around the world (Crane, 1971). It is widely believed that networks in science organise themselves around research areas, or research problems (Mulkay et al., 1975).

The social field perspective of research networks suggests that professional networks of scientists extend beyond direct research collaboration networks, and there is mutual influence of network composition on research outcomes and *vice versa*. They may also include connections with practitioners, policymakers and the general public; more broadly, social networks with former schoolmates and coursemates who, while not necessarily follow the same pathway into the particular area of science a researcher is working in, can provide ideas, for example, for interdisciplinary research, if the network contact is also a scientist, or for broader engagement programmes. In a nutshell, the breadth of a scientist’s social network has impact on her/his professional activities to the same extent as her/his direct professional network (Miller et al., 2009). Therefore, broader networks increase social capital of scientists.

Scientists who live and work in countries other than where they received their training and started their careers have more limited national networks due to the lack of lifelong integration in the domestic social spaces and communities. Some studies highlighted the limiting nature of this lacking factor and the disadvantaged position of foreign-born scientists (Richardson and Zikic, 2007). However, these scientists have broad transnational networks that span across their home country (family, relatives, schoolmates) and other countries (other globally mobile researchers of the same descent). This feature distinguishes all globally mobile researchers, and is the unique attribute of their professional network.

While relocation to a different country never happens without loss of social capital, existing skills, competences and networks may acquire new, additional value in the new context, as they are recognised as uniquely beneficial for professional development. This tends to happen in most cases of international migration: some skills are devalued, while others are recognised as ‘migrant capital’ and are celebrated (Erel, 2010). For the globally mobile
scientists, such ‘migrant capital’ is their predominantly home-country oriented research network at the time of migration. Post-relocation professional development invariably raises the issue of managing and sustaining the existing professional network, developing new ties within the new country, or building a broad transnational network.

Among theories that engage networks in the analysis of research results there are perspectives that attribute any production of knowledge to the networks this knowledge is a part of, which includes people and artefacts alike (Latour and Woolgar, 2013). Other, more conservative perspectives, still admit the importance of the social and cultural context for research activity in terms of developing shared norms and practices (Andrew et al., 2009). While there is little doubt that networks in which scientists are embedded to a significant extent determine the direction and the scope of their immediate research activity in terms of seeking relevant information, setting priorities for future research projects, and sourcing collaborators and research staff, the problem is in distinguishing degrees of this influence, especially in the case of managing networks that include various languages and nationalities.

A simple example of the influence of different components of research network on research practice and the agenda setting is in analysing policy priorities of main funders of research in the country where a researcher is employed. For instance, the UK adopted an initiative called ‘Eight Great Technologies’ in 2013, a part of the UK government’s industrial strategy (GOV.UK, 2010), listing among them advanced materials, where nanotechnology finds direct application. A promising advanced material in the strategy is graphene, discovered in Manchester University. Some studies speak about the ‘graphene hype’ around the world, especially in the US and China (Mukhopadhyay and Gupta, 2011; Shapira et al., 2015). UK is also actively developing its capabilities in research and commercialisation of graphene. At the same time, an analysis of Russian publications and patents in the areas of various carbon nanostructures demonstrates diverging capabilities (Terekhov, 2015). Russia’s research activities in graphene are one of the worst ones among the developed and the developing countries. In contrast, Russia is a leader in the publication, and has big economic potential, in the areas of fullerenes, nanodiamond and other, non-graphene, types of nanocarbon.

For Russian-speaking diaspora researchers who work in the countries where graphene is in the top of all lists of science funding programmes, there is, therefore, a dilemma of setting their future research goals. For a scientist who already has an expertise in nanocarbon
materials research it is not a big effort to switch from studying one material to another. In fact, such ‘hopping’ is an accepted practice in some groups.

If ‘hopping’ is not a big deal for some, changing the structure of research collaborations is. If a scientist is embedded in research collaboration networks with a group in the home country, that group, presumably in Russia, wouldn’t be flexible towards changing their research topic from, for instance, nanodiamond to graphene, because of inflexible funding, dense networks and the overall rigidity of agenda-setting of the Russian academic culture. A choice for the scientist abroad is, therefore, to either remain closely connected with this established and steadily working collaboration, or move away to new research areas and start building a broader network with researchers who share the interest.

While the example is to some extent idealised, every researcher who moves abroad inevitably faces this dilemma sooner or later during the course of the career development. Research network configuration has influence on all aspects of research practice, from agenda setting to the types of research grants a researcher applies to and the promotion prospects. Therefore, some scientists may choose to severe all professional links with the home country to not appear to be ‘unprofessional’. Others choose to maintain some degree of engagement with the research community in their home country or with the community of Russian-speaking scientists abroad. The reasons and effects of these decisions vary and will be discussed below.

In fact, regardless of the decision, most researchers maintain some kind of links with other Russian-speaking scientists abroad or at home, simply because of friendship, family or nostalgia, even when these friends are also scientists, without maintaining professional links. Of course, such networks may transition from potential to active collaborations, but, generally, there is a degree of separation. Using the diaspora network definition, the dividing line lies in letting language and culture-based professional links in the immediate research practice of each scientist. The intention to maintain this separation, as it is formulated consciously by many researchers who participated in this study, strictly delineates the boundaries of professional collaboration network.

Themes of separation of various types of communication with certain communities, and themes of belonging to certain types of communities (American scientific community; Russian science diaspora community; global nanoscience community) were brought up repeatedly in the interviews and have high significance for the majority of interview
participants. Being a part of a community, or being selective about one’s immediate professional network is a core aspect of academic identity and a decisive aspect of academic practice. The influence of the environment is a shaping factor of the identity shift and can be conceptualised as a network influence.

Social and professional networks constitute the social field of the Russian-speaking science diaspora. This field spans across general social interactions with other Russian-speakers abroad, maintaining links with other émigré scientists. It also incorporates elements of this field in the professional activity. The social field is transnational: it spans across multiple countries and continents, encompassing social networks of émigré scientists and the sense of being embedded in them.

Generally, the effects of being a part of a Russian-speaking diaspora tend to increase as the role of this part of network increases among other elements of the immediate professional network. At the more advanced stages, it may manifest in physical mobility – when some professors help found laboratories in their home countries and regularly spend extensive periods of time there, which has strong and noticeable impact on other aspects of their academic practice. However, there are options for less strong engagement.

7.3 Degrees of Diaspora Network Engagement
The social field of science diaspora is multidimensional. First, there is a general issue of communicating with broader diaspora of other Russian-speakers – skilled as well as non-skilled persons who relocated abroad after the breakup of the Soviet Union. Second, there is an issue of maintaining links and collaboration with other Russian-speaking émigrés. Such communication can be termed as ‘transnational academic networks’. These networks may either remain within the field of mutual professional activity, or be confined to general links of friendship and shared past. Finally, there is an issue of communication and professional collaboration with other scientists who remain in the home country or other post-Soviet countries. These communications are a widely discussed ‘engaging science diaspora abroad’ problem, which also has political influence for host and home countries, as well as a developmental dimension.

The border between professional and nonprofessional communication is embedded in the term used to describe this communication: the word ‘diaspora’ is contentious and caused diverging reactions and responses among the interview participants. Admitting to be a part of a ‘diaspora’ is to be backward, Soviet, and, ultimately, not modern. All these contradict an
image of a scientist engaged in frontier research. Therefore, interviewees often drew rigid lines delineating themselves from general diaspora groups, even in those cases when they had relationships with those groups. Details about this boundary work can be found in Appendix 8.

7.3.1 Engagement with Other Émigré Scientists and with the Home Country
Several interviewees have long-term sustained collaborations with other Russian-speaking authors situated in their home countries or abroad. Others work in university departments where almost half of research staff are Russian speakers. A minority had advanced collaborations and projects with research groups in Russia. However, for reasons that could affect their reputation, mainly, implying bias in selection of co-authors and projects, these scientists did not internalise, and some of them outright refuted, a suggestion that they could be a part of a ‘scientific diaspora’ or even a ‘professional community’ of Russian-speaking scientists.

Separating professional diaspora links from nonprofessional diaspora ties seems to be important for interviewees. For some of them, in addition, separating professional Russian-speaking links from other professional links is of particular importance as well. While general research of social ties represents interconnectedness and fuzziness of thereof, it is curious to analyse the reasons why Russian-speaking nanoscientists so often draw strict boundaries between different types of networks, and rationally construct [non]engagement strategies.

The analysis proceeds by using two core concepts from the social field theory of migration: being a part of diaspora network, and belonging to one. Following the interpretation offered in the section 2.2 (Conceptual Framework), being a part of the science diaspora field means engaging in any activities and relationships that have an association of the diaspora identity. These may include joint publications with other scientists of the same origin, maintaining professional relationships with research organisations in the home country, participating in domestic conferences and other events, such as summer schools and seminars, teaching domestic students, including web-based teaching.

Belonging to the scientific diaspora is expressed in a different manner. Levitt and Glick Schiller (2006) designed their theory for identifying cultural and religious social fields that do not coincide with container national borders. According to the authors, wearing a Christian cross or adhering to a particular type of cuisine is a way of belonging to a specific (religious or ethnic) social field.
Professional community has different codes for signaling belonging. First, any indication of formal membership in a diaspora organisation can be portrayed as belonging. Any affiliation with domestic organisations, or engagement in the home country policy programmes indicates belonging to the diaspora community. It becomes more difficult to identify belonging to the science diaspora field in the absence of these clear parameters. For example, does a shelf with Soviet physics textbooks signal a post-Soviet identity, or just mild nostalgia? Such signals can be interpreted as ‘symbolic ties’ – perceived bonds that do not necessarily rely on continuous series of transactions (Faist, 2000: 102). Symbolic ties can be activated by members of the community at any time and transition into social ties, but generally, they serve as links that integrate a group of strangers into a community.

Due to research design of this study, the opportunity to observe symbolic ties that indicated belonging to a science diaspora field of the émigré scientists was limited. Books in Russian, posters for Summer Schools on the office doors and some cultural insignia are among the few I noticed during the research fieldwork. But more importantly, the presence of artefacts that signaled diaspora belonging was accompanied, in most cases, by the vocal acknowledgement of this belonging and of the diaspora identity of a researcher. In other words, in most cases, there was a direct connection, because diaspora engagement was a conscious strategy in that particular researcher’s academic practice.

Therefore, I came to understand the way of belonging to the science diaspora as a conscious and rational strategy that shapes the scope of activities of a researcher. However, a discrepancy exists for some interview participants between being a part of the Russian-speaking diaspora and belonging to it, i.e. having a diaspora identity. This is discussed in detail below.

7.3.2 Being and Belonging to Science Diaspora: Collaborations Analysis

While social fields contain multiple types of entities, including organisations and institutions, the core structuring component of the social field is the transnational network that constitutes its membership (Levitt and Glick Schiller, 2006: 1009). There are multiple ways to trace network membership, which are mainly qualitative, but in the area of academic practice there are formal collaboration networks that serve as a proxy of professional networks.

Publishing papers jointly with other Russian-speaking scientists for émigré researchers is a result of long-term (sometimes, several years) continuous communication. A firm link that
exists between co-authors of jointly published papers is taken as a proxy of ‘being’ a part of the science diaspora field, as this is an actual practice of engagement with other Russian-speaking scientists.

The way of belonging to the diaspora field was assessed by directly asking questions about being a part of the Russian-speaking community abroad, about links with the home country or Russia, and whether the majority of research collaborations of the interviewee scientists were done with other Russian-speaking researchers, regardless whether those collaborators reside in Russia or abroad. The question is a simple indicative measure of perceived diaspora engagement.

Out of 61 scientists employed in public research organisations, 58 provided information about their links and collaborations. About a half of the interviewees responded negatively. The other half responded with a positive answer with a varying degree of firmness. They were further divided into a group ‘yes’, classifying those interviewees who were sure that they predominantly collaborate with Russian-speaking scientists, and in the group ‘yes, but’ for those 8 researchers who were not quite sure, but were not negative.

While it is clear what is “yes” and what is “no”, the distinguishing principle of the “yes, but” group is interviewees who (1) were not sure whether it is research collaboration pattern overall that counts or just recent track of collaborations; (2) attributed higher significance to Russian-speaking collaborations in their network, be it ongoing projects or the shaping influence of advisors in the early career.

These concerns indicate two trends in the diaspora engagement: first, a researcher can become a part of a science diaspora community, but, over time, she/he can leave this community due to many reasons, including subsequent migration, new projects, changing research topic or a research field, or a personal strategy. The second tendency is the perceived importance of diaspora links as contrasted with other research collaborations and links.

During the data analysis stage in Spring 2015 the data on publication activity of interview participants was collected and analysed. Scopus was used as a source database of publications, due to the reason that it contains a way to distinguish authors, thus greatly diminishing author identity problem, developed as a unique digital number jointly with ORCID (Scopus, 2016). Therefore, author data search in Scopus returns relevant and
consistent results as long as the full name and affiliation is known. Recent publication data was collected for interview participants. As the majority of answers related to the present-day situation, the data was collected for the 5 years preceding the interview up to the end of 2014, when last interviews were collected, thus setting the time period for 2008-2014. The data for 56 researchers was collected due to the data availability.

The author data was then cleaned, and the coauthorship analysis carried out, using the surname-based procedure outlined in Chapter 4. As a result, the data files were merged into three separate datasets for the “No” group, “Yes” group, and the “Yes, but” group. The number of scientists who answered negatively is the biggest – 34 researchers (almost 60%) did not perceive that the majority of their collaborations were with Russian-speaking scientists. The other two groups were divided evenly into 14 and 10 scientists for the groups ‘yes’ and ‘yes, but’ accordingly (Table 14).

<table>
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<th>Population</th>
<th>Papers Published</th>
<th>Papers per interviewee</th>
<th>Average number of citations</th>
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<td>14</td>
<td>422</td>
<td>30</td>
<td>10.8</td>
</tr>
<tr>
<td>3.'Yes, but'</td>
<td>10</td>
<td>357</td>
<td>36</td>
<td>22.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Average number of co-authors</th>
<th>Average number of Russian-speaking co-authors</th>
<th>Average Share of papers with Russian-speaking co-authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>62</td>
<td>11</td>
<td>51%</td>
</tr>
<tr>
<td>1.'No'</td>
<td>78</td>
<td>11</td>
<td>30%</td>
</tr>
<tr>
<td>2.'Yes'</td>
<td>36</td>
<td>11</td>
<td>70%</td>
</tr>
<tr>
<td>3.'Yes, but'</td>
<td>60</td>
<td>14</td>
<td>52%</td>
</tr>
</tbody>
</table>

Table 14 Co-authorship Patterns of Interview Participants

Source: author

Scientists from all three groups have Russian-speaking collaborators. With the average rate of about 50%, scientists from Group 1 demonstrate the lowest rates of collaboration with other Russian-speaking researchers, averaging about 30%. Group 1 researchers published more papers on average and also had more co-authors. However, average citation rate is higher for scientists who had concerns about the majority of their collaborations with the Russian-speaking community.

Among the Group 1 scientists, a quarter (8 researchers) actually have over a half of collaborated papers co-authored with other Russian-speaking scientists (Figure 24). This may
be due to interpretation issues, but may also indicate at the perceived importance of non-Russian collaborations over Russian-speaking collaborations and the ‘not-belonging’ stance of these scientists. Among them, two researchers are engaged in science diaspora policy projects in Russia and are developing laboratories there. The relative lower importance of working on these laboratories and the relative breadth of their general professional networks may be an indication of their positioning in answering the interview question.

Figure 24 Distribution of Co-Authorship with Russian-speaking Scientists among Interviewees

Source: author

In Group 2, three researchers actually had less than a half of their papers collaborated with Russian-speaking scientists. All three of these scientists are actively involved in professional and non-professional diaspora community in their respective locations. Coauthorship patterns probably do not reflect their deep involvement in science diaspora activities. Similarly, in Group 3 scientists who published less that a half of their work with Russian-speaking coauthors warned that their overall collaboration rate with Russian-speaking scientists is not major, but major papers were coauthored.
It is not a new idea that researchers assign different value to publications collaborated with different groups of co-authors. There is also no clear distinction between the type of researcher who engages in co-authorship practices with other Russian-speaking scientists. All interviewees have this element as a part of their research network. However, some scientists are more vocal and open about this practice than others. The following sections review the reasons why.

7.3.3 Maintaining of Aborting Diaspora Membership

The discrepancy between being a part of the science diaspora and the diaspora identity is a curious result that relates to perceived benefits of being a part of the diaspora community versus disadvantage (mainly, reputational) that affiliation with a diaspora may bring to a scientist. On the contrary, some researchers, including mature and senior scientists, were happy to be a part of the diaspora as well as identified themselves with it. This part of the chapter covers the three types of the engagement in the science diaspora field that Russian-speaking scientists exhibit:

1. Not Being and not Belonging - Alienation
2. Being, but not Belonging – Pragmatic
3. Being and Belonging – Diasporic Identity

These three types partly correspond with the three kinds of identity change outlined earlier in the chapter, but do not fall exactly in those categories. While the three types of identity reflect the change of research practice and academic self-image, the three kinds of the science diaspora field engagement cover the variety of networking strategies and social memberships of researchers. As such, the ‘diasporic identity’ strategy encompasses both scientists who chose to conserve their identity, but also those ones who have multiple identities and take the best of both worlds. The Alienation identity, the direct opposite, includes researchers who experienced a complete identity shift along with researchers who maintain multiple identities, but choose to not engage with diasporic networks for various reasons.

Not Being or Belonging

Not being a part of the science diaspora field and the resulting ‘not belonging’ in it is an outcome of multiple situations. The general divide lies between the conscious separation from professional diaspora links, or even the denouncement of those colleagues who do not follow the same path. Some interviewees took a strategic attitude to sever the links with
the home country as they left abroad, and not to partake in any professional diasporic activities. One reason that is outlined above is a metonymic transition of meaning of the term ‘diaspora’, which, due to this transition, is perceived as ‘encapsulation’ and conservation in the past.

Sometimes researchers did not see a reason in maintaining the Russian-speaking part of their network. Scientists enjoy membership in relevant professional communities, where they are able to communicate, among others, Russian speakers. For some interviewees, maintaining two separate networks – general professional and Russian speaking professional – is seen as doubling the functions and ineffective use of resources. In the words of a US Assistant Professor, “It’s in some respect unethical to choose co-authors on the basis of language”.

Second, reputation and professional recognition are important in the academic communities. It is expected that the professional network of an academic is based on the proximity of research areas and mutual interest, not on long-running path-dependent language-based collaboration links:

“I know quite a few Russian-speaking professors who received their PhD here [in the USA – MK]. They, for example, avoid employing Russian students in order to not imply that there is a cultural and what? And national bias” (Assistant Professor, USA).

Some senior professors who left the Soviet Union/Russia in the early 1990s were concerned with building excellent reputation abroad, and adopted such alienating approach to professional network-building by confining most or all Russian-speaking links to friendship or general social ties.

Third, some narratives suggest unfair competition among post-Soviet scientists for scarce places in academia in the years of mass emigration. These have reputational implications as well. Similar concerns arise when recent Russian attempts at the engaging diaspora policies are discussed. For example, a full professor in an elite UK university is strategically not maintaining any links with post-Soviet countries and Russia because of reputational concerns.

However, not all non-engagement reasons are so negatively driven. For some, non-engagement with the Russian-speaking community was not a particular choice, but rather was not a part of their professional development strategy. Several interviewees left abroad
and had an exciting career where they were globally mobile and not constrained to the Russian-speaking research network. As a part of their professional development, their research interests were changing, and at some point stopped overlapping with the research agenda of home country scientists, and many diaspora scientists. In these cases, even if the attempts at establishing links were made, they were often unsuccessful:

“No, I do not [maintain links with the home University – MK]. It is partly because they have a different subject-matter than I have now. Only because of this, because [my home University] – it does solid state research, and I’ve moved onto optics. Another difference between Ukraine and America is that in America the research directions are more modern. Over there they are lagging behind a bit, they do more classic research. Over here, when new research directions are starting to develop, everybody hops over and starts doing new research. Just because of this I do not maintain any links” (Associate Professor, USA).

