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RESEARCH CAREERS: CONCEPTUAL FRAMEWORKS AND ACTUAL PRACTICES

BASIC RESEARCH PROGRAM
WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY AND INNOVATION

WP BRP 87/STI/2018

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The paper analyzes the existing approaches to the concept of scientific career, as well as career patterns of PhD holders. The authors consider the choice of alternative career options that do not involve a strict hierarchy or a clear understanding of where a person's career path will take him. Taking into account the approaches developed earlier in the framework of the sociology of science, the sociology of employment and the theory of life cycles, as well as on the basis of the results of modern empirical research, including the results of the international project "Careers of Doctorate Holders (CDH)" (OECD, Eurostat, UNESCO Institute for Statistics), the authors propose a new model of academic career and identify the main factors, allowing to assess the success of a career.

The model was tested on the data obtained during a survey among Russian researchers involving 828 respondents aged between 30 and 49 and employed by universities, research institutes, organizations of engineering services, industrial enterprises, medical centers and clinics.

The analysis revealed 5 main factors determining the research career: recognition in the academic community; application of the scientific results in practice; implementation of research interests; formal criteria for successful employment (salary and level of position); mobility (including international). The results of the study confirmed the initial hypothesis that the factors affecting career success can be classified by their significance for the individual / for the professional community / for society as a whole.

JEL Classification: I23, I28, J24, O15, O30.

Keywords: human capital, research and development, research career, occupational choice, mobility, research institutions, skills.

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[4] This Working Paper is an output of a research project implemented within NRU HSE's Annual Thematic Plan for Basic and Applied Research. Any opinions or claims contained in this Working Paper do not necessarily reflect the views of HSE.

Introduction

Careers seamlessly merge institutional and personal aspects, which makes them a priority subject for social sciences. Most research career studies focus on analyzing the professional development paths of PhD holders. The authors are primarily interested in major labour market trends such as recent career choices of PhDs, barriers they encounter during and after their postgraduate studies, and their distribution between various labour market segments. Secondly, such studies typically describe factors affecting the choice of a research career, e.g. publication activities during postgraduate studies, or students' social capital. Thirdly, researchers analyze doctorate holders' career types and competences.

Previously it was believed that career amounted to workers moving up the career ladder from a lower position (which didn't provide much professional freedom or responsibility) towards higher ones, traditionally associated with broader responsibilities, more opportunities to make decisions, and manage other workers. In recently published research, the concept of career was not interpreted in terms of hierarchical structures only. These days, the concept of career includes opportunities to make choices, multiple development plans, and moving on between various positions which are not necessarily seen in terms of a hierarchical ladder. E.g. not too long ago, doctorate holders' careers were mainly developed in the academic labour market – working in the R&D and education sectors. However, now they can pursue successful careers in "non-academic" domains too. Recent relevant publications (among other things) analyse researchers' mobility between various sectors of the economy, and various R&D and other organizations [Lee et al., 2012; Gargiulo, Carletti, 2014; Deville et al., 2014; Gokhberg et al., 2016].

For example, a survey of major US universities revealed that 50% of students specialising in life sciences and physics saw a research career at university as an attractive prospect [Sauermann, Roach, 2012]. Increasingly more doctorate holders specialising in chemistry, life sciences, or physics opt for non-academic career choices. Meanwhile, universities keep orienting postgraduates primarily toward working in the academic sector. Increased awareness of labour market opportunities and available career choices, combined with universities' more positive attitude towards non-academic work could help to better balance the labour market and increase doctorate holders' job satisfaction.