This somewhat natural divergence of research agendas in the course of professional development is popular among the explanations of not maintaining links with Russian-speaking scientists. Moving to another research area can cause waning of links very quickly, much like in the example with the graphene and carbon nanostructures earlier in the chapter.

In most cases, a potential to re-engage in the science diaspora remains, because few scientists sever Russian-speaking links completely. They may get restricted for various reasons, including a strategy to broaden the non-Russian speaking network and thus to decrease the relative importance of the Russian-speaking part of the network, improve the language proficiency, or establish new collaborations with ‘star’ scientists abroad, but the opportunity to bring the domestic links back in in many cases remains.

**Being, but not Belonging**

To be seen as a part of ‘science diaspora’ seemingly emphasises the role of ethnicity, nationality and language over research ability, proximity and complementarity of research topics, and all other factors that motivate scientists to form long-term collaborative networks. This is especially sensitive in departments with well-formed and clearly defined scientific diasporas. In these circumstances, interview participants were keen on making it clear what was driving their research:

“If you count my co-authors formally, then indeed the majority of them will be Russian. And the majority of them do not live in Russia. But then again I am not sure that Russian-speaking is the main factor here. It is… how do you call it… Don’t even know how to say it in Russian… It’s accidental. It happened and it played its part, but
The ambiguity of being a part of the field, but not belonging to it is driven by the same concerns as for the scientists who do not engage in diasporic activities altogether. By emphasising the accidental nature of using Russian as the language of science among his collaborators, this Associate professor drew a clear line between being a part of a specific science diaspora field and his own non-membership in it.

Russian-speaking scientists abroad cluster together and collaborate, but this tendency cannot be attributed to diasporic networks alone. As Russian science is only competitive in very few research areas. Internationally competitive scientists with post-Soviet upbringing, therefore, cluster in these few research areas. Eventually, many émigré scientists have very similar specialisations and are less distanced from one another than from other scientists in their host organisations. In some cases, universities who were aiming to develop a particular strand of research – such as theoretical physics – would recruit several Russian-speaking scientists to carry out this task. Therefore, unless a scientist changed the topic, there are more opportunities to collaborate with other Russian-speaking researchers due to proximity of research areas.

As maintaining the majority of collaborations with other Russian-speaking researcher can be seen as a negative trait, it may potentially have adverse effect on career development prospects of scientists who do not yet have permanent positions. Therefore, these scientists realise that they are a part of the science diaspora field, but they make it clear that they also do not belong to it, stressing the fact that they do not limit themselves to Russian-speaking areas, topics and communities.

**Being and Belonging**

Despite various professional and reputational concerns, many scientists choose to stay in touch with Russian-speaking collaborators and even develop more advanced transnational diaspora spaces. In science diasporas, search networks, knowledge networks, (Kuznetsov and Sabel, 2006), support networks (Shuval, 2000) and resource networks (Bilecen and Faist, 2015) are distinguished. Diaspora knowledge networks represent a smaller part of the broader professional network of a researcher that provides information about relevant opportunities.
Some researchers do not see a problem in being a part of the science diaspora field, for as long as they are open to other opportunities. Knowledge circulates across all types of network, but in case with diaspora knowledge networks, the circulation is specific to academic culture and activities of Russian-speaking scientists. Scientists who are engaged in the science diaspora field in terms of being and belonging to it, prefer to receive such news and are more receptive to opportunities coming from the home country.

Science diaspora links provide support and give a leeway to settle in the new country context. As highlighted in Chapter 5, many young scientists use the network strategy – their links with the overseas diaspora - to leave their home country, but afterwards change behaviour and utilise more general tools for the job search, especially at the stage of looking for permanent positions. For some of these researchers, science diaspora network was not significant beyond the initial move from the home country.

For others, there were additional benefits in staying in touch with the Russian-speaking part of the network, such as opportunities of onward mobility within the transnational diaspora, or the opportunity to gain tacit knowledge about the research system without advancing for a radical plunge. Moving abroad, but communicating with scientists (mainly, the supervisor) in Russian was a smoother transition for doctoral researchers. They also gained knowledge of independent search and strategy of applying for academic jobs in the host country.

The support function of the science diaspora field is specific to this type of network. As tacit knowledge is embodied in an individual and is transferred with the movement of this individual (Nonaka and Takeuchi, 1995), when globally mobile scientists initiate their first move, they aim to act in the way their previous experience dictates. But, due to the lack of tacit knowledge and the understanding of the alien institutional structure, there are often missteps in these earlier phases of adaptation. For instance, for a currently full Professor in a US university it was a hard lesson after being invited to apply to a position in Princeton:

“The problem is that the [academic] interview procedure over here [in the USA] has standard components, procedures, when a person is appointed to do academic work in a university. And, to my regret, I was not familiar with the details, the components from which the interview would consist. I knew that I needed to give two seminars – one on my current research, and I did it very well. <...> Because I was a person totally unfamiliar with this whole thing, it was a complete surprise for me, and, of course, I failed the interview dramatically. So I was told that I was an intelligent person, but I had no idea what I was going to do. I was not familiar with the university system or with the funding system, or with how the national research system works. It was a
couple of years after I came here. I was just doing my research and didn’t give much thought to any interviews. So the first part was very good, but I failed the second part. But I also gained experience” (Professor, USA).

The lesson for the US professor was to cut off the temporary research work and focus on securing a tenure-track position, because the portfolio of scientific achievements was impressive, but his lack of knowledge of the local system meant that he may have been lingering in a postdoctoral position for too long. Eventually, his search was successful. These mistakes and the discrepancy in expectations are commonplace among globally mobile scientists and can be avoided when science diaspora is enacted as a support network.

For mature scientists who are a part of the overseas diaspora, young post-Soviet researchers constitute benefits brought by their language, academic culture and the quality-price balance. Doctoral and postdoctoral researchers are a useful resource circulated in the science diaspora field. This, along with financial and other non-financial exchange elements, is one part of the resource network role of the diaspora (discussed in more detail below).

Finally, science diaspora engagement may supplement career returns for mature researchers. For those scientists who occupy permanent positions, but without access to the independent research agenda-setting function, science diaspora engagement is a route to make a difference in the department and increase a researcher’s symbolic capital (Bourdieu, 1990) by enacting it not in the mainstream career development path, where the cap is often already reached, but instead in the capacity of becoming a mediating link between the home country and the host country, hereby increasing the informal power and prestige in the employing organisation and internationally.

Scientists who adopt this transnational strategy act as mediators and brokers in international scientific cooperation. They sometimes directly work with national governments, take semi-formal positions in the science diaspora communities, or source Russian-speaking students. In the words of a Swiss researcher, “not all Russians [who came here – MK] became my PhD students, but they all came through me”.

These activities increase symbolic capital of these scientists and give them access to actions and resources that would not otherwise be accessible from their current formal positions within employing organisations. For these researchers, science diaspora engagement becomes a rewarding way to develop professionally and make a difference in the home and in the host country alike.
In other cases, interviewees who were not able to maintain full-time academic career used science diaspora links to remain connected with academia, and channeled their capabilities towards brokerage and global technology transfer, acting as intermediaries and development agents, as outlined in the literature (section 2.2.2). Both sides yield great benefits from activities of these researchers, especially if their employing organisations are situated within the reach of technology hubs, such as the Silicon Valley. By having expertise in cutting edge research and being active researchers themselves, but also by being able to understand business culture both in their home and host countries, these scientists offer the services of advanced knowledge and technology transfer for both parties.

Finally, the most conventional, but also the rarest form of ‘being and belonging’ in science diaspora field is direct participation in research in the home country on the part of full Professors. For them, science diaspora is often a way to overcome career development cap. Professors, who do not wish to grow in the ‘administrative career’ capacity, often choose to extend their research geographically. This is not a specifically case with the Russian-speaking scientists, but rather is a widespread practice among mature professors. The geography of locating their spatially distributed research in the post-Soviet space is what distinguishes the Russian-speaking researchers.

For the Professors who participated in this study, setting up a laboratory in Russia and going there for several months at a time has proved to be a very rewarding experience: it was a challenge, but at the same time, their resources, opportunities, agendas and outputs grew exponentially. The recent trend towards return migration to Russia and other post-Soviet countries also opened this path for younger academics as a way to bypass limitations imposed in their current workplace.

The science diaspora literature suggests this as the main role and the function of the overseas diaspora, but in fact, it is a very advanced stage of engagement. However, this strategy has implications on the overall profile of academic practice and even the type of space in which diaspora scientists operate. This is outlined in the next section.

7.4 TRANSNATIONAL DIASPORA SPACES
As was discussed above, globally mobile scientists maintain multiple identities, specific academic practices, and bring embodied tacit knowledge to organisations where they relocate. If the share of globally mobile researchers is low, this may have little or no impact on the overall configuration of research practices and orientations in the host organisation.
However, if a ‘critical mass’ is reached and a science diaspora field is formed, combined knowledge, expertise and normative perceptions of diaspora researchers may result in changes in the overall profile of the research organisation, usually, a university department, or within the space of one laboratory. This may relate to something that is easy to notice, such as the use of language, but changes may also be subtler.

During the research fieldwork two organisations with the distinctive science diaspora spaces were identified, and in each several interviews were taken. Both universities employed more than 4 Russian-speaking faculty members in the department, and both department heads were Russian speakers. Several other interviewees gave accounts of being a part of science diaspora spaces and then leaving them during subsequent mobility.

The first such space (in the USA) researchers demonstrated a distinctive ‘being, but not belonging’ strategy, insisting that the clustering of the Russian-speaking faculty in the Physics department was accidental and there are no professional or institutional links with other Russian-speaking researchers, or with the home countries.

In contrast, scientists in the second department (in Germany) had fully formed diaspora identity. There was a breadth of collaboration between department researchers with several organisations in Russia, and with other Russian-speaking scientists abroad. Interviewees from other organisations pointed to this department, naming it a ‘professional community’.

Finally, Russian-speaking scientists who were recruited to the department in unrelated ways got involved in diaspora activities.

The reason why science diaspora spaces are formed in some cases where the ‘critical mass’ of researchers is reached and are not formed in others is primarily due to the fact that being a part of a science diaspora is a realised, conscious and rational strategy for most, or all involved researchers, that brings particular benefits that outweigh the risks (reputational and others) that the diaspora engagement may have. As any strategy, it is adopted under certain circumstances and can be discarded when these circumstances change. As a way to stress this statement, below is an account of a US Professor who utilised the diaspora strategy as a way to reach a career output maximisation:

“Professor: Back then, of course, I had to take many students from the Union in order to cope.

MK: You “had to” take students from the Union?
Professor: The locals were too weak. There weren’t many options. For example, you need to recruit students for a research project. Your university is good, but is still 40-something place [in the national ranking – MK]. So you select among those who apply to this university. To a 30-something place university, for example, only 5-10 domestic students apply with not a very good record from OK universities. The problem is that when you are growing your group you need to constantly keep recruiting new students, right? And you need to recruit fairly intelligent ones. So when my group grew to 10-15 students I had to have a reliable source of good students, and the source was the former Union. Half of my group there were Ukrainians, Belarusians and Russians, mainly from universities I know, mainly, of course, from my friends and through my friends, well, as per usual. This is how people get by in smaller universities. Over here the situation changed, of course. In [this university] I am in a completely different situation. Here, I have a group of 20 people and I only have 2. And even these two – because they applied themselves. Here, there is a completely different situation in top universities, and this is a top-5 university, here is a large stream of good domestic students. I have a choice: for example, 100-150 domestic students apply to the graduate school and we only admit 30, it’s already 5 to 1 competition. And then there are hundreds of foreigners, we also only admit 10. It’s 20 candidates per place. And they are perfect candidates. Here, candidates of the Soviet descent lose in quality” (Professor, USA).

As mentioned earlier, research students are the main type of ‘resource’ in science diaspora networks. If a Russian-speaking scientist is employed in a research organisation that is not competitive enough in terms of attracting good quality domestic students, it impedes research progress. At the same time, scientists employed in top organisations that attract the best students see their research progress smoothly.

Globally mobile scientists enact different type of resource – students from Russia – as a way to overcome this problem. The need for science diaspora engagement strategy diminishes as mature researchers move to better organisations, or, as prestige of their employing organisation increases, and it starts attracting better domestic students.

As science diasporas emerge when there is a necessity, they are constantly maintained by interested faculty members, usually with permanent positions and associated resources at their disposal. The requirement to continuously work towards maintaining links and contacts with other Russian-speaking scientists and with researchers in the home country only continues as long as there is a direct rational purpose in maintaining these links. At the same time, diaspora interactions may happen to a different extent: some researchers engage in mutual collaborations and establish formalised institutional links with home country
organisations, but others limit to student exchange and joint projects based on informal networks, rather than using formal channels.

![Science Diaspora Life Cycle](image)

**Figure 25 Science Diaspora Life Cycle**

Source: author

As a result, each science diaspora goes through stages from inception to the decline in a cyclical manner (Figure 25). The details about the four stages of science diaspora life cycle: the initial contact, when the necessity to engage science diaspora is established; field formation, where initial circulatory movement of persons and objects across countries is established; mature science diaspora, when these movements may become institutionalised in forms of teaching or research programmes; and diaspora decline, when the need to maintain intensive diaspora links is lost.

Detailed account on the four stages is available in Appendix 9.

**7.4.1 Simultaneity and Layering of Space**

Science diaspora space does not imply transnational links. Collyer and King (2014) stress that creating transnational spaces also creates opportunities for the home country governments to exercise power outside its borders – by controlling access of diaspora members to its territory, by controlling funds it provides, and other legal entanglements it may have the
impact on. As the Russian state is often quite aggressive towards its citizens at home and abroad, some science diasporas are deliberately not transnational, and the members refute ‘belonging’ to one.

The diasporic formation of Russian-speaking scientists in the USA has tight collaborations structure in the department among the Russian-speaking faculty, recruits Russian-speaking researchers and is a part of a loose network that combines professional and personal elements, stretching across the Russian-speaking community of scientists in the USA. However, no transnational elements were revealed. The academic space that the Russian diaspora was preserving, served rather to maintain institutional identity, and shield scientists from bureaucratic impediments.

For scientists who do not have these reservations, science diaspora field almost always constitutes the involvement of some kind of transnational aspect – be it formal collaborations with other Russian-speaking scientists abroad, or working with the home country. In cases where mature diaspora exists, it is more suitable to discuss the ‘transnational science diaspora field’ as a certain type of space created and maintained by diaspora scientists. It is a physical space populated by Russian-speaking scientists and recognised by other researchers, when, quite literally, “the entire floor here is Russian”, in the words of a German Professor.

At the same time, science diaspora field is a symbolic space that signals the existence of an outlined community with a number of norms and practices that are different from the norms and practices of other scientists in the department.

The German mature science diaspora field is very heterogeneous: it has generational divisions, but also cultural divisions. Initially several professors who were graduates of the same university formed the diaspora, but they maintained identities of belonging to the ‘Moscow school of physics’ and the ‘St Petersburg school of physics’ in terms of the Soviet regional academic cultures, and kept their identities separate.

Being a part of a transnational social field implies maintaining networks and associations across borders. In a research capacity, these associations and networks are professional and bring along mutual research interests and collaborations, ‘associate membership’ in local research organisations, and other forms of transborder research engagements. Transnational social field encompasses people who move abroad and are mobile globally,
those who remain in home countries, and networks that constitute communication and exchange between the two groups.

Transnational science diasporas have two distinctive features in the way they change the nature of social interactions and structural configurations of scientists and institutions involved in the field. These are simultaneity and layering (see Figure 26). Simultaneity is a feature of engagement in the activities relating to several national entities on the part of science diaspora researchers. Layering relates to the processes of institutional change in research organisations with mature science diasporas.

![Figure 26 Transnational Social Field Positioning](image)

Source: author based on Levitt and Glick Schiller (2006); Tsuda (2012); van der Heijden (2011)

Simultaneity of transnational social fields refers to the ability of migrants “to simultaneously affect and influence both the sending and the receiving countries” and is operationalised through “simultaneous participation and dual engagement in two nation-states” (Tsuda, 2012: 632). In relation to science diaspora, simultaneity is revealed in regular engagement of diaspora scientists in research activities with scientists in home countries, including visits.

For instance, a Russian-speaking French Professor has been actively developing diaspora links with Russia for several years. His latest achievements at the time of the interview included setting up a laboratory and developing a joint-degree Masters programme between that Russian university and a French university. Talking about the extent of the simultaneity of connections, he said:

“From 1/5 to 1/7 of my projects have been with Russian or Ukrainian scientists. Usually there are people from different countries in my group, but recently there
have been especially many Russians. But at the same time I am actively instigating the use of French language in the lab” (Professor, France).

While he was visiting Russia regularly and contributed a lot to the overall pace of Russo-French international science cooperation, he is also simultaneously operating in multiple social fields. Despite the great extent of diaspora engagement, he insists that his laboratory is a French space, separating the two by the use of language. Therefore, diaspora scientists not only exist simultaneously in two research systems, but transnational science diaspora fields exist simultaneously along with other social fields and scientists can drop in and out of those fields depending on the purpose and the type of activities they are engaged in.

Postgraduate students, postdoctoral researchers and visitors, who constitute the main mechanism of keeping the science diaspora field intact, are most affected by the simultaneity of transnational being. They are grounded in several social fields at the same time, as they often have families in their home countries, but they are actively engaged in building and maintaining social networks that transcend national boundaries (Gargano, 2009).

By being engaged in a science diaspora space, Russian-speaking scientists acquire the ability to negotiate some of the expectations of university management and establish own rules of the game. In particular, the university’s expectations for scientists to produce research results that have the immediate societal value, such as doing industry consulting, public engagement, or becoming entrepreneurs themselves, do not always go well with scientists of the post-Soviet research culture. While stand-alone scientists who have narrow research-focused academic practice profile may be regarded as not willing to adapt, science diaspora field creates the space that protects certain elements of the ‘Soviet’ academic identity. Science diaspora communities may engage in bargaining with their employing departments for recognition of international collaborations with Russia as wider outreach and impact.

The second feature of science diaspora field is layering. Layering is an institutional theory concept that describes a type of evolutionary institutional change. Boas (2007) conceptualises the layering process as incremental change: “an institution is changed incrementally as additional rules or structures are added on top of what already exists” (p.47). The process of layering of social fields reflects a similar type of incremental change, such as the use of language among research students in the laboratory or the increase in
joint funding applications for international co-operation programmes managed by the host country or by the home country.

Mature science diasporas may cause institutional change through layering as well in reconfiguring international orientations of their employing organisations. For scientists, recognition in one social field (transnational diaspora) becomes a way to transfer their accumulated symbolic capital on to other social fields, e.g. German research hierarchies, which intersects with the science diaspora field (Bourdieu, 1977), to strengthen their roles there, such as achieving tenure or administrative promotion.

7.5 CONCLUSION
Academic identity conservation and diaspora engagement do not always go hand in hand. In fact, the most successful Professors who are the champions of science diaspora spaces, manage to maintain simultaneity of connection and are actively participating in all social fields they are part of. In line with findings of the transnational entrepreneurship research (Portes et al., 2002; Annalee Saxenian, 2002), this study finds that ‘champion’ scientists who drive the creation of transnational science diaspora field, are also successful in symbolic capital accumulation in other social fields they are engaged in.

Being incorporated in multiple social fields and being a part of a transnational diaspora is in no way contradictory to adaptation and the identity shift. Assimilation in the context of the host country, organisation and the research culture is not incompatible with maintaining sustained transnational links with other Russian-speaking researchers and with the home country. On the contrary, the heterogeneity of the social capital accumulated by researchers, understanding of multiple contexts and the unique expertise often become recognised by relevant social groups (senior management, government officials). Scientists with these competences are the unique individuals that have a unique toolset to solve complex problems using various skills and competences of research collectives in various locations, managing people, equipment and financial resources across countries, therefore promoting creativity and originality of scientific enquiry.

However, science diaspora is a laborious undertaking that involves reputational hazards. Russian-speaking scientists only venture to enact and maintain diaspora links when there is promise of very tangible benefits. Among individual researchers, diasporic network is only a part of broader professional and, even broader, general social network. However, this part of network entails promise and hazard alike and requires careful management. While some
interview participants decided to push diaspora networks out of the scope of their professional collaborations, or strictly limit their use, others developed extensive diaspora-based transnational academic spaces.
CHAPTER 8 CONCLUSIONS

8.1 INTRODUCTION
This thesis was designed to explore the connection between global scientific mobility as a macro-level trend that is transforming academic communities worldwide, and tangible aspects of academic practice, in the context of national competition for talent driven by dominant science-based development frameworks. After the examination of relevant literature, the focus on, first, academic career development was assumed. Second, diverging boundaries of academic identity in different countries were used to analyse the impact of global mobility on academic practice.

Positioned in the context of examining the role of academia in technological and socio-economic development of nations, this work addresses two gaps in the existing scholarship. First, it investigates drivers of scientific migration currents as they change dramatically under the influence of globalisation. Second, it examines the tension that arises when assumptions of innovation research are challenged with findings from STS and mobility scholarship. The gap is addressed by developing a framework to examine one of the elements of academic practice, its boundaries, in the context of nationally bounded academic communities and transnational science diasporas.

This concluding chapter sums up the key findings of the research before proceeding to discuss theoretical, conceptual and methodological contributions more explicitly. This research has several implications for national policymaking bodies in the sending countries as well as in countries-recipients of populations of globally mobile scientists. There are practical organisational implications that are useful for the management of public research universities, which broadens up the scope of interested audiences of this study.

The exploratory nature of this research offers a variety of future research directions, which conclude this thesis.

8.2 REVIEW OF KEY FINDINGS
Four core findings of this work are offered for discussion before proceeding to answer research questions directly.

First, this study found that global scientific mobility is driven by career-related reasons, rather than by economic reasons, as suggested in previous studies of scientific migration.
Among the interviewees, each mobility move was also a career move. This comes into contrast with the perspective adopted in the overwhelming majority of studies that disregards the career aspect of mobility completely. A work by Ackers (2008) mentions career-driven incentives, but for doctoral students in social sciences, and with the purpose to eventually return to their home countries. Among the study population of this research, permanent relocation between research organisations only happened as a part of academic career development, mostly occurred at contractual (postdoctoral) stages of career development, and was sometimes ‘forced’.

Second, this study found that scientists undertake mobility between organisations and not between countries. While mobility incentives factored as the main influence framing mobility decision, it was on the organisational level that the eventual decision was made. As mobility very often occurs along the lines of professional networks, the choice of destinations for mobility was very narrow for scientists. National-level factors only featured strongly in framing broader preferences, such as the language.

Third, the findings of this study provide evidence that there is an adaptation challenge among globally mobile scientists caused by the tension between academic identity and local academic culture. This work does not dispute established findings about superior performance of globally mobile scientists (Bosetti et al., 2015; Chellaraj et al., 2005; Franzoni et al., 2014). However, the way in which scientists resolve the adaptation challenge has profound implications on the scope and types of their academic activities and career development opportunities.

Fourth, the findings of this work contribute to the growing body of research that attempts to understand implications of current disbalances in ALMs (Richardson and Zikic, 2007; Musselin, 2004; Pitt and Mewburn, 2016; Powell, 2015). In the career development aspect, global mobility can be utilised as a strategy to break out of contractual positions. More importantly, the findings indicate that scientists who occupy casual contractual positions engage the least in broader contexts of academic activities. Confining the majority of academic labour force to precarious jobs can be conceptualised as a factor that hinders innovation spillovers from science.

**Answering Research Questions**
This study attempted to answer two research questions with two sub-questions each. Detailed answers to each of the questions are provided below.
RQ 1: What are the drivers of global scientific mobility?

Global scientific mobility is not limited by relocation from the home country to a host country. This study finds significant subsequent national and international mobility among Russian-speaking scientists. The insecurity of fixed-term contractual employment and mobility incentives of national research systems are the strongest drivers. Mobility ceases after scientists receive permanent positions.

It was found that globalisation has significant effect on the configuration of ALMs, causing the decrease in significance of national borders along with regional fragmentation, increased rates of international and national scientific mobility, increase in competition for positions in organisations of high prestige, and the emergence of global identity in conceptualising scientific profession as global profession. This finding is surprising, because previous research identified mainly impediments on the way for labour markets to become global.

Labour markets do retain national characteristics. This features in professional networking strategies limited to national borders, or in the tendency for academic career development pathways to still be different across countries. Additionally, academic career institutions have significant national variations and strong national specificities.

Enabling and constraining roles of global and national institutional configurations structure the flows of global scientific mobility. Search and mobility enablers provide greater opportunities, while high international competition increases the hierarchies in ALMs along the criteria of location and reputation.

Scientific mobility flows are organised from locations (countries or regions) with lower priority to locations with higher priority; and from organisations with lower reputation to organisations with higher reputation. The two criteria form a stepwise mobility matrix. Research clusters acquire special importance for globally mobile scientists, because these are spaces with high density of professional networks that can be leveraged as external resources to mediate employment in lower reputation organisations.

SQ 1.1: What are the capacities of nation states to retain, or otherwise extract benefits from the highly skilled and highly mobile researcher workforce?

The findings of this study reinforce the call for nation states to attract and retain globally mobile scientists. Currently the majority of Russian-speaking nanoscientists work in the USA,
with minority diaspora groups in Germany and the UK. These scientists are on average more prolific in publications than researchers who reside in Russia.

Russian-speaking scientists move between established and recognised research centres in the global North. Factors that influence scientific mobility on the macro-level divide into push, pull and hold categories. However, pull and push factors are the strongest on the organisational level, and only hold factors (retaining capacity) are equally important at all levels.

Opportunities to retain globally mobile scientists lie in providing long-term job security, incentives to participate in innovation activities, stimulation of significant time and resource investments of a scientist into assimilation. There is particular importance of laboratory equipment and specialist facilities, and of the general environment that provides opportunities not only for scientists, but also for their families.

The USA remains the country that is drawing in scientists now only directly from the developing countries, such as Russia, but also from the countries of the Western Europe and Canada. These scientists are attracted, predominantly, by the large size of the US domestic labour market and opportunities for assimilation in the multicultural society.

Effects of this cause intensification of uneven development of central and peripheral research organisations. Recruiting globally mobile scientists is a strategy that many aspiring peripheral universities use in the countries with net immigration. This is usually a mutually beneficial arrangement for the organisations and scientists alike.

For scientists, these organisations serve as a stepping-stone to further employment. Mobile scientists gain experience and understanding of the local research culture, acquire missing skills, and move on to a more prestigious employment that was inaccessible from their previous outsider position. This way, new regional centres of excellence are developing in countries with net migration.

**SQ 1.2: How do career development strategies incorporate scientific migration and why?**

Scientists work institutional structures of global scientific mobility flows to maximise their personal benefit. As different types of researchers have different goals, these strategies and the ways interviewees use their capabilities differs significantly.
Previous experience of global mobility is seen as an advantage by Russian-speaking scientists, who employ subsequent international mobility to increase career returns. This study indicates four main ideal typical strategies that scientists may enact to cope with professional-personal challenges, or to maximise career development opportunities. These are career output maximisation (with three sub-type strategies), networked migration, lifestyle [non]migration and global trotting.

Career output maximisation is enacted when desired positions in desired research organisations are not available straight away. Scientists use global mobility to increase the chances of reaching desired employment. These include stepwise migration from less favourable countries to others, capability adjustment, when a safe move is followed by an ‘adjustment’ and move upwards in the reputational hierarchy; loopy migration, when scientists go to a lower priority country with the intention to return, and the ‘greener field’ development that reflects mobility of senior scientists to chase attractive opportunities.

Networked migration is a strategy that reflects the overall importance of professional networks for global scientific mobility. In a few cases, interviewees never left professional network spaces throughout their mobility history.

It was found that personal factors are significant for scientific mobility decisions. While lifestyle [non]migration outlines mobility strategies of scientists that pursue non-professional interests, global trotting reflects recent trends towards exploration, enabled, but not driven by the academic career.

**RQ 2: How does global mobility affect academic activities and career development opportunities of scientists?**

The findings of this research aim to contest general assumption that S&T capital and other types of embodied knowledge are easily transferrable across borders. Losses that mobile scientists experience post-relocation are not limited to the loss of network and setback in terms of establishing routines. As the notion of ‘skill’ is historically and geographically specific, this research found that academic skills are specific to academic cultures.

Economic and societal gains of receiving countries and organisations are mediated by academic culture of globally mobile scientists. Academic cultures are differentiated across countries and are transferred over as embodied knowledge during relocation. While the literature indicates beneficial effects from research and innovation activities of foreign-born
scientists, it is in fact a subject of successful adaptation to the new, nationally specific, academic environment.

This study finds that the Russian academic culture is distinctive in its narrow understanding of academic activities as scientific research only. After relocation, Russian-speaking scientists face issues in adapting to usually much broader understanding of academic citizenship in their new employment.

International scientific mobility has transaction costs. With all benefits global mobility has, it invariably results in the initial setback of academic practice. There are impediments for all activities: for teaching – the requirement to learn new curricula and new courses; for research – the necessity to move the laboratory, purchase new equipment, recruit new temporary staff and students. In the outreach and public goals activities the networks are usually highly informal and localised, so setting out to develop the network in the new context takes time.

The setback in academic practice and transaction costs of migration cause unequal opportunities in academic career development of native-born and foreign-born scientists, especially when leadership positions and administrative career development are concerned. At the same time, mobile scientists acquire unique skills and unique competitive advantage in terms of managing geographically distributed research teams.

**SQ 2.1: How is the tension between academic identity and academic practice resolved among globally mobile scientists?**

There is a link between academic culture and practice in terms of acquired norms that are brought over during mobility and are enacted post-mobility. By contrasting narrow ‘Soviet’ understanding of activities and academics with broader academic identity boundaries of the USA, UK and Germany, this study identified the link between adapting to the new environment and changing academic activity profile among interviewee scientists. Scientists who chose to adapt also demonstrated broader activity profiles.

The adaptation tension is resolved by (1) adaptation of academic culture to local rules, or (2) searching for options to settle in the local context and preserve academic culture. Career development incentives, university orientation, professional networks and peer pressure are the main factors of changing academic culture of globally mobile scientists.
This study distinguishes three types of academic identity options – conservation, shift and plural identities - in terms of adaptation of academic culture to expected norms of academic practice. These holders of identities have different attitudes to the ‘domestic’ academic culture and different ways in which these three groups of scientists approach and organise their work.

Enactment of various identity types results in a multitude of strategies, ranging from reconstruction of Soviet-type spaces in laboratories abroad, to mimicry and knowledge moderation, to a complete normative shift. Scientists are more likely to broaden practice profiles in societies that are more receptive to migrants in general.

Public engagement and outreach is the academic activity most affected by the tension between domestic and local academic cultures, to the point where globally mobile scientists may decide to transfer their outreach activities to the home country.

**SQ 2.2 How and why do scientists enact transnational networks?**

This study finds that professional networks are important for scientists prior to, during, and after mobility. Scientists most often start their international mobility using professional network tools, as they provide more security and support in adaptation.

Scientists use networks to navigate their mobility options and manage increased global competition. After leaving their home countries, they often remain embedded in transnational diaspora networks and leverage them as opportunities when local resources are scarce.

After relocation abroad, diaspora networks wane unless actively maintained. Science diaspora membership is temporary, and science diaspora engagement is always a rational strategy, as it requires significant tradeoff with supporting other elements of professional network.

This study finds that science diaspora engagement contains opportunities as well as reputational hazards. By enacting the social field theory, it highlights ways in which Russian-speaking scientists manage being a part of transnational network and belonging to one, depending on personal agendas and priorities. Scientists work in multiple social fields, enacting different identities in different contexts, experiencing simultaneity and layering of
academic spaces. The skills acquired in this practice can be enacted in other contexts, for example, in academic entrepreneurship.

The findings of this study support previous research that stresses the role of science diaspora for the home country. Diaspora scientists are positioned in the middle between the Russian scientists and the world in general in terms of research areas and specialisations, publishing more interdisciplinary research in wider range of subject categories. Science diaspora authors are important for the development of international cooperation between academic communities in different countries, especially if the current rate of cooperation is low.

8.3 Contributions to Knowledge
This study offers theoretical, conceptual and methodological contributions to the existing body of knowledge.

8.3.1 Theoretical Contributions
This study has developed an interdisciplinary research approach, and its design benefited from the use of theories and concepts from several streams of literature. Contributions to knowledge concern these multiple theories and approaches used.

First of all, the findings of this research contribute to the debate on the role of foreign-born scientists in the knowledge economy. While I do not aim to refute the mainly quantitative findings pointing to higher productivity of foreign-born scientists, this research problematises the frameworks used to identify contributions of scientists.

This study finds that scientists contribute to broader economic and social development of their national systems in a variety of ways besides publishing or patenting. It further argues that this contribution is not a given, as skills and capabilities of scientists contain tacit knowledge and embodied knowledge of research systems of upbringing, thus sometimes causing issues with adaptation and, as a result, underperformance.

Human capital approaches to the analysis of science and technology capabilities usually distinguish formal knowledge and professional networks, acknowledging some transaction costs (Bozeman and Corley, 2004; Cañibano and Woolley, 2015). The findings of this study suggest that the impact of relocation on academic activities of scientists may be much deeper due to the complex and heterogeneous rules of academic community membership.
This research conceptualises contribution of foreign-born scientists not only in terms of research outputs, but in terms of their roles in the broader STI system, as well as educational, social and political systems, as is seen by social studies of science. In this respect, science systems and academic communities are far from ‘denationalization’ (Crawford et al., 1993). Certain level of adaptation is required to incentivise foreign-born scientists to broaden up academic activities, otherwise these activities will be either formalist, or may benefit a different (home) country instead.

Second, current scholarship investigating the impact of globalisation on innovative development notes the increasingly important role of global mobility of the highly skilled, but there is little understanding of the implications of this phenomenon on the national systems of innovation (Smits et al., 2010). This work has aimed to propose theoretical and an analytical framework that can overcome the hurdle of methodological nationalist outlook on scientific mobility by focusing on factors shaping career development strategies of researchers and the role of mobility in these strategies.

By using transnational and social network approaches, this research showcased continuous interactions and activities of globally mobile scientists with their peers in émigré networks as well as with domestic scientists in the home country. The role of national policies decreases in the process of geographic fragmentation of scientific mobility.

This study illustrates how retaining continuously mobile scientists within national borders is becoming an increasingly important political task for nation states. With positive effects on development potential, spillovers to regional innovation systems, and unique set of skills, globally mobile scientists can be a source of systemic competence building (Lundvall et al., 2002) of countries and regions. This work has offered multiple examples of how globally mobile scientists have the potential to advance innovation-led growth.

Third, this work elaborates on the role of nonhuman actors in scientific mobility. Previously, the geographies of sciences approaches have examined knowledge produced in certain spatial configurations of actor-network (Jöns, 2015). This work contributes to the development of this strand of literature by proposing to include broader scope of nonhuman actors in mobility analysis frameworks. These actors perform structuring functions of mobility, such as when scientists are drawn to large-scale facilities, or when a rare research topic leaves only few choices for geographic relocation.
Fourth, this research contributes further to understanding the importance of place in scientific practice and the embodied spatiality of research performance. It explores the potential effect of globally mobile scientists on institutional configurations and practices of local academic communities. It has been suggested before that scientific knowledge production has spatial character, that social factors, such as gender, have influence on the type of practices and research results received in the laboratory (Mellström, 1995). This study did not analyse research process directly, but by conceptualising academic culture and identity, as well as the comparative framework for the analysis of academic culture, it adds evidence to a small set of studies (Borjas and Doran, 2014) on the role of globally mobile scientists in transforming social and institutional configuration of local academic communities.

Fifth, this work makes a significant contribution to the development of science diaspora research. By applying the social field theory to the study of science diaspora, it enriches the existing body of research in terms of refining the definition of the concept, examining boundaries and diaspora life cycle, its role in academic activities of organisations in home and host countries. More importantly, this work highlights the circumstances under which scientists decide to engage in science diaspora activities, despite reputational hazards, and the benefits they sow from this engagement.

Lastly, this research offers contribution to the literature on post-Soviet scientific mobility. It highlights patterns in global mobility trajectories of scientists who ‘disappeared’ from the radars of social scientists after leaving their home countries. This research further enriches an emerging stream of studies, so far exclusively in Russian (for example, see Dezhina, 2010), on the role and the potential of diaspora scientists for the home country development, and on improving Russia’s relationship with the community of émigré scientists.

8.3.2 Conceptual Contributions
This work contributes to conceptual delineation of ‘scientific mobility’. While the general evolutionary trajectory of the existing scholarship is towards understanding mobility of scientists as continuous and iterative process, where the boundaries between ‘job’ and ‘non-job’ mobility are blurred (Flanagan, 2015), the use of the concept ‘scientific migration’ is still widespread, especially in quantitative and bibliometric-based research. Scientific migration, in terms of permanent relocation from one country to another, only describes a small part of
mobility history of the majority of researchers and is a reductionist way to examine scientific mobility histories. Furthermore, mobility is conceptualised and described in this research in terms of career development trajectories of scientists.

Second, this study proposes an improved conceptual framework for the analysis of global scientific mobility. It builds on traditional concepts of ‘push’ and ‘pull’ mobility factors by adding ‘hold’ factors, or the capacity of regions and nations states to retain highly skilled talent after having ‘won’ the competition. Then, the concept of multi-tiered analysis of scientific mobility (MORE Compendium, 2011) is expanded to analyse in-depth types of non-national factors that have impact on mobility decisions.

Third, this research conceptualises embodied knowledge transfer during scientific migration in terms of academic culture, thus providing a comparative framework for further analysis.

Finally, this study utilises the conceptual framework of laboratory activity profiles and adapts it for the analysis of individual level strategies of foreign-born scientists in three countries. This is a novel application of this framework and can benefit future research.

8.3.3 Methodological Contributions
The main methodological contribution of this research is the development, testing and application of the bibliometric search query based on the particular features of the morphology of Russian surnames. This method enriches the literature attempting to detect and measure the impact of foreign-born scientists or inventors on the science and technology development of their host regions and countries. Robinson-Garcia et al. (2015) demonstrate that the existing surname-based methodologies, including concentration index, clustering and the golden list methodologies, but existing methodologies still fail to accurately outline communities of certain ethnic origin.

Scholarship exploring the impact of ethnic communities on technology invention, as well as the role of transnational ties among geographically distributed communities, is developing into a separate research stream (Kerr, 2008; Kerr and Lincoln, 2010; Kissin and Bradley, 2013). Some of these studies use surname-based approaches. The method developed as a part of this research uses information retrieval indexes to statistically test the reliability of the surname-based search query. This presents an important step towards improvement in sophistication of these methods, as well as the improvement in the scope of problems that this methods enables to investigate.
8.4 **Science Policy Implications**

Four broad policy lessons are offered: moving from vertical to flat hierarchies; moving from return migration to the pools of knowledge; moving from rigid to flexible academic employment schemes, and aiding in adaptation.

8.4.1 **From Vertical to Flat Hierarchies**

Vertical organisation of academic employment is the biggest push factor of mobility among early career researchers, who also demonstrate highest mobility. National states tend to compete for senior scientists who have a proven track record of previous research, but already achieved tenure. In contrast, the promise of future achievement is what enables early career scientists leave their home countries.