The "Career" Concept, and the Overall Theoretical Framework for Career Studies

The concept of "career" applied in academic literature is ambiguous and is constantly reviewed, acquiring new meanings and losing old ones. Earlier studies frequently used broad and sufficiently vague definitions. According to Hughes, "career is the moving perspective in which persons orient themselves with reference to the social order, and of the typical sequences and concatenations of office" [Hughes, 1937]. In a later study, Baruch and Rosenstein define career as "a process of development of the employee along a path of experience and jobs in one or more organizations" [Baruch, Rosenstein, 1992]. Also, earlier studies (e.g. [Arthur et al., 1989]) tended to view the individual as solely responsible for their career path (as opposed to the employer). Subsequently (see, e.g. [Gutteridge et al., 1993]) researchers' focus shifted towards employers, and organizations were held responsible of individuals' quality of life and careers. However, still more recent studies place the responsibility for career development back on the individual. In the past people believed they'd always work for the same employer. Now they expect to change employers in the course of their career, getting as much as possible while they work for each of them.

The concept of career traditionally implied hierarchic, multilevel, rigid structures. Institutionally, career was seen as a ladder which employees ascended as they acquired the necessary experience and skills. Companies stressed "steady prospects of gainful employment" to attract the workers they needed. Today the accent is placed on "opportunities for self-realisation", and "interesting and diverse work". People now consider alternative career options which do not imply a strict hierarchy, or a clear understanding of where the career path may be leading.

The "boundaryless career" concept originally suggested by DeFillippi and Arthur [1994] deserves particular attention. According to the authors, a boundaryless career implies disruption of the static, clearly delineated system of "career ladders", and emergence of a more open and transparent environment for people's professional development. The authors believe (that) the career is less dependent on the employer and the evaluation criteria applied to the employee in the past, and to a greater extent on the possession of three kinds of knowledge. It is, first, the "know why" (values, attitudes, internal needs); second, "know how" (career competencies: skills, expertise), and third, "know whom" (networking, relationships, how to find the right people).

Ambiguous interpretation of the career concept creates problems with assessing career success. It may not be limited to an adequate material compensation or social recognition, or freedom to set one's own working hours (autonomous work), but also imply opportunities to change the content or place of work, take part in certain (major, promising) projects, meet particular needs or aspirations. Also, work provides the basis of the individual's identity, status, and access to social benefits. Work gives people goals, motives to compete, satisfaction – and, of course, material income. Hence the multiple criteria which can be applied to measure career success. In the case of research careers, lack of a strict unidimensional hierarchy in the academic community presents a particular problem. Research career is a unique path connected with the individual's studies and, especially, their creative abilities. In the course of building a career researchers may change employers and organizations, but they very rarely change the main area of their professional specialization.

An approach to studying research careers which combines various elements of the life cycles theory (life course theory, life course approach, life course perspective), sociology of work, and sociology of science is seen in the present-day literature as a productive methodology for studying research careers.

The Life Cycle Approach

The life cycle approach to studying careers is focused on individuals' changing roles, and their assessment of these changes. Life cycle consists of changing patterns of personal life experience. In turn, these patterns emerge as a sequence of roles and social moves people make from birth till death as constantly socializing members of the society, which are determined by the specific culture and the individual's age [Caspi et al., 1990, p 15]. The life cycle prism is applied to study how individuals go through various age periods, how their expectations and choices change, thus affecting subsequent events – which determine life stages, moves, and turning points [Erikson, 1950; Sheehy, 1977; Levinson, 1978, 1997; Neugarten, 1979, 1996].

Studying academic careers it should be kept in mind that various age cohorts of researchers have emerged, and went through their life cycle stages in very different socio-economic "contexts" [Riley et al., 1988] (different working conditions at laboratories or universities). The patterns and the career stages characteristic of researchers, for example, twenty years ago, are unlikely to be considered successful by those who currently receive the same status at the same age.

The Sociology of Work and Occupations Approach

Studying research careers from the sociology of work and occupations point of view requires addressing works by E. Hughes [1958, 1971, 1994]. He approached the career concept from two sides. One side is the objective career which comprises a sequence of statuses the person acquires during a long period of time (freshmen, graduates, associate professors, professors). The other (inherently linked with the first one) is the subjective career which amounts to changes in people's individual perception of themselves and their work. Hughes suggested a social mechanism which explains how and when subjective careers change: a system of turning points matching the objective career [Hughes, 1958]. In the course of life and career development not only the objective status changes, but also individuals' subjective perception of themselves – i.e. a two-way adjustment occurs, which helps to avoid an internal conflict [Glaser, Strauss, 1971].

The Sociology of Science Approach

In terms of sociology of science, a research career means a certain position in the system of social hierarchies, and more broadly in the academic environment which comprises institutions and individuals. It is necessary to find out how the scientific careers are structured, how the space of science is organized and how the positions of scientists are stratified in it.

According to the concept suggested by P. Bourdieu, scientific capital is a key aspect defining the success of a researcher's career. It comprises characteristics interpreted as socially significant resources for scientific production, which regularly generate income for the agent defined in terms of stakes made in the course of this production [Bourdieu, 1984]; note that such resources remain available for a long time. In other words, scientific capital defines the individual's chances to win academic recognition, and/or secure an administrative position. Under this approach a research career should be seen as a sequential change of positions in the scientific field. Meanwhile the scientific field, according to P. Bourdieu, is constructed as "a system of objective relations between positions already won (in previous struggles); the scientific field is the locus of a competitive struggle in which the specific issue at stake is the monopoly of scientific authority" [Bourdieu, 1975, p. 19]. Thus the scientific field can be presented as a social network which consists of positions taken by interacting individual and collective agents, with each agent's evolution affected by the behaviour of their neighbours.

In the concept of R. Merton [1973, 1988], the central object for studying scientific stratification is the system of rewards and its impact through social contexts of scientific practices. Rewards of different forms and sizes awarded for scientific achievements constitute

social recognition [Cole, Cole, 1973; Allison, Stewart, 1974; Long, 1978; Allison et al., 1982; Gaston, 1978]. Recognition, in its turn, is the central factor of the scientific employment system, and of scientists' individual perceptions. Recognition by competent colleagues is the main indicator of the researcher's contribution to advancing science, and accomplishing the goal of scientific learning [Merton, 1973, p. 293]. The rewards system used by various institutions is quite broad and diverse, and is designed promote not just academic achievements, but also practices only indirectly connected with science [Clark, 1987; Blackburn, Lawrence, 1995; Finkelstein et al., 1998].

Thus from the sociology of science point of view, analysis of research careers should focus on factors and mechanisms affecting emergence of a positions system in the field of science (in the scope of P. Bourdieu's concept), or on emergence of differentiated structures system of professional strata (if we decide to adhere to P. Merton's theory). Various resources comprising scientific capital should also be studied, along with rewards and recognition systems which directly affect researchers' career aspirations.

Main Career Patterns in the Academic and Non-academic Sectors

The relationship between various types of competences and career patterns was analysed by Lee, Miozzo, and Laredo [2010]. Their analysis is based on the empirical data collected through a survey of doctorate holders specialising in natural and engineering sciences who have received their degree at various UK research universities. The main conclusion of the study is that competences acquired in the course of working on dissertation are valued differently depending on the career path the doctorate holder chooses. E.g. knowledge directly related to relevant subject matter is seen as more important for academic or research careers. This career type in academia or at public research organizations has a larger share of workers on temporary employment contracts, which applies to new entrants (holders of their first job) and workers with 7-10 experience on the labour market alike. Knowledge directly connected with relevant subject matter, and more general "transformable" skills are seen as particularly important for careers which imply holding technical positions at production companies. Finally, general analytical skills and problem solving competences acquired in the course of post-graduate studies are deemed to be valuable for all career types.

Another paper by the same authors [Lee et al., 2012] presents an analysis of labour mobility conducted to study specific features of the labour market for doctorate holders specialising in natural and engineering sciences. Labour mobility, and development of knowledge and skills vary depending on career patterns. Three pattern types were identified. Doctorate holders