Training early-career researchers and nurturing their competence is a significant public effort in any country where the government invests in the science and technology skills base development. This investment is often rewarded by the loyalty on part of junior researchers in receipt of the training, and it may result in the spillover of their skills to the industry.

In the fieldwork countries of this thesis early career scientists face restrictions in access to permanent positions. The lack of job security is a strong incentive for early career scientists to enact further global mobility when the pool of opportunities dries up. Sometimes these scientists leave with intention to return, implementing ‘loopy migration’ strategies, but in other cases they find better conditions elsewhere.

For the nation states that continuously experience the influx of talent, this may not be a big loss. However, on a large scale, recruiting and supporting foreign-born scientists throughout their careers not only results in loyalty, but also in reduction of costs caused by adaptation of academic activities profiles of these scientists. Currently, when they come, receive training and leave again, many benefits from the investment are lost.

Retaining, rather than attracting highly skilled cohorts, and especially early career researchers, should therefore be an important shift in the policy focus among countries competing for academic elite. Adopting flatter academic employment structures and designing more options for permanent positions can greatly enhance the retaining capacity of national research systems.

8.4.2 **From Return Migration to the Pools of Knowledge**
This work identifies two problems in current Russian science diaspora management frameworks.

The first problem is that return science migration policies are designed to include a much broader scope of global scientific elite. This in some sense gives an opportunity for internationally renowned non-Russian scientists to take advantage of the rich funding, and result in the advancement of domestic science, which is the ultimate goal of these programmes. For example, the initial round of ‘mega-grant’ funding attracted applications, such as Nobel Prize Laureate Ferid Murad (USA) (Clery, 2010).

This hybrid approach hinders the policy focus to unlock true potential of the diaspora abroad. Seguin et al. (2006) point at the importance of political will and recognition of the existence of scientific diaspora for the success of the diaspora-based development projects. Therefore, policy framing of an essentially science diaspora project as ‘international scientists’ project actually impedes participation from a numerous Russian-speaking science diaspora abroad.

Furthermore, the experiences of interview participants of this study point to the fact that a very small minority is actually prepared to spend a significant amount of their time (4 months per annum is the shortest option offered) in Russia. Some senior researchers combined this commitment with other ongoing projects and with family business, but for the majority such divide in commitments was unacceptable.

A policy shift from programmes that essentially target ‘return migration’ to science policy that exploits foreign-based scientists as ‘pools of knowledge’ can be a solution. There are international precedents of enacting such programmes in the countries with poor economic conditions or dangerous political situations (Lundvall, 2012). The ‘pools of knowledge’ policy framework encourages regular links and contacts between domestic and diaspora scientists, organisation of events and circulation visits, but does not require long-term settlement commitment. Understanding that the exploitation of human capital and its utilisation for the science and technology development does not require geographical positioning of the carriers of this capital within national borders is in the core of this ‘soft’ power policy tool.

In this light policy actions of the Russian Government appear to be misplaced. The need to understand and distinguish among different kinds of scientists who reside abroad and
different types of diasporic formations they are engaged in is the key in designing diaspora engagement policies that work.

8.4.3 FROM RIGID TO FLEXIBLE ACADEMIC EMPLOYMENT SCHEMES
The diverse variety of options for scientists to engage in the production of knowledge that goes beyond codified knowledge is an exciting opportunity. However, institutional incentives associated with gaining prestige in the community, as well as the criteria of promotion and tenure seem to be rooted in the frameworks of the ‘Ivory Tower’.

‘Academic citizenship’ incentivises scientists to produce heterogeneous knowledge that benefits a variety of communities. However, in most employing organisations the main criterion of receiving a permanent position is a strong publication track record and high productivity in terms of production of codified knowledge. This is especially valid at early stages of academic career development. These reward criteria disincentive scientists employed in precarious positions from partaking in any of the ‘extra’ activities beyond the very minimum.

Public universities, it seems, have inherent contradictions between the type of institution they are striving to be (taking down the ivory tower) and the type of academic profile they incentivise the majority of researchers to maintain (research-only activities). Variety in terms of practices, types of knowledge and, most importantly, identity, only starts at the very top of the hierarchy, among senior professors, who are usually overworked.

Skewed academic career development structure persists in organisations that publicly commit to entrepreneurship or societal public values, but reward differently. Therefore organisational approaches to incentives and promotion should be adjusted accordingly. Universities will only be able to perform their societal mission when they will be able to reward scientists they employ for participating in these types of activities.

8.4.4 AIDING IN ADAPTATION
Furthermore, there are issues with the institutional management on the part of globally mobile researchers. Using the example in the variety of academic practices expected within institutional configurations of the Soviet/Russian and the US/UK and German systems, this study highlights possible issues of underperformance and systemic disadvantage of Russian-speaking globally mobile scientists that arise due to misunderstanding of tacit expectations and norms.
While this problem in the discrepancy of tacit expectations is recognised, for example, for international students going to study abroad (Zhou et al., 2008), science studies literature, often points to the denationalisation of science and the uniformity of the process of scientific discovery across countries. It is certainly the case with the contents of research process, as it is strictly self-regulated by the academic community. However, research culture manifests in the context of this process.

University management should consider issues of adjustment and adaptation of foreign-born scientists who arrive to be employed in the organisation. These considerations go beyond extra resources and time that new faculty members need for, to give an example, learning curriculum of a new course. Getting used to the host research culture is a challenge that may not be obvious to some globally mobile scientists, but may have serious implications on their academic career development opportunities.

Adaptation includes understanding of career promotion criteria and the duration of the employment, expected outputs and expected activities. It can take the form of online or printed materials, workshops, or even mentoring schemes.

8.5 LIMITATIONS OF RESEARCH
There are limitations associated with each of the theories, concepts and methods of this study. They are noted separately at the end of each data-based chapter (Chapters 4-7). This study also has broader limitations. First of all, the focus on nanotechnology as a boundary and the scope of this study imposes disciplinary limitations and limitations in comparability. The majority of interviewees are physicists, which has a mediating effect, however, broader divisions between experimental and theoretical areas of physics exist, which makes the findings of this study approximate.

Second, this study focuses on Russian-speaking researchers, who constitute a very specific science mobility phenomenon. In many instances, post-Soviet migration currents have differed from other widely studied highly skilled and mobile populations, mainly of Chinese and Indian origin. Scientific mobility currents are often more complex for those populations, predominantly because of the issues related to the 2nd and later generations of transnational families. Therefore, exploratory generalisations from this work should be taken with caution and validated in further research.
Some approximations made in the study, mainly relating to national research cultures, or national strategies, or national circumstances, are broad generalisations. I acknowledge that not only regional differences exist, but they also need to be strongly accounted for during the data collection and analysis. This limitation is inherent to the qualitative study design and is in part mediated by the use of bibliometric methods to obtain broader outlook.

Triangulation of the quantitative and the qualitative data was not used to its full potential in this study. This is largely due to the time constraints and the text size limitations. However, it needs to be acknowledged that in its current form this thesis may be criticised for having quasi-mixed method design (Tashakkori and Creswell, 2007) and could use the data obtained with its supplementary quantitative method more efficiently.

8.6 Future Research
This exploratory research opens up several further directions of inquiry. As it was mentioned above, findings of this study are limited to the population and technology delineators used to frame it initially. Further research should aim and extend the reasoning developed in this thesis to other technologies (non-emerging technologies, technologies with high ethnical regulation, to social sciences) and to other mobile populations from developing and developed countries.

Further study of global scientific mobility may take shape of: increasing the scale of the sample to test the findings related to academic activity profiles of scientists; exploring science diaspora effect in international collaboration patterns of host and home countries; designing further exploratory frameworks to investigate the findings associated with underperformance and inequality; designing ethnographic research to conceptualise academic/research culture in relation to research process, not context. Finally, history of restricted and state-controlled mobility of scientists in the Soviet Union is another direction for future research.

These ideas can be broadly distinguished into those that aim to increase generalisability of the findings towards either engaging other populations, or increasing the scope of the sample and moving towards quantitative hypotheses and methodologies; those that explore less substantiated, but important findings, such as unequal opportunities and structural disadvantages; and those that develop in-depth approaches towards further validation of findings of this work within unconventional interdisciplinary paradigms.
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## APPENDIX 1. INTERVIEW PROTOCOL

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<tr>
<th>Interview Questions</th>
<th>Prompts</th>
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<tbody>
<tr>
<td><strong>Block 1: Career History</strong></td>
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<tr>
<td>1. Please, tell me about your career history from the beginning to the end.</td>
<td>• When did you leave Russia?</td>
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<td></td>
<td>• Why did you choose your first destination?</td>
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<td></td>
<td>• Why did you move on from there?</td>
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<td></td>
<td>• Do you have experiences of temporary research positions in other countries? (exchange visits, sabbatical leaves)</td>
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<tr>
<td>2. Please, tell me about the main reasons of your career choices</td>
<td>• What were the main reasons that made you leave your previous job?</td>
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<td></td>
<td>• What are the reasons that make your current work place attractive?</td>
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<td></td>
<td>• What keeps you from changing your job?</td>
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<td></td>
<td>• Do you think you will change your job in the future?</td>
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<td>3. Please, take a look at the list of possible factors that I have composed based</td>
<td>• Such as moving to another country, another university, another lab</td>
</tr>
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<td>on the literature. Have any of these been particularly important in making your</td>
<td></td>
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<tr>
<td>decisions to change the job after you left Russia?</td>
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<tr>
<td><strong>Block 2: Current Academic Practice</strong></td>
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<tr>
<td>4. Have your research interests changed a lot since you left Russia?</td>
<td>• Would you say you picked new research affiliations, because your research interests were changing, or new research environment facilitated new interests?</td>
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<td></td>
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<td>5. When you move to another organisation, or another country, do you adapt to the</td>
<td>• Such as enduring the continuing collaborations in previous affiliations</td>
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<td>new environment easily? What were the main challenges that you had to face?</td>
<td>• new research groups</td>
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<td></td>
<td>• different research environment</td>
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<td></td>
<td>• need to adjust to how people do things</td>
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<td>6. Is there something important for doing scientific research that one can only learn</td>
<td></td>
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<tr>
<td>in Russia?</td>
<td></td>
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<td>7. What are other activities that you have to do besides research?</td>
<td>• Such as teaching, consulting, public engagement</td>
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<td></td>
<td>• What are the shares of these activities in your working hours?</td>
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| 8. | Would you set up a start-up company based on your patented discovery? | • Why?  
   • Do you have any other ‘innovation’ opportunities in your work? Would you like to use some of them? |
| 9. | During your work do you in any way interact with the following: | • Other universities  
   • Companies  
   • Consultancies  
   • Other Professional Bodies, such as NGOs? |
| 10. | Are there elements in your job that are of substantial importance at the current work place that were not so important/ not important at all previously? | For example,  
   • necessity to write lengthy reports  
   • necessity to communicate with officials and the higher-ups?  
   • the necessity to patent discoveries  
   • the necessity to engage in consulting activities |

**Block 3: Russian-Speaking Links**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>Have you visited Russia since you left?</td>
<td>• Do you have affiliation in Russia? Do you collaborate with Russian scientists?</td>
</tr>
</tbody>
</table>
| 12. | Do you think there is a professional diaspora of Russian scientists in your employing organisation? | • Are there any other visible ethnic professional diasporas?  
   • Why do you think there is no Russian diaspora? |
| 13. | Do you think your ethnicity and Soviet scientific upbringing helped you during your career, or hindered your career progression? | • Getting promoted  
   • Better or worse access to opportunities |
| 14. | Would you advise new Russian PhDs to seek academic research work in your organisation? In your country of residence? Why? | • Which place would you recommend? |
| 15. | Do you think it would be the same, harder, or easier for the new generation of Russian PhDs and postdocs to reach your academic position? |   |
**APPENDIX 2 LIST OF PROMPT MIGRATION FACTORS**

The List of Factors that May Affect the Decision to Migrate (was distributed to a minority of interviewees).

<table>
<thead>
<tr>
<th>Language</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Immigration Regulations</td>
<td></td>
</tr>
<tr>
<td>Visa/Residence Permits/Citizenship Accessibility</td>
<td></td>
</tr>
<tr>
<td>Labour Market Regulations</td>
<td></td>
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<tr>
<td>History, Culture, Reception</td>
<td></td>
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<tr>
<td>Working Environment in Organisation</td>
<td></td>
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<tr>
<td>Salary and Financial Incentives</td>
<td></td>
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<tr>
<td>“Star” Scientists and Reputation of the Organisation</td>
<td></td>
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<tr>
<td>Opportunities for Training and Professional Development</td>
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<tr>
<td>Career Development Opportunities</td>
<td></td>
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<tr>
<td>Teaching vs Research Loads vs Admin Loads</td>
<td></td>
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<tr>
<td>“Clusters” and favourable regional positioning</td>
<td></td>
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<tr>
<td>Research Agendas</td>
<td></td>
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<tr>
<td>Research Equipment and Facilities</td>
<td></td>
</tr>
<tr>
<td>Scientific Diasporas of countrymen</td>
<td></td>
</tr>
<tr>
<td>Company and User Links, Availability of Knowledge Transfer Mechanisms</td>
<td></td>
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<tr>
<td>The Overall Organisation of the Research System</td>
<td></td>
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<tr>
<td>Access to Research Funding and Grants</td>
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<tr>
<td>Personal Research Network</td>
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<tr>
<td>Access to Childcare and Schools</td>
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<tr>
<td>Maintaining Personal Relationships</td>
<td></td>
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<tr>
<td>Maintaining/ Transferring/ Accessing Health Insurance, Pension Rights and other benefits</td>
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<tr>
<td>Age of the Researcher</td>
<td></td>
</tr>
<tr>
<td>Religion</td>
<td></td>
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<tr>
<td>Ethnicity of the Researcher</td>
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</tbody>
</table>
APPENDIX 3 CONSENT FORM

“Societal Effects of Scientific Migration: Insights from Russian Speaking Nanoscience Émigrés”

Participant Information Sheet

You are being invited to take part in a research study. This page will introduce you to the project and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish, before you decide whether you would like to participate. Please do not hesitate to contact me using the details below if there is anything that is not clear or if you would like more information. Thank you for reading this. Your participation in the project will be greatly appreciated.

Q1: Who carries out this Project?
Maria Karaulova, 3rd year PhD researcher, Manchester Institute of Innovation Research.

Q2: Research Objectives?
This doctoral research project examines career trajectories, research practices, attitudes and motivations of Russian-speaking researchers who are now established scientists of the former Soviet Union. The project seeks to understand patterns of scientific mobility, as well as the spectrum of activities undertaken by these researchers, and broader effects on science technology and innovation systems.

Q3: Why am I chosen as a participant?
I identified you through a review of publications, university web sites, and publicly available biographical information.

Q4: What am I asked to do if I participate?
I would like to ask about your educational background, career history, professional choices, current work environment, collaborative networks, and innovative activities. I will NOT ask for any confidential information, or information which is proprietary. You can choose not to answer any particular question, if you wish.

Q5: How do you deal with the data collected?
Interview data will be processed through template analysis, content analysis, and tested statistically. In general, they will form the empirical foundation for the thesis that I am working on.

Q6: How do you guarantee data confidentiality?
Interview data will be stored in the researcher’s encrypted computer. The interview is strictly for the purposes of my academic thesis research: I will not share the interview data with any other organisation.

Q7: How long will the interview last?
No more than 1 hour. If necessary, and if you agree, you might be approached later on for further information or interview.

Q8: Will I be paid?
No, but your cooperation is very much appreciated. If you express such a wish, you will be thanked in the publications that this research produces.

Q9: Will the results of this Project be published?
Yes, the results will be published in the form of research articles, a PhD thesis and, possibly, articles in press. You can decide whether to stay anonymised or not. You can also clarify during the interview regarding which part of information you would rather keep confidential and unpublished.

Q10: Where is this Project being conducted?
The research relies on bibliometric mapping method developed at an earlier stage. During the multi-sited fieldwork I have visited 8 states of the USA, 2 Länder of Germany, France and Switzerland. This is the final round of fieldwork. Data analysis and writing-up will take place in Manchester.

Q11: What if I do not want to participate, or if I change my mind?
It is completely up to you to choose whether or not to participate, and to decide when to quit. If you do want to be an interviewee, I will ask you to sign a Consent form (please refer to the next page) before the interview starts, and you will be provided a copy of this Information sheet as a record.

Contact for further information:
Maria Karaulova
PhD Candidate,
Manchester Institute of Innovation Research,
Manchester Business School
The University of Manchester
Booth Street West Manchester M13 9PL
Email: maria.karaulova@postgrad.mbs.ac.uk

If a participant wants to make a formal complaint about the conduct of the research they should contact the Head of the Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PT.
Method Development

In many research areas, including nanoscience, publications in SCI journals serve as the main output of research activity and as the main indicator of research productivity. Hence, most active scientists publish their findings. Scientific publications are used in this chapter as the main source to identify Russian-speaking scientists who reside abroad.

When a research paper is published in the SCI-indexed database, the affiliation of each author can be approximated to the location (country and organisation) where the scientist was conducting research that resulted in a publication. Following the critique presented in the review of the relevant literature, I aim to avoid focusing on counting scientists who change their affiliation address and country, which other studies take as the main method of studying scientific migration using bibliometric means (Moed et al., 2013; Moed and Halevi, 2014). A common limitation here is that any scientist who changes the affiliation address from Germany to the USA will be identified by these methods as a German researcher migrating to the USA.

Instead, I use the particular structure of post-Soviet surnames as the main proxy of their ‘heritage’. While this take has its own limitations discussed in the end of the chapter, it nevertheless allows to identify scientists who left abroad decades previously and since then worked in multiple countries, for as long as they keep their original names.

Author affiliation fields usually only contain permanent affiliation data and do not indicate temporary mobility. Therefore they serve as a good proxy of permanent relocation to different organisations, or aboard, on part of the authors. Therefore, collecting author affiliation information from ISI WoS database and matching authors with Soviet heritage names that are affiliated with organisations situated outside of the territory of the former Soviet Union points to the community of Russian-speaking scientists who migrated abroad.

The method presented in the chapter focuses on detecting a community of ‘active’ scientists, rather than building a time series picture of dynamic change. Moed et al. (2013) define a researcher as ‘active’ if they publish in year T and/or in years (T-2) to (T+1). This study adopts a narrower definition of an ‘active’ researcher due to the dynamic nature of an emerging science and technology area in the focus and sets the scale to 3 years, spanning 3 years: 2010, 2011 and 2012. The data for this study was collected in 2012 and informed research fieldwork initiated in 2013.

After the nanoscience data was collected from the Web of Science and the three relevant years were extracted, a procedure was developed to identify Soviet Heritage researchers abroad using their surname structure (Figure 1). The next part of this chapter outlines in detail the development and testing of this procedure.
Figure 1 Bibliometric Search Procedure Development and Application
Overseas Diaspora Set Extraction

The two-step search query returns 220,197 records authored by 447,791 scientists in 2010-2012. Russia has remained the post-Soviet country with the biggest publication output: 6254 nanotechnology papers were published by authors with the affiliation in Russia. Additional 3116 papers were published by authors affiliated with post-Soviet countries and Bulgaria. As a first step of the identification algorithm, Russia, post-Soviet countries and Bulgaria were excluded from the further work with the dataset, as it aims to extract author data of the Russian-speaking scientists who work outside of their countries of birth and training.

Excluding Russia and the post-Soviet countries from the analysis follows a set of assumptions that need to be listed here. First, such exclusion assumes that post-Soviet scientists who are working outside Russia publish papers by themselves or in collaboration with non-Russian scientists. Excluding country affiliation “Russia” from the dataset excludes also all scientists who only published in collaboration with Russia, because exclusion is based on publications, not authors. However, this case seems to be unlikely, especially that the time span of the set is 3 years.