employed by academic/public research organizations tend to face "dualistic" labour market aspects, i.e. a sharp contrast between regular and "periphery" staff (or in other words, permanent and temporary employees). Representatives of this career type apply knowledge and skills acquired during their postgraduate studies to make rapid progress at organizations which employ them. However, many of the workers on temporary contract tend to leave the sector because they don't get promoted and offered the desired permanent contract. Another career pattern comprises technical positions in the entrepreneurial sector, i.e. researchers and engineers employed by production companies. In this case doctorate holders tend to develop their general skills and quickly move up the career ladder until they become managers of their organizations, or decide to change jobs. The third career pattern has "hybrid" characteristics: it implies having mobile knowledge and skills, i.e. sector-specific knowledge and general skills. Representatives of this career pattern tend to migrate between organizations. Lee, Miozzo, and Laredo also described two types of barriers hindering transfer of knowledge and skills obtained during postgraduate studies in natural and engineering sciences into other, nonconventional employment types. These barriers are due to lack of knowledge and links between conventional and nonconventional employment, since knowledge acquired during postgraduate studies turns out to be useless for the latter type of work.

Based on the results of a sample survey of Swiss medical school graduates conducted in 2008 under supervision of Buddeberg-Fischer, Stamm, and Klaghofer [2008], the authors designed a scale for measuring career success. Swiss doctors consider as a success careers at prestigious medical organizations, typically a position of practicing physician at a hospital, or an academic position.

The authors identified seven factors which define a successful academic career:

- making presentations at conferences;
- having publications;
- participation in joint research projects;
- length of period during which research was the top-priority occupation;
- being awarded a stipend;
- being awarded a grant;
- having awards for research activities.

It should be noted that in Switzerland doctors aspiring to get an administrative position in medicine must have a successful research experience. This applies to practicing physicians and members of the academic community alike. To get a management job, a doctor must have at

least 20 publications in prominent peer-reviewed English-language journals and be the leading author of at least half of them. Medical teachers are recruited from the ranks of senior clinical doctors, or among researchers specialising in basic research with a sufficient number of academic publication to their credit.

Doctorate Holders' Career Patterns

On the basis of data collected in the scope of the OECD project "Careers of Doctorate Holders", Balsmeier and Pellens [2014] made several conclusions regarding doctorate holders' motivation to keep their academic positions. Using the results of the survey of 263 researchers, the authors reconstructed the careers of people who have received their degree in 1996 and subsequently spent at least a year working in academia. The average period when a researcher is likely to drop academic career in favour of a different one was calculated at 6,08 years. Publication activity turned out to be an important factor: the more publications doctorate holders had, the more likely they were to carry on with their academic career. Each additional publication reduced the inclination to leave academia by about 6%.

Bonnal and Giret [2010] analysed factors affecting access to permanent academic positions in France; the empirical basis was provided by the sample comprising 1,400 doctorate holders. The authors noted the importance of publishing in peer-reviewed journals during post-graduate studies. Having published research results significantly increases the chances to obtain a permanent academic position. Scientific publications are particularly important in chemistry and life sciences, and less so in mathematics, physics, and applied sciences. The authors stress that non-academic publications do not play a significant role. To compare, in social sciences and humanities having publications does not significantly affect the chances of securing a permanent position later on.

The abovementioned study of doctorate holders' careers presented another important conclusion regarding factors affecting their career development. It concerns patenting of doctorate holders' inventions. Postgraduate students who have submitted patent applications during or after their studies, even if they had numerous publications, were more likely to discontinue academic careers than students who have never submitted patent applications. The authors conclude that patenting increases the chances of opting for a non-academic career because it shows doctorate holders' interest in commercialising their research results. Inclination to commercialise research is more common to doctorate holders who prefer a career in industry, not in the academic sector.

Interdisciplinarity of Doctorate Thesis

Millar [2013] revealed a positive correlation between interdisciplinarity of the doctorate thesis and the chances of securing an academic or postdoctoral position. At the same time the author stresses that the topic of a multidisciplinary dissertation has no effect whatsoever on the type of position the doctorate holder gets in the higher education sector. These results were obtained by analyzing the data of two longitudinal surveys of US doctorate holders specializing in natural, engineering, and medical sciences. The author conducted multidimensional regression analysis to assess the impact of multidisciplinarity on career development. Millar concluded that authors of multidisciplinary dissertations tended to have more publications than other doctorate holders, which in turn favorably affected their chances to secure an academic position.

Postdoctoral Positions

Bonnal and Giret [2010] analyzed various factors which affected access to permanent academic positions in France. The French academic labour market (or more precisely, the permanent teaching or research positions segment) has low demand combined with high supply. Still, doctorate holders keep opting for academic jobs, which results in a widespread use of short-term contracts for young researchers, and a large number of postdoctoral positions. The authors of the above study concluded that chances to secure a permanent position depend on candidates' research competences, which can be measured via the number of academic publications, the source of funding of their postgraduate studies, the type of research institute, and postdoctoral positions. The main conclusion was that having work experience at a postdoctoral position positively affected the chances to secure a permanent research or teaching job at a university, compared with candidates – doctorate holders without such experience. This is particularly relevant for chemistry and life sciences (where the postdoctoral positions institute is highly developed), and less so for mathematics, physics, and applied sciences. According to the French Ministry of Higher Education and Research, about 40-50% of doctorate holders specializing in chemistry and life sciences find postdoctoral positions within the first two years upon completing their postgraduate studies. To compare, in social sciences the relevant figure for the same period of time is just 5%.

According to statistics presented in Sauermann and Roach [2016], 74% of doctorate holders specializing in biology and life sciences find postdoctoral positions upon completion of their studies, compared with 46% in other disciplines. The survey was conducted in 2010 and 2013, covering postgraduate students at 39 US research universities; the authors also used online career-related data. The sample included 5,928 respondents who attended postgraduate

programmes in biology and life sciences (37%), chemistry (11%), physics (14%), engineering (27%), and computer science (10%). A frequent personal reason for accepting a postdoctoral position is to increase one's chances of securing a better job later on. Postgraduate students who intend to find postdoctoral positions usually plan to pursue an academic career; however, their specific career intentions differ. E.g. about a third of postgraduate students would like to find university positions with no research responsibilities. One of the main conclusions of the study was that the present-day labour market rather encourages newly minted doctorate holders to take postdoctoral positions than hinders them to do so; accordingly, the supply of such positions does not decline, even despite universities' low demand for researchers on permanent contracts.

Employers' Status in the Labour Market

Contia and Visentin [2015] note that doctorate holders' choice in favour of a particular future career is much more complex than the choice between academic or non-academic employment. The empirical data was collected by surveying students who have completed postgraduate studies at French technical universities in 1999-2009. The sample comprised more than 3,300 doctorate holders. The authors identified indirect factors affecting the choice of a research career. In particular, they checked for correlation between working at specific organizations with the size of the student cohort and several control variables. It was concluded that postgraduate students value positions at prestigious universities and prominent research organizations equally high, and prefer these two career options to everything else. When looking for work, doctorate holders do not show any particular interest in positions at non-prestigious universities, companies which do not conduct research, and startups, or in administrative positions.

Mobility

The already mentioned study by Lee, Miozzo, Grimshaw, and Laredo [2015] presents a secondary analysis of career path data for doctorate holders specializing in physics and engineering sciences at British research universities. The data was collected in 1998-2001; the sample comprised about 600 postgraduate students. The survey questions concerned the respondents' employment history for the previous 10 years, their geographical relocations, specific work experience, etc. Using the discrete-time event history analysis and regression analysis techniques, the authors determined how candidates' mobility affected their access to postdoctoral and permanent positions. Like everywhere else, temporary employment contracts are quite common in the UK higher education sector, so many start their career with numerous temporary employment contracts. Researchers aspiring for a permanent academic position at a

university tend to be highly mobile, and frequently change employers. They are highly likely to secure a permanent academic position within 2-4 years upon completing postgraduate studies. However, the longer they work in temporary positions, the smaller are the chances to find a permanent academic job (this also applies to less mobile researchers who stay with the same employer for a long time). The study results indicate that postdoctoral positions serve as an important step towards securing a permanent employment contract only if the researchers build, and extend, a personal network of professional contacts.