Second, such isolation refutes the existence of the 2nd generation Russian scientists: those who may speak Russian, but were brought up abroad and received their research training entirely overseas and are completely unrelated to the Russian culture. This bias cannot be fixed within the method and can only be manually verified. A partial overcome can be to exclude researchers with a low number of publications (less than 3) from the further analysis, leaving only mature researchers who publish more, assuming that the 2nd generation issue is less pronounced among this group.

Finally, there is bias that includes non-Russian speakers in the search query. Among them are some Eastern European authors, whose naming customs are similar to Russian and post-Soviet. Exclusion mechanism based on first names is one way to reduce this bias, but almost half of the author information fields in the database do not contain first name information. This bias will be investigated in more detail at the end of the chapter.

Excluding Russia and other post-Soviet countries from the dataset leaves it with 208,865 publications authored by 423,714 researchers. The bibliometric search procedure based on surname morphology was then applied to extract post-Soviet overseas diaspora from this large set of authors. In Step 1 (maximising Recall) 29 538 authors were selected (about 7%). Step 2 (maximising Precision) further reduced the number to 15 483 authors (3.7%).

After the automatic selection was finished, manual verification of the surname data was carried out. Search terms, such as “Yu”, which can be a Chinese name or an indication of a Russian patronym, could not be included in the automatic string and were removed.

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8 When added up, the number of papers published by Russian and by non-Russian scientists does not add up to the 220 thousand publications of the whole dataset, because when post-Soviet countries were isolated, 2 293 papers that were published collaboratively between post-Soviet and foreign scientists were not selected.
manually. This left 14,931 surnames in the dataset. The final step was further manual reduction of the false positive search results, which reduced the number of names to 6,279 (1.5% of the original set or about 40% of the automatically identified authors).

Author Disambiguation

The final step before the analysis of the data is cleaning. Working with author information causes a problem of authorship identity, or name disambiguation (see Tang and Walsh (2010) for an overview). This classic problem problematises automatic assignment of singular authorship to several authors with homonymous names, or, on the contrary, splitting the name of an author, which may be variations in spelling, into several separate ‘authors’. Working with author information without resolving the problem of authorship identity for each dataset is not feasible.

Russian surnames are more a subject of the second problem of the authorship identity than the first one; as they need to be transliterated into the Latin alphabet from their native Cyrillic when publish in international journals. Several options of spelling the same surname may exist. In addition, authors may include their initials or full versions of their names in different publications, depending on the requirement, which may lead to creation of several ‘authors’ when the records are analysed in the Web of Science.

In the VantagePoint software author name disambiguation and merger procedures are done using the data cleaning tools. It is carried out in a semi-automatic manner, with further manual verification of results and checking most popular surnames. Due to the large volume of excluded author information and to the fact that the search procedure accounted for all spelling variations, data cleaning was carried out after the initial diaspora set was successfully extracted. After the data cleaning was finished, 5,114 unique author names were left checked in the Overseas Diaspora dataset, which constitutes about 1.1% from the whole volume of author information in 2010-2012.

Data Source

Several databases provide source publications for the study of emerging technologies. Scopus and the Web of Science (WoS) are among the most structured, and the Google Scholar is gaining popularity. Specialist databases, such as PubMed, are available for the analysis of field-specific science and technology areas. The source of the data of this chapter is the Thomson Reuters Web of Science (WoS), which provides one of the most comprehensive sources for publications in nanotechnology and includes conference papers and proceedings in addition to papers published in scientific journals (Huang et al., 2015). The largest alternative data source, Scopus, has been reported to return consistent statistics of macro-level bibliometric indicators (Archambault et al., 2009) and is used separately for the follow-up analysis of the individual data of interview participants (see Chapter 7).

As nanoscience is a diverse field that spans across disciplines, identifying nanoscience publications is not a straightforward task. Thomson Reuters introduced nanotechnology as a subject category since 2005. However, it may not measure the entire nanotechnology
output. The development of nanoscience can be captured by using institutional, social or lexicological search and selection strategies. Institutional strategy means collecting data from a set of relevant journals that represent the interdisciplinary field, e.g. *Journal of Nanoparticle Research*. Social strategy reflects mutual citations maps in the community of nanoscientists, and the lexicological strategy reflects using keyword queries that usually work with title and abstract information, and, more rarely, with the full text data. Huang et al. (2011) report a much wider diversity of various lexicological strategies in comparison with journal- or citation-based strategies. In addition, the authors note broad similarities in search results when different keyword-based strategies were used. In fact, they observed significant differences with journal-based method, and differences in sizes of resulting datasets, but not differences in basic statistics, or in disciplinary compositions of nanotechnology publications.

However, when a complex emerging technology, such as nanotechnology, is concerned, evolutionary methods that are continuously refined yield better results. For this reason, in this study I use a lexicological query based on inclusion and exclusion terms. The query was developed by a group of researchers in Georgia Institute of Technology and is detailed in Porter et al. (2008). The strategy, which researchers call a modular nano search algorithm, consists of two steps: (1) database download using specific ‘nano search terms’ that were discussed with nanotechnology experts, and (2) excluding records that are unrelated to nanoscience and nanotechnology, using keywords specific to those particular research areas, such as ‘Plankton’, or by singling out papers that only use the term ‘nano’ in relation to simple sizing measurements, such as ‘nanometer’.

The search strategy has been refined as the emerging technology field evolved. It has become relatively easier to identify nanotechnology publications in recent years, because researchers tend to use nano-prefixed terms for nanotechnology research considerably more often as nanotechnology becomes an established field (Arora et al., 2013b). However, there is change in the technology itself as new discoveries are made. The most recent publication by Arora et al. (2013a) updates the search query for nanoscience and nanotechnology. It maintains the same two-step structure, offering incremental improvement. The search strategy was applied to collect the working publications dataset for further analysis and author surname data extraction.

**Russian (Soviet) Heritage: Inclusivity and Representation**

In order to identify the relevant population of Russian-speaking nanoscientists abroad, two criteria must be satisfied: (1) they must be a part of the scientific profession and be engaged in nanoscience research; (2) they must have shared heritage.

Heritage is a compound term that relates to common research upbringing of scientists that causes them to have shared research culture. As the Soviet Union was isolated from the rest of the world for a significant part of the 20th century, it developed particular ways of teaching and doing science, its authentic ‘scientific schools’ – self-reproducing communities of scientists that adhered to structured systems of scientific views, usually led by exceptional scientists recognised globally (Ustyuzhanina et al., 2011). After the country opened up, the
practitioners of these isolated ‘schools’ went abroad and sometimes transformed entire disciplines in their new host countries: for example famously, the Soviet mathematicians who changed the institutional rules of the game of the American mathematics discipline (Borjas and Doran, 2012b). In this sense, shared heritage does not only point to the country of origin or researchers, but also classifies them as carriers of a particular type of tacit knowledge that relates to research culture and research practice.

Identifying such heritage using bibliometric search means is unprecedented. Fortunately, due to the isolation of the Soviet Union throughout the 20th century, it is deemed possible to trace the Soviet Heritage of researchers using onomastics – the study of places and names. Morphological structures of surnames that ethnic Russians and other ethnicities of the former Soviet Union hold still have a significant connection with their place of origin. Previous research determined that there is a significant probability that a holder of a Russian surname will be genetically Russian and live in the Soviet Union (Revazov et al., 1986). Unlike with many other nations, post-Soviet there were no significant movements of people between Soviet Bloc countries and rest of the world between 1920 and 1989. Therefore, it is possible to make an assumption that the persons with post-Soviet names residing outside of their native territories and publishing in SCI-indexed journals would be in their majority holders of the Soviet heritage.

While Russians constituted the majority of population in the Soviet Union, it, and the Russian Empire before it, was a multi-ethnic country. The Russian culture may have been dominant (including in science), but it is not possible to name the heritage of scientists, most of whom are Russian, as ‘Russian’ heritage, because throughout the history Russia and the Soviet Union represent an amalgamation of nations.

The latest census of 2010 indicated that ethnic Russians constituted 77.7% of 190 nationalities living on the territory of Russia (Population Census, 2010). Most of the nationalities living on the Russian soil were conquered and assimilated into the Empire since the XI century (for a detailed overview see Kappeler, 2014). As a part of this process, nearly all of these ethnicities adopted Russian naming customs. This includes Tatars, now the second largest ethnic group in Russia. Ukrainians are the third largest ethnic minority in Russia with 1.9 mln people living there permanently. Other post-Soviet and Russian-speaking ethnic groups living on the territory of Russia include Armenians, Belarusians, Germans and Jews (see Table 1).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Nationality</th>
<th>Share of all population</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Russian</td>
<td>77.71 %</td>
<td>111 mln</td>
</tr>
<tr>
<td>2</td>
<td>Tatar</td>
<td>3.72 %</td>
<td>5.3 mln</td>
</tr>
<tr>
<td>3</td>
<td>Ukrainian</td>
<td>1.35 %</td>
<td>1.9 mln</td>
</tr>
<tr>
<td>7</td>
<td>Armenian</td>
<td>0.83 %</td>
<td>1.2 mln</td>
</tr>
<tr>
<td>10</td>
<td>Kazakh</td>
<td>0.45 %</td>
<td>648 thousand</td>
</tr>
<tr>
<td>11</td>
<td>Azerbaijan</td>
<td>0.42 %</td>
<td>603 thousand</td>
</tr>
<tr>
<td>16</td>
<td>Belorussian</td>
<td>0.37 %</td>
<td>520 thousand</td>
</tr>
<tr>
<td>23</td>
<td>German</td>
<td>0.28 %</td>
<td>394 thousand</td>
</tr>
<tr>
<td>24</td>
<td>Uzbek</td>
<td>0.20 %</td>
<td>290 thousand</td>
</tr>
<tr>
<td>32</td>
<td>Georgian</td>
<td>0.11 %</td>
<td>158 thousand</td>
</tr>
</tbody>
</table>
Russian surnames of White Russian or Ukrainian heritage constitute the most significant minority of non-Russian surnames, along with the names from other Slavonic languages (Unbegaun, 1982: 4). Surnames of Jewish, German and Armenian origin are met as well, within and outside ethnic communities. Developing a procedure that would capture all Russian-speaking researchers and researchers that were educated in the Russian scientific tradition, even if they have foreign names, and to not capture false positives, is a dilemma of the method. The procedure, which is inclusive of surnames of ethnic groups who lived in the Soviet Union, but is exclusive of typical names that are met in other countries, has been developed.

Types of Russian Surnames

The total number of Russian Surnames exceeds 15 000 (Balanovskaya et al., 2005) and because of the extreme variability no exhaustive list is available, published or online. Several sources provide representational selection of names. The most comprehensive source published in English is “Russian Surnames” by Boris Unbegaun (1972) based on bibliographies, indexes and directories of St Petersburg in 1910. The author uses morphological and semantic classifications of the surnames. Vladimir Nikonov published an analogous study in his 1988 book The Geography of Surnames [Geographiya Familiy] (Nikonov, 1988), available in Russian only. As the title suggests, the book outlines geography of surnames across the Soviet Union and Europe. Similarly, a list of Slavic surnames is available to collect from online sources. Russian Wikipedia lists all common surnames observed on the territory of Russia and updates it in a semi-automatic manner (Wikipedia, 2015). Most recent studies have been focused on looking for commonly met surnames in Russia and on the most popular surnames in Russia, rather than on rare structural names (Balanovskaya et al., 2005; Zhuravlev, 2005).

Unbegaun’s work provides the most consistent, comprehensive and widely recognised source of surname information, covering not only the origins of ethnic Russian surnames, but also touching on other surnames in the Russian empire, as well as Russian surnames that originate from the Western Europe, have Turkic and Jewish origin. It relies on pre-Soviet data and is significantly outdated, but the data is consistent with the results of other, more recent studies on Russian surnames.

As mentioned above, Russian surnames of various origins can be classified on the basis of their morphology and on the semantic basis. Semantic classifications outline origins of various surnames that are rooted in history, geography and class. Morphological classifications focus on the types of linguistic units that make up each surname. Most notably, Unbegaun focuses on the suffix of Russian surnames. Suffix is a morpheme that is placed after the stem of the word, but before its variable ending (in the Russian language). Surname stems are a subject of semantic classification, whereas surname suffixes are less variable and are a subject of morphological classification.
Morphologically, the majority of Russian surnames are of patronymic origin. Patronymic suffixes and case-endings, indicating male or female surname, is a distinctive feature of the Russian language.

“The overwhelming majority of Russian surnames are patronymic. This patronymic character is expressed by special suffixes, almost exclusively –ov/-ev and –in, the former being more common than the latter. A small minority group of patronymic surnames consists of names formed by the surviving genitives of adjectives, either in the singular, or in the plural” (Unbegaun, 1972: 2).

These suffixes are derived from a name, a place, or a profession. As an example, the most popular Russian surname, Ivanov, literally means “belonging to Ivan” and conveys the meaning of a dynasty. The third most popular surname in Russia, Kuznetsov, is a ‘Blacksmith’. The patronymic suffix indicates that the bearer of the surname belongs to the profession. There are morphological types of patronymics in Russia. For example, suffixes –skii (and spelling variations) almost exclusively relate to the place. A small number of surnames ending with –in are in fact metronymic, i.e. the suffix is derived from a female name. Table 2 presents a full scope of Russian patronymic and metronymic suffixes with variations in spelling and endings.

The popularity of the three most popular patronymic/metronymic suffixes among Russian surnames is estimated to exceed 80% (Unbegaun, 1972; Zhuravlev, 2005). The –ov format is used in linguistics as a morphological marker of a Russian surname (Bratishenko, 2010). The share of adjectival surnames varies at about 15%, while the share of substantival surnames is virtually negligible.

To conclude, suffixes of Russian surnames are consistent and allow identification of Russian speaking scientists from a database of authors. With regard to the fact that the majority of ethnicities that lived in the Russian Empire and the Soviet Union and may now be independent nations adopted Russian naming customs, predominantly with –ov patronymic suffix, this suggests a reliable source to identify Russian heritage.

Among other types of names met on the territory of Russia and the Soviet Union, three groups should be noted. First, the naming customs of other Eastern European countries are mixed with, but do not overlap with the Russian naming customs. Second, separate types of naming customs exist in countries like Georgia and in the Baltic countries. Finally, another three groups of surnames are a special case: these are the Jewish, Germanic and Armenian surnames. Unbegaun lists these surnames as “Russian surnames of foreign origin” and points that ethnic Russians hold many of them.

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9 Russian surname endings change depending on the gender of the surname holder. Male endings are usually null in the nominative case and the suffix is, therefore, at the end of the word (e.g. Ivanov, where “ov” is the patronymic suffix). Female surname adds the ending –a to the word, extending it, e.g. Ivanova, where “ov” is the patronymic suffix and “a” is a female ending. Some types of surnames do not acquire female variations (e.g. Voinovich).
<table>
<thead>
<tr>
<th>Surname Type</th>
<th>Subtype</th>
<th>Male Version</th>
<th>Female Version</th>
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<tbody>
<tr>
<td>Patronymic/metronymic</td>
<td>ov</td>
<td>ova</td>
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<td>cyn</td>
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<tr>
<td>Non-patronymic</td>
<td>substantival</td>
<td>Rare Names (list)</td>
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<td>adjectival</td>
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<td>ny</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ykh</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ykch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>geographical</td>
<td>sky</td>
<td>skaya</td>
<td></td>
</tr>
<tr>
<td></td>
<td>skiy</td>
<td>skaiya</td>
<td></td>
</tr>
<tr>
<td></td>
<td>skii</td>
<td>skaia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>skoi</td>
<td>skoi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>skij</td>
<td>skaja</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Morphological types of Russian Surnames

As this study aims to identify broad post-Soviet heritage, identifying authors with surnames that are markers of other post-Soviet countries is an important task. Therefore, the use of surname suffixes in identifying publication authors has three main challenges:

1. The broad inclusive approach that will encompass all types of surnames from all countries and nationalities of the post-Soviet space has a risk to include high share of irrelevant results, which will eventually obscure the analysis. For example, identifying Russian surnames of German origin by using the ending –burg will likely return many results of German surnames that are completely irrelevant;

2. A narrow exclusive approach that will only include the three most popular endings – ov/-ev and –in runs a risk of completely ignoring the contribution of Russian scientists with surnames of foreign origin, including Ukrainian and Belorussian scientists, and the risk of ignoring the contribution of non-Russian scientists who nevertheless share Russian (Soviet) academic culture and speak Russian as the main language of science, and were brought up in the Soviet scientific tradition. This would reduce the post-Soviet heritage and legacy of science exclusively to the heritage of its titular country and nation, Russia.
3. A possible overrepresentation of Russian surnames of foreign origin among people working in science. This may be due to the existence of scientific dynasties, due to long-term class issues, or because of the entirely different reason. A first indication of this bias is the fact that among the 12 Soviet/Russian scientists who received the Nobel Prize in physics, only 5 have surnames ending with ‘-ev’ (Table 3).

<table>
<thead>
<tr>
<th>Year Received</th>
<th>Nobel Prize Laureates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958</td>
<td>Pavel Cherenkov</td>
</tr>
<tr>
<td></td>
<td>Igor Tamm</td>
</tr>
<tr>
<td></td>
<td>Ilya Frank</td>
</tr>
<tr>
<td>1962</td>
<td>Lev Landau</td>
</tr>
<tr>
<td>1964</td>
<td>Nikolai Basov</td>
</tr>
<tr>
<td></td>
<td>Alexander Prokhorov</td>
</tr>
<tr>
<td>1978</td>
<td>Petr Kapitsa</td>
</tr>
<tr>
<td>2000</td>
<td>Zhores Alferov</td>
</tr>
<tr>
<td>2003</td>
<td>Alexei Abrikosov</td>
</tr>
<tr>
<td></td>
<td>Vitaly Ginzburg</td>
</tr>
<tr>
<td>2010</td>
<td>Andre Geim</td>
</tr>
<tr>
<td></td>
<td>Konstantin Novoselov</td>
</tr>
</tbody>
</table>

Table 3 Russian and Soviet Physics Nobel Prize Laureates of the 20th Century

With the regard of the possible overrepresentation of Russian names of foreign origin in Russian science, requires a finer, more complex search. Such search was developed as a result of iterative procedure based on testing various combinations of surname endings (suffix+gender endings) with lists of rare or exclusive surnames. Ubegaun’s morphological classifications of Russian surnames are taken as the basis of compound blocks of these strategies. These endings that constitute a distinctive suffix together with the ending of the name (in case of a female version), sometimes with several versions of its spelling, form the core structure of the bibliometric search query. Eventually, six scenarios of the search query were tested. The next sub-section provides a detailed analysis of the overrepresentation of surnames of foreign origin in Russian science, which was an important insight during the development and testing of bibliometric query scenarios.