Deville et al. [2014] studied researchers' mobility on the institutional level, and the impact of mobility on research productivity. The authors analysed about 420,000 physics-related academic publications published between 1893-2010. They focused on changes in researchers' institutional affiliation, which allowed to track more common career paths and their directions. The authors concluded that researchers changed jobs only at the beginning of their professional career, and typically only once or twice. Geographically, they tended to relocate within relatively close vicinity. Researchers' professional mobility can be not only spatial or temporal; institutional stratification is also an important factor. Most of the researchers changed jobs to work at organizations of a similar status. When researchers left more prestigious organizations for less prominent ones, the authors of the study interpreted it as a decrease of their research productivity. However, the study revealed that moving on from less prestigious to more prestigious organizations didn't always result in an actual increase of the scientist's research productivity.

Gargiulo and Carletti [2014] analysed bibliometric data for academic publications provided by the American Physical Society for the period between 1955-2009. The goal was to identify the authors' individual career paths. They examined how academic careers were affected by such variables as geographical proximity between two sequential career positions; the institutions' importance for research careers (measured via the number of publications); and certain socio-cultural characteristics. The results revealed that geographical proximity wasn't especially important for predicting the next turn of the career, while other factors, including "previous career moves" (especially positions taken at the early stages of professional activity), and linguistic, cultural, or historical similarity between various countries were much more significant. Analysis of individual career paths indicated that researchers typically changed institutions 2-4 times during their career, and 90% of them have ever worked at no more than 4 universities in 3 countries. Early career stages were particularly important: they produced the so-called "memory effect" which affected the subsequent career path. E.g. if a scientist started their career at a less-than-prestigious research institution, the chances they'd ascend to a high

academic position were small. At the same time researchers mostly tend to have traditional careers moving on from lower institutional positions to higher ones.

Social Capital

The importance of social capital for analyzing factors affecting academic careers in physics in Italy and France was noted in the study by Pezzonia et al. [2012]. The authors studied careers of physicists working in Italy and France in 2004-2005. It was discovered that social capital was more important in Italy than in France. In Italy, recruitment of new candidates for permanent positions at universities is supervised by ordinary professors on the national level. Candidates who have good social connections with professors specializing in their (or other) fields have advantages over others. The chances of securing the desired position depend on the "credit" the candidate has with the ordinary professors. In France the situation is different: national-level connections are less important because final decisions are made locally.

Bonnal and Giret [2010] analyzed career paths of 1,400 French postgraduate students who have completed their studies in 2001. The identified factors affecting their access to permanent academic positions included having local social contacts: the more connections the candidate has at a specific university, the higher their chances to get the job they want are.

Personal Interest: "Taste for Science"

A "taste for science", and doctorate holders' personal preferences were analysed in the study by Roach and Sauermann [2010]. The authors focused on individual characteristics of candidates – postgraduate students specialising in natural and engineering sciences at major research universities in North Carolina (US). They studied data for 400 natural sciences and engineering postgraduate students, including their "taste for science" measured using such indicators as aspiration for independence, desire to publish, win recognition by colleagues, and interest in basic research. The authors analyzed career preferences of postgraduate students (not actual doctorate holders) because they were interested in how career choices were actually made (as opposed to conducting a retrospective analysis). Data was collected at university job fairs, and by surveying postgraduate students. The sample comprised 472 postgraduates specialized in natural and engineering sciences. Having analyzed the students' personal characteristics the authors suggested several hypotheses to explain the choice between a career in industry or in the academic sector. Students who showed independence, desire to publish as much as possible, and an interest in basic research tended to opt for a career in science, while those who were interested primarily in material aspects (salary, access to resources) were more likely to choose a career in the entrepreneurial sector.

Empirical studies of research careers were mainly focused on factors affecting the decision to carry on with an academic career upon completing postgraduate studies and obtaining a doctorate degree; the choice of various career paths; and successful professional development of doctorate holders. E.g. according to certain studies, a high publication activity increases the likelihood of postgraduate students' opting for an academic career. Other identified factors included submitting patent applications; the nature of dissertation (including multidisciplinarity); employment at postdoctoral positions; the employer's status in the labour market; young scientists' labour mobility; availability of sufficient social capital; and doctorate holders' personal preferences (e.g. having the so-called "taste for science"). Many studies analysing the above factors were based on quantitative data analysis.