**Procedure Operationalisation: Testing Scenarios**

The list of surname endings of the minority names can be found in Table 4. These include, separately, post-Soviet names (Ukrainian, Belorussian, Armenian, Georgian, Baltic), and Germanic/Jewish names. An educated guess in the beginning of the procedure development was that some of the non-traditional surname endings were going to return more false positives than others. In order to test these, a group of ‘green’ suffixes was selected from the overall list of Ukrainian/White Russian, Armenian and Georgian surnames.
Table 4 Russian Surname Endings of Ukrainian/White Russian, Armenian, Georgian, Rumanian and Baltic Origin

<table>
<thead>
<tr>
<th>Ukrainian/ White Russian origin</th>
<th>Armenian Origin</th>
<th>Georgian Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>enko</td>
<td>ents</td>
<td>zun</td>
</tr>
<tr>
<td>onko</td>
<td>ura</td>
<td>pun</td>
</tr>
<tr>
<td>uk</td>
<td>ash</td>
<td>tun</td>
</tr>
<tr>
<td>ik</td>
<td>itsa</td>
<td>run</td>
</tr>
<tr>
<td>ovich</td>
<td>itza</td>
<td>ist</td>
</tr>
<tr>
<td>evich</td>
<td>ilo</td>
<td>akh</td>
</tr>
<tr>
<td>yuk</td>
<td>ylo</td>
<td></td>
</tr>
<tr>
<td>lv</td>
<td>an</td>
<td>Baltic Origin</td>
</tr>
<tr>
<td>ko</td>
<td>yz</td>
<td>nek</td>
</tr>
<tr>
<td>yta</td>
<td>az</td>
<td></td>
</tr>
<tr>
<td>juk</td>
<td>enka</td>
<td></td>
</tr>
<tr>
<td>ak</td>
<td>nok</td>
<td></td>
</tr>
<tr>
<td>chno</td>
<td>kun</td>
<td></td>
</tr>
<tr>
<td>anko</td>
<td>gun</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 Russian Surname Endings of Germanic and Jewish Origin

<table>
<thead>
<tr>
<th>Germanic Origin</th>
<th>Jewish Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>ke</td>
<td>el</td>
</tr>
<tr>
<td>ig</td>
<td>son</td>
</tr>
<tr>
<td>en</td>
<td>man</td>
</tr>
<tr>
<td>er</td>
<td>mann</td>
</tr>
<tr>
<td>kind</td>
<td>bach</td>
</tr>
<tr>
<td>ein</td>
<td>ker</td>
</tr>
<tr>
<td>burg</td>
<td>ach</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Names of the Baltic origin were not comprehensively included in the search query. The main concern here is the language: Russian is the biggest minority language spoken in the Baltic countries, but mainly by the local ethnic Russian population. At the same time, the official politics towards the use of Russian in these countries has been termed “discriminative” towards the speakers of Russian and does not encourage the use of the language (Ozolins, 2003, 1999). Therefore, an assumption was made that the Russian speaking population in these countries would adhere to typically Russian naming tradition, and the Baltic population would not speak Russian. Only one suffix specific to Baltic surnames was included in the query: ending in –nek, because it became relatively widespread in Russia. Also, a suffix of Rumanian origin that is only ever met in names outside Romania (including the post-Soviet space) was included.

The resulting lists of surname endings were verified using recent studies of popular Russian names, and some outdated spellings and endings were removed.

In order to determine the scope of the search, testing scenarios for the procedure were developed. The purpose of scenarios is to determine the procedure of identifying the population of the post-Soviet heritage scientists living and working outside of Russia. The relevant search query is constructed from two general steps: adding authors with relevant surnames to the set of potentially post-Soviet authors, and then excluding authors that do not satisfy known surname and first name exclusions that identify them as surely non-
Russian. The general algorithm of identifying the relevant population of scientists is depicted on Figure 2. The algorithm works with the dataset that contains publications in the area of nanotechnology dated from 2010-2012 and uses the “Authors” field that contains surnames and, in about half of the cases, first names as well.

Figure 2 Overseas Diaspora Set Construction Algorithm

The desired result of the algorithm is a dataset of individual authors all of whom have post-Soviet names and, by proxy are of post-Soviet heritage. The set will comprehensively cover the existing Russian-speaking scientific community overseas. At the same time, all false items are excluded from this dataset based on the combined value of surnames and first names, which minimises the bias of further calculations done using the Overseas Diaspora set. The purpose of scenarios testing is to identify optimum query for outlining Russian and post-Soviet surname ‘endings’ (may include variations of full surnames), and to outline relevant exclusions terms.
As a type of classifier (relevant-irrelevant), search results are identified within the terms of a confusion matrix (Table 6). Ideally, any search query is looking to return 100% true positive results (to find all Russian speaking authors) and to also classify all true negative results as negative (to not identify any of the non-Russian authors as Russian). However, the two mistakes – classifying relevant results as irrelevant (false negatives) and classifying irrelevant results as relevant (false positives) happen often.

<table>
<thead>
<tr>
<th>Actual Condition Positive</th>
<th>Actual Condition Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Condition Positive</td>
<td>True Positive (TP)</td>
</tr>
<tr>
<td>Predicted Condition Negative</td>
<td>False Negative (FN)</td>
</tr>
</tbody>
</table>

Table 6 Confusion Matrix (adapted from Chawla et al. (2002) by the author)

Testing scenarios are composed from different combinations of search ‘rules’ (Table 7). The simple rules correspond to (1) the types of Russian names and (2) to the type of search query. A bibliometric search query may be based on full words, so-called ‘golden list’ of surnames that are associated with a certain country (Robinson-Garcia et al., 2015), or on names endings. The full list of Russian surnames, as mentioned before, is easily obtainable from Wikipedia and presents a much lesser challenge from the perspective of capturing irrelevant results than the surname endings search. Similarly, lists are available for rare substantival names that do not adhere to morphological classifications, and a list of Russian speaking scientists with ‘foreign’ names can be constructed from the dataset and used as a list of full surnames, instead of using the bibliometric query based on Germanic and Jewish surname endings. All these alternatives are explored in the alternative scenarios for the development of the bibliometric search procedure.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Russian surnames</td>
</tr>
<tr>
<td>B</td>
<td>post-Soviet surnames</td>
</tr>
<tr>
<td>M</td>
<td>Baltic and Romanian surnames</td>
</tr>
<tr>
<td>C</td>
<td>Germanic and Jewish surnames</td>
</tr>
<tr>
<td>H</td>
<td>Irregular Russian surnames</td>
</tr>
<tr>
<td>T</td>
<td>Surnames of top Russian scientists with foreign names</td>
</tr>
</tbody>
</table>

Table 7 Simple Rules of the Bibliometric Search Query

Simple lists are not enough to construct a bibliometric search query. The Optimum scenario for the bibliometric search procedure includes a combination of the rules that add records to the set of overseas diaspora scientists and then exclude falsely captured records. Additionally, an iteration of search is made and ‘Extras’ – relevant surname endings that were omitted from the original query but capture positive results – are added. The seven testing scenarios of the bibliometric search query are summarised in Table 8. Scenarios 1, 2 and 5 have two alternatives for each, exploring, in the case of S1 and S5, the feasibility of using surname endings or lists of surnames, and, in the case of S2, the feasibility of use of a broader or a narrower list of post-Soviet surnames.
Scenario type “regular expression” classifies the type of search. Surname endings search is a left-hand truncation type of regular expression, which was not supported by the WoS search tools in 2013. Therefore, the data had to be downloaded to the VantagePoint bibliometric analysis software, and the relevant surnames had to be extracted from the database of nanoscience publications 2010-2012. The formula that was used to search for a surname ending with “in” was the following:

\[(a - z) + in\backslash b\]

The term \([a-z]\) means that the ending must be preceded by a lower case alphabet letter. The combination \(\backslash b\) identifies the end of the word. The combination of surname ending search formulas was used in a Boolean search string to identify and select all surnames with relevant endings.

With the list-type of surnames, full surnames were used as ‘regular expressions’, which included variation of a surname. In VantagePoint the search for the exact surname will only capture authors whose author information field only contains surname data, no first name or initials data. As the probability of finding records like this is almost zero, surname lists were used as regular expressions, i.e. a rare substantival surname Moroz returned author information “Moroz, A. I.”, “Morozov, A.I.”, and “Morozova, A. I.” Some rare three-letter surnames (e.g. Ber, Rut) had to be removed from the lists in further iterations of the scenario development for returning many false positive results and very few true positive results. However, lists of full names were still used as a list, essentially returning much fewer search results than endings-based queries. Therefore, they are distinguished in the ‘type’ of search in Table 8 as “surname lists”. As far as the actual search query is concerned, endings search terms and surname lists could be used in the same string as a part of one search query as regular expressions.

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Description</th>
<th>Formula</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>&quot;Simplest Rule&quot;</td>
<td>Russian surname endings that supposedly capture 87-95% of Russian surnames</td>
<td>A</td>
<td>Regular Expression</td>
</tr>
<tr>
<td>S1.1</td>
<td>“WIKI list”</td>
<td>1850 surnames from WIKI Russian Names Project</td>
<td>Golden List</td>
<td>Surnames List</td>
</tr>
<tr>
<td>S2</td>
<td>S1+ all &quot;Soviet Surnames&quot;</td>
<td>Soviet Union was a unitary research system; surnames from former Soviet countries constitute a majority of non-Russian origin surnames in Russia</td>
<td>A+B</td>
<td>Regular Expression</td>
</tr>
<tr>
<td>S2.2</td>
<td>S1+ selected &quot;Soviet Surnames&quot;</td>
<td>Post-Soviet names that are most commonly met or most probably to not capture false positive results</td>
<td>A+B_green</td>
<td>Regular Expression</td>
</tr>
<tr>
<td>S3</td>
<td>S2.2. + Romanian and Baltic surnames</td>
<td>Russianised surname endings of Romanian and Baltic Origin</td>
<td>A+Bg+M</td>
<td>Regular Expression</td>
</tr>
</tbody>
</table>
The first scenario (S1) looks at the simplest possible way to capture the relevant population of Russian speaking scientists: by using the rule ‘A’ only. In case this scenario captures over 90% of all relevant records, no further complications would be necessary. In case this does not happen, S1.1. is tested in order to identify whether it is an ending-based regular expression search, or a Golden List-based search that works better as a basis for the further query build-up.

The second scenario tests the query that combines Russian and post-Soviet names, with a narrow and a broad option for the post-Soviet surnames list, the latter termed ‘B_green’, for the green highlight of the used endings of the narrow selection of post-Soviet names. The third scenario adds two Romanian and Baltic surname endings to the query, increasing it slightly.

Scenarios 4 and 5 maximise the inclusive potential of the bibliometric search procedure by adding, in the first instance, Germanic and Jewish surnames, and in the second, by adding a list of rare Russian names from the list of rare names, or by adding a list of names of selected top ('star') nanoscientists who are Russian speakers and have irregular and foreign surnames. The loss of these Russian scientists was selected from the collected author information and verified manually by checking available CV and employing organisations’ website information. All three scenarios are tested as alternatives with the scenario S2.2 as a base, as there are concerns that they may return many false positive results, or, on the contrary, very few true positive results.

Finally, Scenarios 6 and 7 represent the development of scenarios after initial testing was done. It transpires that adding extra endings search terms was necessary, most notably, for surnames that contain an apostrophe. To identify almost exclusively Russian and Ukrainian
names that are spelled with an apostrophe (for example, Ovid’ko), an advanced search query was used:

\[ ^{\wedge}A – Z a – z 0 – 9 k o \backslash b \]

It indicates that all letters or signs can precede the surname ending. In addition to this more complicated query, five extra ‘post-Soviet’ endings that had not been assessed as necessary were added, along with 10 rare and foreign names from the unused list of substantival names and from the unused Romanian/Baltic search string (Silhanek). The full list of Extras (added endings and full names) is available for review in Table 9.

<table>
<thead>
<tr>
<th>Surnames with Apostrophe</th>
<th>Post-Soviet Surnames</th>
<th>Extra Full Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>^{\wedge}A-Za-z0-9ev\b</td>
<td>[a-z]+chak\b</td>
<td>Chkalo Kyzyma</td>
</tr>
<tr>
<td>^{\wedge}A-Za-z0-9eva\b</td>
<td>[a-z]+chko\b</td>
<td>Dymshits Raikher</td>
</tr>
<tr>
<td>^{\wedge}A-Za-z0-9ko\b</td>
<td>[a-z]+elko\b</td>
<td>Golovin Silhanek</td>
</tr>
<tr>
<td>^{\wedge}A-Za-z0-9naya\b</td>
<td>[a-z]+gyn\b</td>
<td>Golub Toeroek</td>
</tr>
<tr>
<td></td>
<td>[a-z]+shko\b</td>
<td>Krysa Tsybulya</td>
</tr>
</tbody>
</table>

Table 9 Extra Search Terms

Similarly, excluding false positive search results is an important step in identifying the overseas diaspora set. As discussed above, the exclusion part of the algorithm is based on (1) excluding authors based on their surnames and on (2) excluding authors based on their first name. Among false positive surname results, Middle Eastern and Indian surnames ending in –in and –aya (aja, aia) were the biggest problem. Miscellaneous European surnames with endings resembling Russian and post-Soviet endings (Cordova, Brain) had to be identified and excluded individually. However, first names were the biggest problem during exclusions terms development.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Example</th>
<th>Solution</th>
<th>Exclusion Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Eastern Surnames</td>
<td>Kamruddin</td>
<td>Exclude [a-z]+ddin\b</td>
<td>Regular Expression</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exclude Middle Eastern First Names and typical surnames</td>
<td>Regular Expression + Name List</td>
</tr>
<tr>
<td>Indian Surnames</td>
<td>Bhattacharya</td>
<td>Exclude typically met endings</td>
<td>Regular Expression</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exclude typically captured surnames</td>
<td>Name List</td>
</tr>
<tr>
<td>Miscellaneous Surnames</td>
<td>Castranova</td>
<td>Exclude Individually</td>
<td>Name List</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exclude all that start with &quot;th&quot;(\Th)</td>
<td>Regular Expression</td>
</tr>
<tr>
<td>Chinese first names</td>
<td>Yaqin</td>
<td>Exclude all Chinese surnames (less variability than first names)</td>
<td>Name List</td>
</tr>
<tr>
<td>European first names</td>
<td>Augustin</td>
<td>Exclude all European first names</td>
<td>Name List</td>
</tr>
<tr>
<td>Eastern European names</td>
<td>Stoyan</td>
<td>Exclude all Eastern European First Names</td>
<td>Name List</td>
</tr>
</tbody>
</table>

Table 10 Exclusion Terms Development
The use of first names is partial in the data. Therefore, the inclusion part of the query could not rely on first names. However, a lot of “true foreign” first names are captured in the search and are identified as Russian surnames. Among them there are many Chinese first names, such as Zhimin. As a solution, all Chinese surnames were singled out and excluded from search results, as they have less variability than the first names. The second biggest problem was first names ending with –in. Such popular Western names, as Martin and Kevin, were identified separately and added to the list of known non-Russian first names along with French, Anglo-Saxon and Eastern European first names that are very rare or nonexistent in Russia.

The next section follows the steps for testing the scenarios by, first, outlining the general procedure, then by following the steps for the test set construction, and, finally, by listing the combination of precision and recall measurements for each of the scenarios.

Method Testing

Procedure Testing: Recall, Precision and F Measure

Measuring the effectiveness of bibliometric search scenarios effectively means measuring the effectiveness of information retrieval. Traditional instruments – recall, precision and F-measure - have been used regularly to assess the quality of information extraction and information retrieval. This method has a long history in information science (Makhoul et al., 1999; van Rijsbergen, 1979). In bibliometric studies recall and precision are commonly used to assess search results retrieved from various databases, often comparing them (Gehanno et al., 2009; Walters, 2009), or to automatically assign retrieved items to pre-determined categories with a certain degree of probability of success. For example, these can be scientific fields or author disambiguation (van Eck et al., 2010; Wooding et al., 2006). The purpose of the bibliometric search procedure developed in this study is the latter: it attempts to assign automatically identified authors to a category of the ‘post-Soviet scientists’ based on the structure of their names.

Recall and Precision are two inversely related indicators that measure the degree to which a search query captures relevant records and leaves irrelevant records out. Cunningham et al. (2015) define Precision as share of the correctly identified items to the total number of items identified. As a formula it looks like following:

\[ P = \frac{TP}{TP + FP} \]

Recall measures the share of the total number of correctly identified items to the total number of items:

\[ R = \frac{TP}{TP + FN} \]

In most cases search queries have to settle for a tradeoff between Precision and Recall (Buckland and Gey, 1994). In the terms of identifying the overseas diaspora, it is easy to reach 100% Recall by adopting as wide scope of the search as possible with all variations of
surname endings. However, this query would have such low Precision - so many irrelevant results will be captured falsely - that any further analysis will be greatly obscured.

A weighted harmonic mean of Precision and Recall is called F-measure. It reflects the tradeoff between recall and precision, when the two are weighted equally (Manning et al., 2008):

$$ F = \frac{2P \times R}{P + R} $$

All three measures are used to assess the effectiveness of the bibliometric search query scenarios. The process of identifying the community of Russian-speaking scientists abroad has the purpose of maintaining both high Precision and Recall measures: for the further analysis I will need low amount of noise in the data (and thus high precision), and I also need to identify as many scientists belonging to the community as possible (high recall).

Recall-precision method contains bias. Powers (2011) lists three main shortcomings of the recall-precision measures. First, recall and precision ignore performance in identifying irrelevant items correctly. Second, there are underlying marginal prevalences and biases, such as rates and kinds of errors made. Finally, they do not take into account chance level performance. Thus, the author argues, in many cases these traditional measures are used without understanding of the underlying bias and they return more positive results of the system performance than other, more sophisticated measures, would.

It appears plausible in this case, to use Precision-Recall measures to test the scenarios of the bibliometric search query of Russian authors. The first bias of the method is irrelevant in this case, because the aim of the procedure is not to allocate authors to categories A and B, but to allocate them to categories A and non-A. There will be no further processing of the non-A category (true negative items). Ultimately, the database and the scale of the search do not amass enough variability to use sophisticated measures that account for the type of noise captured by the procedure. Instead, the two-step search strategy focuses separately on maximising recall and precision. The first step by captures a broad set of researchers that contains most of the relevant authors names thus maximising recall (Arora et al., 2013a). The second step excludes unrelated records and increases precision.

*Managing an Imbalanced Dataset: Testing Set Construction*

The nanotechnology dataset from which a small part of post-Soviet surnames needs to be extracted is a typical imbalanced dataset, which means that in the original dataset positive and negative results are distributed highly unevenly. Chawla (2005) points out that “the main goal for learning from imbalanced datasets is to improve recall without hurting the precision”, because “…when increasing the true positive for the minority class, the number of false positives can also be increased” (p.857). Indeed, in the case of identifying Russian surnames, the “Simplest Rule” scenario returns about 94% Precision and 81% recall. Most other attempts to increase recall hurt Precision (Table 12).
As a way of countering such effects of imbalanced datasets, Chawla (2005) points to sampling techniques as a way to manipulate the balance of the majority and minority class items in the training dataset. Undersampling techniques that use a subset of the majority class (in this case, true foreign author names) in a lower proportion to the minority class (true Russian authors) in order to train the classifier (to select an optimum scenario) before applying the classifier on the whole dataset can provide a solution to the imbalance problem (Liu et al., 2009). Undersampling has an important shortcoming: it may ignore some of the rules and examples of the majority class, and these can be revealed after the classifier is applied.

Arguably, undersampling is a more efficient strategy in comparison with the other sampling scheme, oversampling, which produces similar results at the extra computational cost (Drummond and Holte, 2003). Therefore, in order to determine the optimal combination of search rules that will form a bibliometric search procedure, Precision, Recall and F-measure will be tested not on the whole nanotechnology publications dataset, but on a training set, where the proportion between true Russian surnames and true foreign surnames is not maintained. True foreign surnames in the set will be undersampled.

The construction of the testing set proceeds in two stages. At the first stage, the dataset that contains 1001 Russian names, to be termed “known true positives”, was constructed. In order to do this, a sub-dataset of authors affiliated with Russia was created from the whole 2010-2012 nanotechnology publications dataset. The proportion of foreign-born researchers is insignificantly low in Russian research organisations, and the number of foreign-born students does not exceed 3.7% (OECD, 2011). An assumption was made that, because Russian science is to a big extent national, authors working in Russia will be Russian or post-Soviet and will have Russian surnames. The top 1000 authors with the highest publication contribution were selected in the first instance. Their surname and, in case of non-Russian surname, biographical information were checked. Finally, 1001 surnames belonging to 1001 unique people were identified. Some of the surnames were repetitive, but this is a characteristic of any sample, so they remained in the dataset.