Methodology. The research career model

The purpose of this paper is to further develop the research career model, identify factors affecting career success, and test the suggested model using empirical data collected by surveying Russian researchers. One of the central provisions is that "subjective" careers are no less important to researchers than "objective" ones, and self-realisation combined with the belief that the prospects for further professional development are good is more important to them than their actual position in the office hierarchy. A career in research is a unique path closely connected to the scientist's studies and personal abilities. Building their career, researchers may change jobs and organizations but they very rarely change their professional specialization areas.

The key hypothesis of the study is that the main factor affecting the success of research careers, objective and subjective ones alike, is peer recognition that is either achieved or expected. It can be accomplished on three levels (ranging from individual to global):

1. on the level of a specific individual (the researcher's assessment of their working conditions, implementation of their professional potential, scope for further professional development)
2. on the level of the professional community (which lives by its own laws: careers are assessed by using specific criteria for the particular group of professionals, and the main way to win the recognition of colleagues and associates is to achieve a high research productivity)
3. on the level of the whole society (nationally and internationally), when professional self-realisation criteria include high status, stable employment, sustainable financial wellbeing, and opportunities to realise one's professional potential not just in one's own country but on an international level, as well.

The suggested model is based on the principles developed in the scope of sociology of science and sociology of professions, and the approach adopted by the Careers of Doctorate Holders (CDH) project (implemented under the auspices of the OECD, the UNESCO Institute of Statistics, and Eurostat). This project covers 25 countries (including Russia), and it offers the most complete and structured data about the motives for choosing a career in science, researchers' employment, specialization areas, and mobility. The objective of CDH project is to identify the formation patterns and human resources' development trends in the science and technology sphere. The main data collection method is questionnaire-based surveys of doctorate holders; all participating countries use the agreed toolset including the questionnaire structure.

Data on researchers' careers is collected at their current and previous (if any) employer(s). The methodology is based on the "career path job" concept[5]. It's assumed that researchers may have various kinds of work experience (especially at the early stages of their career), but then choose the career path job for full professional self-realisation.

For doctorate holders, "career-affecting professional experience" primarily implies the research-related component of their work. The amount of time they spend on research (as the share of total working time), and the length of time working in a research position are the indicators which by themselves define the scientist's current position in the professional community, and their further career prospects. A key professional experience indicator is research productivity, in particular publication and patenting activity, practical application and commercialization of research results. Another important indicator is international mobility, which measures the researcher's willingness to participate in global research cooperation.

A detailed analysis of existing approaches, in particular those developed in the scope of sociology of science and sociology of work, and the ones applied in the framework of the OECD CDH project [Auriol et al., 2012] allowed to design a research career model and empirically test it using data collected by surveying Russian doctorate holders. The proposed research career model (table 1) includes 9 main blocks; for each of them key variables are provided, which allow to measure researchers' career success in quantitative and qualitative terms.

[5] A "career path'' job is a job that will help further your career plans or is a job in a field where you want to make your career. (See Manual: Definition 14: Career path job)

Tab. 1. The research career model: key variables

Engagement in research work	– duties include research activity – research experience as a share of the total work experience – managing research projects – supervising postgraduate and PhD students – broad and diverse research areas, interdisciplinary projects
Mobility	– changing jobs and employers – changing occupations, getting promoted – changing research area
Social status and financial situation	– income, salary, financial security – permanent contract – occupation – managing teams, having subordinates
Productivity	– number of various kinds of publications – number of patents granted – practical application of research results – presentations at conferences
Social capital	– awards – personal grants/stipends – membership in expert councils and editorial boards – working at a prestigious organization, employer's prestige
Freedom and independence	– freedom to manage own working time – opportunity to choose research topics – opportunity to work part-time for other employers
Meeting personal needs and goals	– opportunities for self-realisation and personal development – implementation of personal research interest – work/life balance, ability to pursue personal interests other than research-related ones
Advance of professional skills	– access to education (including additional education programmes) – opportunity to upgrade skills at work
International mobility and international cooperation	– experience of working/studying abroad – participation in international research cooperation – joint publications with international co-authors – knowledge of foreign languages