The second stage was a construction of the dataset of the “known true negatives”. It was undersampled and in its final version it contains 1194 authors that are known foreign-born researchers. The sampling strategy corresponded to the contribution of countries to the body of research in nanotechnology in 2010-2012. The USA and China are the two top contributors, publishing 54 244 papers and 47 033 papers correspondingly, which is consistent with the results of Arora et al. (2013). A sub-dataset was created of all countries that published in nanotechnology with the exception of post-Soviet countries and Bulgaria, which has very similar patronymic naming customs as Russia. The resulting dataset contained 208 962 author names. Authors were selected for the inclusion to the testing set among the top publishing authors for each country. Their biographical information was verified, where available, to confirm that they were permanently employed in those countries. The number of authors selected for each country corresponds to that country’s nanotechnology research output. The top 6 countries (contribution over 5%) are presented in Table 11.
<table>
<thead>
<tr>
<th>Rank</th>
<th>Pubs</th>
<th>Country</th>
<th>Share</th>
<th>Authors to Select</th>
<th>Authors Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54244</td>
<td>China</td>
<td>25.96%</td>
<td>259.5878677</td>
<td>259</td>
</tr>
<tr>
<td>2</td>
<td>47033</td>
<td>USA</td>
<td>22.51%</td>
<td>225.079201</td>
<td>229</td>
</tr>
<tr>
<td>3</td>
<td>14395</td>
<td>Japan</td>
<td>6.89%</td>
<td>68.8881232</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>14242</td>
<td>South Korea</td>
<td>6.82%</td>
<td>68.15593266</td>
<td>68</td>
</tr>
<tr>
<td>5</td>
<td>14150</td>
<td>Germany</td>
<td>6.77%</td>
<td>67.71566122</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>12438</td>
<td>India</td>
<td>5.95%</td>
<td>59.52278405</td>
<td>59</td>
</tr>
</tbody>
</table>

Table 11 Known True Negatives Dataset Construction - Top 6 Countries

Authors were selected manually for each country with the overall contribution over 0.5% (5 authors were selected for those countries). Among the 99 countries with the contribution of less than 0.5% 45 authors were selected based on the top publication contribution. Overall, 1194 Known True Negative authors were grouped together.

The final testing set contains the total of 2195 authors, which belong to the two mutually exclusive groups: “known true positives” and “known true negatives”. These authors published 48 734 publications, and there are more ungrouped authors in the ‘authors’ field of the dataset that includes Russian and non-Russian authors. The way some of those authors were captured during the bibliometric search procedure testing was examined with the purpose to refine rules, add extras and negatives, but was not counted during the calculation of the recall and precision measures.

Method Testing Results

Scenarios testing results can be found in Table 12. The first dilemma of the method – whether to take the list of surnames or to use ending-based regular expressions – is resolved towards the use of regular expressions. While the ‘Golden List’ rule results are more specific – return much less known true negative results – they also have very narrow Recall of about 30%. In contrast, using typical Russian surname endings (rule A) returns much higher Recall with only 4 percentage points tradeoff with Precision.

Adding post-Soviet names to the search string increases the amount of noise in the results, but with using only a selected number of post-Soviet surname endings (“B-Green”) the decrease in Precision was only 0.3 percentage points, with the increase in Recall by 6.5%, whereas in case of using the full post-Soviet name list there is a much bigger tradeoff between 8.8% increase in Recall, but 11% decrease in Precision. Further testing was done with the base combination of Russian and selected post-Soviet names.
<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Type</th>
<th>Known TP captured</th>
<th>Known TN Captured</th>
<th>Total Known Captured</th>
<th>Recall</th>
<th>Precision</th>
<th>F-Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&quot;Simplest Rule&quot;</td>
<td>S1</td>
<td>819</td>
<td>52</td>
<td>871</td>
<td>81.82%</td>
<td>94.03%</td>
<td>87.50%</td>
</tr>
<tr>
<td>Golden List</td>
<td></td>
<td>S1.1</td>
<td>283</td>
<td>5</td>
<td>288</td>
<td>28.27%</td>
<td>98.26%</td>
<td>43.91%</td>
</tr>
<tr>
<td>A+B</td>
<td>S1+ all &quot;Soviet Surnames&quot;</td>
<td>S2</td>
<td>907</td>
<td>186</td>
<td>1093</td>
<td>90.61%</td>
<td>82.98%</td>
<td>86.63%</td>
</tr>
<tr>
<td>A+B_green</td>
<td>S1+ selected &quot;Soviet&quot; Surnames</td>
<td>S2.2</td>
<td>884</td>
<td>59</td>
<td>943</td>
<td>88.31%</td>
<td>93.74%</td>
<td>90.95%</td>
</tr>
<tr>
<td>A+B+M</td>
<td>S2.2.+ selected Romanian and Baltic surnames</td>
<td>S3</td>
<td>884</td>
<td>59</td>
<td>943</td>
<td>88.31%</td>
<td>93.74%</td>
<td>90.95%</td>
</tr>
<tr>
<td>A+B+C</td>
<td>S3+ Jewish and Germanic Surnames</td>
<td>S4</td>
<td>898</td>
<td>255</td>
<td>1153</td>
<td>89.71%</td>
<td>77.88%</td>
<td>83.38%</td>
</tr>
<tr>
<td>A+B+H</td>
<td>S3+ Irregular Russian Surnames</td>
<td>S5</td>
<td>884</td>
<td>59</td>
<td>943</td>
<td>88.31%</td>
<td>93.74%</td>
<td>90.95%</td>
</tr>
<tr>
<td>A+B+T</td>
<td>S3+ top RU scientists with 'foreign' names</td>
<td>S5.2</td>
<td>938</td>
<td>59</td>
<td>997</td>
<td>93.71%</td>
<td>94.08%</td>
<td>93.89%</td>
</tr>
<tr>
<td>A+B+T+Extras</td>
<td>S5.2 + Extras</td>
<td>S6</td>
<td>962</td>
<td>59</td>
<td>1021</td>
<td>96.10%</td>
<td>94.22%</td>
<td>95.15%</td>
</tr>
<tr>
<td>A+B+T+Extras -Exclusions</td>
<td>S6 - Blacklist</td>
<td>S7</td>
<td>962</td>
<td>15</td>
<td>977</td>
<td>96.10%</td>
<td>98.46%</td>
<td>97.27%</td>
</tr>
</tbody>
</table>

Table 12 Scenarios Testing Results
Adding the two endings of Rumanian and Baltic origin did not change the retrieved results of known surnames. A test running of these two endings on the whole dataset returned a small sample of completely irrelevant results. Therefore, the rule was not used in the final scenario. Similarly, irregular substantival surnames (Scenario 5) did not change the output of the search string and was not used in the final search procedure.

Testing Scenario 4, which adds Russian surnames of Germanic and Jewish origin to the query returned results of the increase in Recall by 1.4 percentage points (extra 14 surnames), but dramatically decreased precision: an extra 196 known true negative names were captured in the search. Understanding that prominent scientists of Germanic and Jewish origin contribute significantly to the development of Soviet and Russian science, but not wanting to compromise the sensitivity of the search procedure, as a solution Scenario S5.2 was developed. It collects ‘foreign’ names of Russian-speaking scientists and adds them to the search query as a list. Initially only top 50 names were collected and tested, but eventually the list grew to 79 names, and some irregular substantival names were added as well to enrich it.

Scenario 5.2 demonstrated a marked increase in Recall, increasing it by 5.4% to 93.7%, while maintaining the same level of Precision. Target measures of recall, precision and the F-measure for the optimal scenario were set for the 95% probability rate of retrieving a relevant item. Therefore, further analysis of true positives, true negatives and other captured results was carried out to develop extra additions and exclusion rules that can increase the effectiveness of the search. Both are outlined in the previous section, along with the rules and scenario descriptions.

During the process of examining known true negative results and other surnames captured during the query, some of the rarer spellings had to be removed from some of the basic rules. For example, ending –ine is a variation of spelling a surname ending with –in so that it looks more like a Latin surname (e.g. Mymrine instead of Mymrin). However, such practice is rare and the search for surnames with endings such as this returns many false positive results with French surnames. Therefore, ending –ine, which is a variation of spelling –in, was removed from the search query (for the full list of removed endings see Table 13).

<table>
<thead>
<tr>
<th>Rule</th>
<th>Removed Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>oy</td>
</tr>
<tr>
<td></td>
<td>oi</td>
</tr>
<tr>
<td></td>
<td>oj</td>
</tr>
<tr>
<td></td>
<td>ny</td>
</tr>
<tr>
<td></td>
<td>ine</td>
</tr>
<tr>
<td></td>
<td>aja</td>
</tr>
<tr>
<td>Bg</td>
<td>ik</td>
</tr>
<tr>
<td></td>
<td>ets</td>
</tr>
<tr>
<td></td>
<td>ist</td>
</tr>
<tr>
<td></td>
<td>akh</td>
</tr>
<tr>
<td>T</td>
<td>Bert</td>
</tr>
<tr>
<td></td>
<td>Blank</td>
</tr>
<tr>
<td></td>
<td>Rut</td>
</tr>
<tr>
<td></td>
<td>Gordon</td>
</tr>
<tr>
<td></td>
<td>Ber</td>
</tr>
<tr>
<td>M</td>
<td>all</td>
</tr>
</tbody>
</table>

Table 13 Search Terms Removed from the Rules
As a result of adding extra search items, the Recall of the dataset was increased to 96%, which was an acceptable rate. The second step of the procedure targeted the Precision measure by excluding FP items that were systematically retrieved in the search. The final rate of 98% Precision, along with the weighted average of 97% was settled on as acceptable, and the bibliometric search procedure was then applied to the whole nanotechnology publications dataset.

**Bibliometric Search Procedure Results Validation**

Verification of bibliometric search procedure results showcases reliable identification of persons with genuine Soviet or post-Soviet background across major science diaspora locations, including the USA, UK and Germany. Some countries, such as Israel and Czech Republic, demonstrate inconsistencies in true positive results retrieval, which are a subject of further development of the method.

A disproportionate volume of positive results indexed in countries like Czech republic, Slovenia and Slovakia has been alarming. In order to verify the results of the bibliometric search procedure, a small representative sample of author information was randomly extracted for each country, and manually verified using the available CV and website data.

Author names were selected for manual checking randomly based on their country of affiliation. 20 names were selected for the top 4 countries, 15-17 names for the countries with significant Russian-speaking diaspora shares, and 5 names for countries where over 1% of the diaspora authors are located. If it was not possible to find the biographic data of a scientist, the next one in the list was selected. Verification continued until the target number of researchers was identified.

![Figure 3 Bibliometric Search Procedure Results Verification](image)

The results of manual verification for the major diaspora host countries can be found in Figure 3. Randomly retrieved surnames in the major diaspora hubs – US, Germany and the UK – demonstrated good results in verifying the author data, ranging from 90% to 95% share.
of correctly identified scientists. Across the board, the correct retrieval share remains at around 80% with few exceptions. Czech Republic and Israel demonstrate anomaly in results, which does not repeat in other major science diaspora hubs. These two countries demonstrate systematic retrieval of false positive results.

There were two types of mistakes tracked: first, a major mistake – a name that was captured wrongly and could be avoided with the increase in the sophistication of the search query. A minor mistake was a name wrongly captured (a false positive), which cannot be avoided by improving the query, only by using additional data sources. Generally, the share of major mistakes in the names selected is about 30% (4.1% of the total volume of surnames). These can be fixed in the next iteration of the dataset application. The UK, Swiss, Dutch and Finnish names lists contained major mistakes only.

Minor mistakes – names that are homonymic to post-Soviet names and cannot be excluded by the means of morphology – constitute the largest share of mistakes. Among the US, German, Canadian, Australian, Swedish and Japanese names, scientists of Czech, Serbian of Bulgarian origin were identified incorrectly as Russian-speaking researchers. These mistakes point to the overall bias in the search query. French and Italian name lists contained both types of mistake, which means that there are domestic naming customs that interfere with the precision of the query, as well as non-Russian-speaking researchers with Eastern European names that closely resemble post-Soviet names.

Finally, Czech Republic and Israel returned significant number of results of the bibliometric search query, but also demonstrated very low rate of precision after the manual verification of the results. A common mistake in capturing Czech names falsely is that carons used to distinguish Czech names from other Eastern European names are not captured in the Web of Science, which makes Czech surnames resemble Russian surnames. It is, however, easy to distinguish the two types of names during manual verification. Only one Czech name was identified during the manual verification in other countries with high numbers of Russian-speaking diaspora, which may indicate to the limited spread of Czech scientific diaspora abroad.

The pattern is different for Israel. All names in the randomly selected list conform to the Russian surname morphology, including first names. However, the biographic data for almost a half of the researchers in the list suggests that they never studied in the post-Soviet countries. Their entire education and research experience was in Israel or other foreign countries. This may have explanation in the historic roots of highly skilled migration to Israel. While high rates of migration from the Soviet Union to Israel, including highly skilled and scientific migration, in the beginning of 1990s, is undisputed (Siegel, 1998), the migration flow from Russia and other post-Soviet countries to Israel abated after that first intensive period. Hence, young people of Russian descent, with Russian names and even fluency in Russian language are now studying and working in Israeli higher education institutions, but have no professional relation to post-Soviet countries and are therefore, ‘false positive’ results in the search query.
While there are significant limitations of the search procedure, these limitations are confined to certain nation states, such as Czech Republic (along with Slovakia and Serbia) and Israel. The share of minor mistakes among other countries with significant diaspora concentration does not exceed 8.2%. Partly this may be due to the sheer size of workforce, as Russia is not only larger than countries like Czech Republic and Israel, but are also has the highest share of the labour force with postsecondary education per million population (Bloomberg, 2015). To conclude, the search query can be used to identify the overseas science diaspora fairly reliably for the top diaspora clusters, omitting the countries with obvious bias from the analysis (as is done with the Czech Republic in this section). The next part of the chapter discusses the limitations of the method in more detail.

Limitations

The method contains limitations, some of which have already been mentioned above. The first limitation of this method is clear from its initial strength: it is limited to tracking monoethnic communities or countries with dominantly distinguishable naming custom. While there are countries like this in the world, such as Japan or Vietnam, or Finland, a surname-based method is limited to looking at these nationalities. The method has little potential to accurately distinguish researchers who originated in countries whose populations are spread over several national states or countries, such as the Ukraine. Using the traditional country affiliation data is more suitable in this context, as well as using alternative ways to track scientific migration.

The second limitation of the method is its limited potential to distinguish researchers who carry relevant names, but actually do not possess the traits usually associated with these names. In the case of Russian-speaking overseas diaspora the purpose of the bibliometric search was to associate Russian and post-Soviet naming customs with speaking Russian as the main language and with the upbringing within the Soviet and the post-Soviet research culture. This should only have been the case to some limited extent. More and more young people who migrated abroad with their families receive education entirely outside of their ‘home’ countries, and more and more young people from post-Soviet countries leave abroad to pursue higher education. When these young people become scientists, their research upbringing is completely unrelated to their nationality or the dominant language.

Similarly, students whom Russian émigrés supervise, grow up into scientists with post-Soviet research upbringing, albeit they may be from Canada or China. There are few nations in the world that are so closed they are ‘pure’ when it comes to their research culture. The Soviet Union was probably one of those nations, but its human capital legacy is diluting and spreading out, and is becoming ever harder to capture using bibliometric means.

The third limitation of the method is its limited ability to get rid of unrelated information. As was noted in the previous section, unnecessary large selection of Czech, Polish, Slovakian and Slovenian names were captured during the bibliometric search procedure. The bias is not significant and was fixed manually during the verification step, but it took longer than necessary. More worryingly, some surnames looked entirely identical to Russian names. Bulgaria was entirely excluded as a country from the analysis, but the Bulgarian overseas
diaspora, for obvious reasons, remained in the database and could have inflated the final results, along with scientists of Serbian and Czech origin who live and work outside of their home countries. Assuming they have different scientific migration patterns and destinations, it may have biased the patterns of Russian-speaking researchers.

Finally, there is a traditional limitation resent in most scientific migration studies: scientists get married and sometimes change their surnames. This is especially the case with female scientists. In this case, they become untraceable based on the morphology of their surnames. Sometimes migrating researchers change their surnames to adapt to the naming culture of their host countries. In fact, this was often the case with Russian researchers who left in the first years within the breakup of the Soviet Union: they anglicised or francocised their first names and surnames and become much harder to identify.

Combining affiliation information and the temporal dynamic with the surname search procedure, e.g. tracking the place where scientists receive their first qualification, or the organisation where they publish their first paper, is a method to somewhat overcome the limitations of the pure surname search. In that case, the place of first publication will be an indicator of the place of origin and research culture, not purely the surname. Change of affiliation and publishing papers in countries different than the first one could serve as a proxy of scientific migration.
### APPENDIX 5 PULL, PUSH AND HOLD FACTORS OF COUNTRIES AND REGIONS

<table>
<thead>
<tr>
<th>Location</th>
<th>Pull</th>
<th>Push</th>
<th>Hold</th>
</tr>
</thead>
</table>
| USA      | Research-specific:  
- large academic job market;  
- more opportunities for science and professional development for young researchers  
- internationally recognised strong national science system;  
- more opportunities and freedom of choice to do research;  
- talented people leave EU for America;  
- less paperwork when applying for positions;  
General:  
- "society of opportunity";  
- Language - accent doesn't matter;  
- favourable immigration legislation (H1B visa that allows to apply for Green card as a visa holder);  |
|          | Research-specific:  
- hard to maintain work-life balance;  
- highly competitive and stressful work environment;  
- short-term contracts in contrast with EU countries where contracts are temporary but longer  
General:  
- Lifestyle and culture;  
- far away from home country;  
- lower quality of schooling and little welfare;  |
|          | Research-specific:  
- Once you leave the system, it is hard to come back in;  
- faster career progression than in EU;  
General:  
- don't feel like a foreigner - "migrant society";  
- liberty to maintain any lifestyle you choose without pressure from the society;  
- linear procedure of receiving a 'green card';  |
<table>
<thead>
<tr>
<th>Location</th>
<th>Research-specific:</th>
<th>General:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boston</strong></td>
<td>• Famous research cluster</td>
<td>• clustering of research organisations - unique opportunities for interdisciplinary research;</td>
</tr>
</tbody>
</table>
| **Switzerland** | Research-specific:  
• Very high salary for scientists;  
• a lot of benefits for young researchers;  
• strong research done in the country in my area;  
• good funding structure - easy to get it if eligible;  
• highly international system; | General:  
• Opportunities to find job for 2-body couples;  
• some of the best medium and high schools in the US;  
• history and the community; |
| **UK** | Research-specific:  
• "UK is the best place for science in Europe";  
• funding system of research councils and Societies tailored for different projects;  
• Industry funding and collaboration; | Research-specific:  
• Excellent organisation of work for scientists in terms of funding and purchasing experiment materials;  
• Nature and environment;  
• High investment in learning the language; |
| | Research-specific:  
• "In Switzerland in my area there are only 10 permanent positions" - strong push;  
• more vertical hierarchies in research groups;  
| General:  
• migration quotas  
| Research-specific:  
• Freedom of agenda setting in terms of research;  
• offers without funding | General:  
• Great quality of life;  
• Democracy as a political factor;  
• Contrast with the US - not live to earn but earn to live; |
| | | General:  
• possibility to maintain work-life balance; |
<table>
<thead>
<tr>
<th>Country</th>
<th>General:</th>
<th>Research-specific:</th>
<th>General:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• close to home country;</td>
<td>• Prestige;</td>
<td>• Personal affinity to the country;</td>
</tr>
<tr>
<td></td>
<td>• Language</td>
<td>• flexible in giving relocating scientists time to adapt</td>
<td>• British culture of praising rather than criticising in the community</td>
</tr>
<tr>
<td>Oxbridge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General:</td>
<td>Research-specific:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Proximity to London and its opportunities but being outside London proper;</td>
<td>• less personal freedom for younger scientists in comparison with other places in the UK;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research-specific:</td>
<td>• Oxbridge degree needed to be promoted to permanent position</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prestige;</td>
<td>• Internal politics;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• flexible in giving relocating scientists time to adapt</td>
<td>• path-dependency: rich history hinders development</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>Research-specific:</td>
<td>Low salaries for researchers;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Easier to receive offers for positions than in most European countries;</td>
<td>Nationalism in domestic science ('France for the French');</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research-specific:</td>
<td>'paternalistic' research system: not too much research freedom as a medium level scientist;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need to learn the language to progress</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strasbourg</td>
<td>Research-specific:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Policy to be attractive to students and researchers from around the world - in general contrast with France;</td>
<td>Very high competition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• no need to teach in French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Research-specific:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• many opportunities for temporary visits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Research-specific</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Israel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Programs for immigration of post-Soviet scientists and students;</td>
<td>close to home country;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>Excellent resources; availability of positions;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Programs for immigration of post-Soviet scientists and students;</td>
<td>close to home country;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- and temporary positions;
- funding availability;
- close research links with the home country;
- science culture: fundamental approach to research;
- funding support and research infrastructure

**General:**
- close to home country;

**Research-specific:**
- Very few universities in the country;
- expected to go to postdoc abroad before returning;
- the brightest minds leave to the US and EU;
- only employ graduates of the university;

**General:**
- High quality of life;
- community;
- climate

**Research-specific:**
- high investment in learning the language and rules of the system;
- comfortable place to live; personal affinity with the country;
- immigration regulation for dependents;
- social welfare better suited for bringing up children;

- factor for non-German speakers from UK and USA;
- few permanent positions for young researchers beyond Young Investigators Programme (no middle link in the system);
- hard to get positions for non-Germans;
- 12 year employment law;
- long span to launch academic career (habilitation) and requalification

**General:**
- exotic culture

**Research-specific:**
- collectivism - less personal freedom;
- you had to live at work;

**General:**
- lack of ‘feel at home’ feeling;
Scientific Migration Factors - Countries

The analysis of important factors that determined migration (and the absence of thereof) to and from various countries among the study participants, distinctive features are drawn for each of the case study countries and some regions within these countries.

When prompted to name distinctive features of living in their country or plans to move elsewhere, the narratives of the study participants usually contained implicit comparisons. One type of such comparison is countries that researchers previously visited and lived in, but the other type relates to the countries that researcher never visited before, but, knowing some parameters of research systems in those countries, they used them as explanatory units to compare their current countries of residence against. For instance, the UK interviewees compared being a researcher in the UK with being a researcher in the US on the one hand and with the EU as an aggregate system of ‘continental science’ in general. Researchers from Switzerland used other continental European countries – Italy and Germany – to contrast life in Switzerland against. US-based researchers preferred to say “Europe” to highlight the differences in research culture. Nobody mentioned Russia or other post-Soviet countries as benchmarks for comparison with their current countries. In fact, Russia was mainly mentioned as one of the developing countries, alongside China, that source research students to study in universities in the developed countries, or in the context of the home country where scientists at some point hoped to (or already held) temporary visitor positions, bringing in reputational benefits to local research organisations.

Overall, there is an observable balance between research-specific factors, such as research system organisation and employment patterns, and general factors, such as language, immigration and family-related factors. However, certain countries demonstrate disbalance among the type of factor that attracts scientists to the country and the type of factor that holds them. For instance, the entirety of ‘push’ factors in Germany and Israel were research-specific factors, such as unavailability of permanent positions in the system, or mobility expectation. In contrast, ‘hold’ factors for both countries related entirely to general characteristics of living in the country, such as the quality of life, family, childcare benefits. These countries, in general, are very attractive countries to live in, but both are extruding extra researchers to look for more stable employment options abroad.

The initial move abroad for many scientists did not have a country dimension, but rather depended on the existing network of links and partnerships that their university had. By utilising this link, many research participants got a chance to experience short-term visits abroad, meet a foreign professor (or an émigré who stayed in touch with his former university), and get a chance to apply for a postgraduate degree or a postdoctoral contract with these organisations. While some researchers, especially in the initial post-Soviet wave, left the country by utilising independent search and application strategy, at later stages more and more scientists went to organisations their home university had links with, irrespectively of the country these foreign organisations were located in.

In this respect, mobility incentives (slightly different for each system) are the main factor that ‘pushed’ scientists to consider other locations for migration.
### APPENDIX 6 PUSH, PULL AND HOLD FACTORS MEASURES

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APPENDIX 7 WORKWEEK TIME ALLOCATION ANALYSIS DETAILS

Workweek Time Allocation

As mentioned in the previous section, in relation to education, most scientists in the US public universities must teach, but this is not a compulsory element of academic activities of some Germany-based scientists. Faculty workweek time allocation framework is used to examine these general aspects of academic practice in the first instance before moving on to discuss the impact of academic culture directly.

The three types of activities under examination are not easily separable. Activities, such as tutoring graduate students and grant writing combine elements of research-teaching, or research-service, and the higher the position of a scientist, the more fusion there is between these elements of practice:

For example, there are students, research students. I tell them things and we discuss things. On the one hand, it relates to our ongoing research, but on the other hand this is also training of sorts. These cases are quite numerous, so I am hesitant to reply. Discussing projects and writing report – it takes a lot of time and you can’t avoid doing it, which one is this? (Professor, Germany)

Service as a category is also ambiguous, because while research and teaching are straightforward to understand, service may include different activities depending on the type of organisation and country, from sitting on committees to organising conferences and maintaining network communication in large European Commission projects. In most cases, these have been clarified in fieldwork interviews to reach consistency of responses: student-related activities were asked to be classified as ‘teaching’, and grant-writing was asked to be put down as ‘research’, because it directly enables future research. Service work and administration work were asked to be counted as one category. The overall ambiguity of the three categories was the eventual decisive factor of not using the concept to analyse the impact of research culture on academic practice.

The initial analysis focuses on the impact of the following categories on the practice profiles of researchers: country of residence, type of position, gender, and the type of employing organisation. The country of residence and the type of research position impose framework conditions on academic activities of researchers. As highlighted previously, different countries have varying approaches to what constitutes necessary elements of academic practice, and use hard as well as soft instruments to facilitate the diversification of academic profiles from simply research towards other activities, or enable scientists to concentrate solely on groundbreaking research. The type of position imposes similar requirements, as, for example, teaching becomes a necessary element of academic practice upon reaching professorial positions in most countries in the world. The type of employing organisation also incurs differences in the workweek time allocation: for instance, teaching is usually not performed in specialised public research institutes (Max-Planck Society institutes in Germany or National laboratories in the USA).
Out of the 62 scientists employed in public research organisations, the topic of workweek loads distribution was covered in 52 interviews. Among them, 1 interviewee noted that the distribution of loads she had at the moment of the interview was temporary and would change. One interviewee could not give an answer due to the vagueness of categories (see the quote above), and other three had significant loads of workweek dedicated to other types of activities (own company, consulting) and could therefore not answer the question within the posed boundaries. Therefore, responses from 48 interviews constitute the basis of this analysis.

The workweek measures provided are not only indicative, but are designed to solely highlight relative specialisations of scientists employed in various types of countries in various positions, and cannot be compared with findings of other studies or generalised to the whole population of the type of position or country.
APPENDIX 8 NONPROFESSIONAL DIASPORA ATTITUDES

In earlier interviews questions about ‘science diaspora’ or a ‘professional diaspora’ were asked, but these questions were often misinterpreted. Scientists thought that I was asking questions about what they associated with the word ‘diaspora’. In these instances, the reaction to being ascribed to the general nonprofessional, diaspora, was overwhelmingly negative.

To a large part, this realised difference between the self-image of scientists and perceived image of general Russian-speaking migrants, as well as the difference in the type of activity and institutional instruments used for migration, has led to perception of science diaspora and nonprofessional diaspora as two separate groups:

(1) “Germany is a very special case because of the rich history of emigration in the 1990s. There, a diaspora exists, but I think that this generation will go away. There was a large non-professional diaspora in Cassel, but they read different books, they belong to different social strata” (Group Leader, Germany).

(2) “My wife doesn’t want to leave [here] – she’s got an established social circle now, with other Russian-speaking housewives. <…> In general – yes, there is a community. My wife and kids are engaged. Non-professional communities exist, but it’s not interesting to talk there” (tenure-track Professor, Germany).

This second researcher’s broad social network includes some diaspora contact. However, he strictly excludes himself (not necessarily his spouse) from the social membership in the Russian-speaking diaspora. Furthermore, these distinctions developed in a way that there is a generational effect among research migrants with different academic identities. Younger scientists who experienced global mobility as a ‘global profession’ without any engagement with other Russian-speaking researchers prioritised other social and professional links to communication with older emigres. In the words of the same interviewee:

“There are many physicists here over 40 years old of the old training, “the Soviet type”. I don’t see much point to organise a professional community by the type of country people come from. It may, indeed, be the case that it’s easier to communicate with such people, but it doesn’t mean that it’s interesting. <…> On the contrary, Young Investigators Network is a very interesting initiative. People in the network are similar to me, they mostly have temporary positions. We meet informally sometimes. <…> There is a professional Russian-speaking community here: I see how they walk together and eat together. But I didn’t become a part of it. Young researchers with international experience, we are all like this. But I think it is also dependent on the age” (Tenure-track Professor, Germany).

This young professor uses the same discursive constructions to describe his Russian-speaking colleagues as other scientists describe the nonprofessional Russian-speaking communities. In contrast, early career researchers who used the networked scientific migration strategy and therefore took advantage of science diaspora links to advance their
career, were mostly positive about being a part of the research community abroad. Thus there is not only heterogeneity among the general population of post-Soviet migrants overseas and a strict delineation of science diaspora and non-skilled diaspora, but there is also a gap between researchers who engage in the science diaspora field and those who do not.

These negative references to the general ‘diasporas’ of post-Soviet migrants abroad have, without doubt, had impact on the strategy of researchers towards the engagement in professional diasporic networks, and in developing the identity towards belonging to these networks. While the science diaspora social field exists among Russian-speaking nanoscientists, it membership is still ambiguous.

Some researchers emphasised the segregation of their personal and professional relationships with diasporas. Whereas in personal life many interviewees were embedded in formal and informal diasporic networks and associations, at the workplace they explicitly stated their non-involvement with ‘professional diasporas’ of Russian-speaking researchers.

While I stopped asking questions that explicitly use these two terms in later interviews, the discrepancy between the construct that is used in social research and social categories in which these people position themselves (Hacking, 1999), persists presently. In order to overcome this controversy, further analysis of the borders that separate professional and nonprofessional diaspora spaces, as well as ways of engaging in these spaces, is necessary. This separation is very important for most scientists who participated in research interviews. While I accept the possibility of blurring boundaries and mutual transition of information and artefacts across professional and nonprofessional spaces, the somewhat artificial separation is necessary in order to make sense of the interviewees’ narratives.
APPENDIX 9 SCIENCE DIASPORA LIFE CYCLE

From the perspective of scientific diaspora cycle, 3 ‘generations’ of scientists have significant functional influence. A ‘generation’ of scientists is defined here in terms of training a PhD student. Therefore, a linear 3-generation sequence would look the following: a professor (1st generation) who trained a PhD student, who, upon receiving a tenure-track position (2nd generation) undertook the training of a PhD student of their own (3rd generation). Just like ‘academic age’ only starts with the first publication in a peer-reviewed journal, an initiation rite into academia often occurs when a candidate manages to secure a tenure-track position in a public research organisation and start training students of their own, hereby committing to a career in academia in contrast to leaving public research to work in private research organisation, or in military research.

New scientific collectives are being formed continuously in new locales as the old diasporas decline: the lifespan of scientific ‘generations’ is sometimes quite short, as people retire or leave academia. Thus the model of scientific diaspora formation, reproduction and decline illustrates typical stages of scientific diaspora formation as they were occurring since the late 1980s onwards. The circulation of embodied human capital – such as graduate students, postdoctoral researchers and temporary visitors – is always an internal part of transnational diaspora spaces. The subsequent generations of researchers therefore have the roles of establishing and sustaining networks among more senior scientists, such as their supervisors, and upon receiving posts in academia or research jobs in private sector, they may choose to join the diasporic space and partake in its reproduction. As a result of these decisions, some of the previously burgeoning diaspora spaces decline, and at the same time new ones emerged, going through the same stages.

The diaspora life cycle in case of the Russian-speaking scientists normally involves 4 clear stages: making initial contacts (Initiation of the diaspora), the formation of the diaspora, reproduction of the diaspora, and the decline of the diaspora. Not each diasporic formation has to go through all four of these stages. The variety of formations is large and depends on the strategies of the participating scientists. Depending on the purpose of the researchers that participate in the diaspora networks, it may remain balanced at any of the stages, or go into rapid decline bypassing the ‘mature diaspora’ stage.

At some point of maturity, institutionalisation of the diaspora networks may become self-sustaining regardless of changes in terms of participating people and organisations. Supposedly, science diaspora spaces may become institutionalised, but it is hard to make this judgement, as Russian-speaking science diaspora globally is institutionalised to a very limited extent.

Stage 1 ‘Initial Contact’

On a meso-level, science diaspora spaces are continuously created in various research organisations for various reasons. The process starts with the ‘Initial Contact’ and results in the creation of the diaspora knowledge network (Meyer et al., 2001). The role of the first generation researchers here is going to conferences and maintaining professional contacts
with other diaspora scientists and with the home countries. The 2nd generation scientists start participating in the diaspora formation by applying for exchange visits and temporary positions abroad, publishing in international journals and establishing links with the 1st generation researchers.

One interviewee, a US tenure-track professor, was in the process of setting up the initial science diaspora contact. After a long postdoc and issues with realising the institutional expectations, he took a professorship in a university that was much weaker and less recognised than the place where he spent 2 postdocs previously. Overcoming the initial frustration from the lack of adequate students and required equipment, he was exploring alternative ways to boost his career and research outputs. These included, first, an opportunity to establish transnational diaspora links with the home country and, second, engaging with other Russian-speaking researchers in the department:

“I am collaborating with [a university in Moscow]. <…> Me and the person who is working there studied together. He is a bright and a fairly strong physicist, he moved there after graduation and is developing a nanocenter. We studied together and started joint, so to say, activities, when I was still [a postdoc]. <…> And currently I am planning to expand. We are organising a nanoplasmonics center in the university at the moment – [another Russian-speaking scientist] received funding. I am planning to stretch my experimental activities quite a lot towards nanoplasmonics, because it is interesting, there are intersections between what I am currently doing and what I plan to do” (Assistant Professor, USA).

The need for additional capacities and resources drive scientists towards taking advantage of all opportunities they can find, and tapping into the diaspora resource is one of such opportunities. The narrative above demonstrates the inception of the science diaspora field – establishing first links among disjointed Russian-speaking faculty in the employing organisation, and, at the same time, using the alumni network to establish some first links with the home country, possibly, with the purpose of sourcing good quality students.

Stage 2 ‘Science Diaspora Field Formation’

After the initial contact is established and the initial positive experience is shared among network members, the social field of the science diaspora starts forming. A key scientist is required to form a science diaspora, and this scientist becomes the key node in the diaspora network. It has been suggested in the literature that the new diasporic spaces exist as long as they have such ‘champions’ (Séguin et al., 2006b). Champions establish a new collaborative research project with other Russian-speaking emigres or with the home country, or engage in the activities usually associated with the science diaspora participation, such as domestic conferences of consulting home country governments on science policy.

Diaspora champions are most often the 1st generation scientists who reach permanent positions abroad and start recruiting research students and postdoctoral researchers from the home country (3rd generation). These students make up a significant part of the
laboratory workforce. The 2nd generation researchers work closely with research students, participate in joint research projects and perceive other emigres as an important part of their collaborative network. Activities of Russian-speaking scientists are now taking not only the form of communication with the home country, but also form a significant part of the research process in the host country.

Such collaborations may remain in the form of very weak loose networks for quite long periods of time, as a form of ‘hibernation’. After new opportunities come up, they may intensify and start developing into an advanced form of collaboration, which require significant input of time and resources on the part of the champion scientist. As in the case of the new opportunities with the ‘mega grant’ and other recent funding programmes in Russia:

“Professor: At the moment I am in a situation where career-wise I’ve reached maximum position. When it comes to research tasks then all scientists have high ambitions and we want to do something that nobody’s ever done before and we want to score the highest in the science games we play. But in the last couple of years I’ve had very interesting period of time because I started to spend more and more time in Russia. I received a mega-grant and I managed to build a good contemporary laboratory right in the center of Moscow, about which I’m quite happy and I gladly go there regularly”.

MK: Do you consider moving there permanently?

Professor: No. Too much effort was put in the infrastructure development over here, and of course a lot has been done in recent year in Russia and there are hopes that everything will go well, but in Russia there are still few long-term guarantees that it will all continue in two years time. The maximum of how long its existed is 5 years I think” (Professor, Germany).

This researcher was fully immersed in this new opportunity to establish a laboratory in one of the Russian universities, included other parts of his network in this activity, and engaged in several more programmes besides this one. He also became a public figure in the Russian media, giving interviews and sharing his experiences as a leading international scientist of the Soviet origin. At the same time, he maintains intensive research activity at his day job, publishing over 60 papers in 2008-2014. This Professor is expanding his research activities and distributes them geographically without losing the intensity of research activity. However, discussing the professional community in the department with other interviewees, although his name was often mentioned, it was mentioned in the context that, in the words of another professor, “he spends more and more time [in Moscow]”.

As the science diaspora develops, other colleagues and collaborators of the champion scientist who is engaged in science diaspora activities, especially if these activities are transnational and require simultaneous work in multiple geographic locations, start to adjust their expectations of his availability for future research projects. It may be frames in terms of the opportunity cost of the development of the science diaspora field.
Stage 3 “Mature Diaspora”

Circulation of human capital, knowledge and expertise through the diaspora nodes strengthens the social field. Science diaspora reaches maturity as it starts being institutionalised, or when its representatives gain recognition among the wider faculty in the employing organisation, e.g. the activities of the science diaspora are highly beneficial for the research organisation, and partaking in these activities is rewarded. The rate of home country engagement is high. The infrastructure of collaboration grows in significance within the hierarchy of the research organisation.

The 2nd generation scientists are circulating as well, as they themselves mature and seek permanent employment elsewhere. However, they are replaced quickly by new middle-level research staff, be it the former graduate students, or other Russian-speaking researchers attracted from abroad. Constant circulation of Russian-speaking graduate students becomes a norm within the research organisation.

At this point, ‘champion’ researcher(s) may want to establish an institutionalised link with their Russian-speaking co-authors by setting up a joint laboratory or educational courses. For instance, senior diaspora scientists may lobby adopting a strategic cooperation agreement with their collaborating university at home, facilitating exchange of undergraduate students as well, or by establishing joint educational programmes.

For the ‘champion’ scientists the engagement in diasporic activities always means a trade-off with other responsibilities that tenured staff have at research organisations. This is why science diaspora engagement is operationalised as a strategy and as a resource that is used to the extent the members require it. Engaging the science diaspora can be a personal career development strategy for mature scientists, as outlined in the narrative earlier in this section. In these cases diasporas only exist as long as their ‘champions’ require the resource.

Science diaspora can also be used as a certain type of space that is created and maintained by multiple ‘champions’ with the purpose of establishing a certain working environment.

Stage 4 “Diaspora Decline”

When the champion scientist relocates away - to a more prestigious place or to develop a new research centre, or to the home country permanently - or retires, the significance of diaspora activities for other members of the science diaspora field decreases. As the rationale for supporting diaspora-related programmes and networks is lost, the space begins to dissipate. 2nd generation scientists may start moving away, or changing their research agendas to accommodate more promising contacts and projects. The circulation of doctoral researchers stops.

Diaspora links should be actively maintained and encouraged, otherwise there is a natural tendency for them to decline over time, even when there are formal diasporic networks. Diasporic knowledge networks decline naturally when research interests or career priorities of scientists on either end of the network change. If the motivation in maintaining low-value links is declining, these links and social fields they create will decline also.