The research career model combines "objective career" indicators (the sequence of statuses the researcher obtains over they career paths) with "subjective career" ones, such as the researcher's assessment of their abilities and opportunities, personal prospects, and work-related achievements. E.g. indicators such as scope for self-realisation and personal development, being able to pursue personal interests other than research-related ones, and meeting personal needs and goals at work are subjective assessments, and reflect specific researchers' perceptions of their career position.

Results. Empirical testing of the model

The model was empirically tested using data collected in 2016 in the scope of the "Monitoring top-skilled R&D personnel" project (the Russian segment of the OECD CDH project). The respondents comprised researchers and engineers employed at R&D divisions of universities, research institutes, engineering services providers, industrial companies, medical centres, and clinics. The surveyed researchers were specialising in S&T areas with the best prospects in Russia, in particular information and communication systems, new materials and nanotechnology, the agricultural sector, life sciences, medicine, biotechnology, efficient environment management, energy, transport, and space. The survey was conducted in all Russian federal districts in large cities with research institutes and major universities, and in "naukograd" (science cities). To adjust for the age factor's effect (which significantly affects many career-related variables), a sub-sample of middle-age respondents was constructed (30-49 years old).

The sub-sample comprised the total of 828 respondents (59,1% of them male). Distribution of the respondents by employment sectors and positions was as follows: 71,8% were employed at the academic sector (out of them, 34,6% worked at research institutes and 37,2% – at universities); 28,2% were primarily employed by industrial and service sector companies. 25,8% of the respondents worked at management positions; out of them 2,7% were CEOs and deputy CEOs of their organizations, and 23,1% managed various divisions.

On the whole, Russian researchers do not change jobs frequently: most of them didn't change jobs during the previous 10 years (68,7% of the sub-sample), and had no plans to do so in the future (71,6%). Researchers employed at the non-academic sector were more highly mobile, with a much bigger share of those who changed jobs two or three times during the previous 10 years (figure 1).

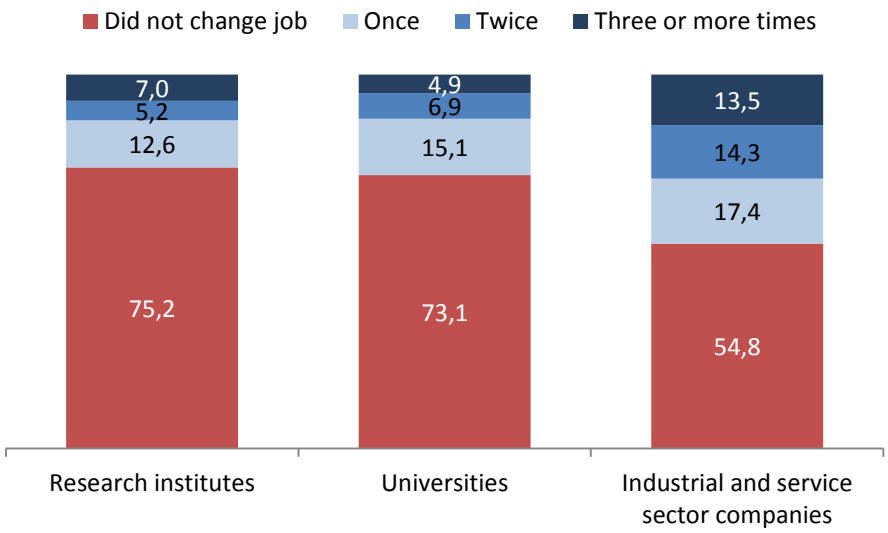

Fig. 1. Frequency of changing principal job during previous 10 years, by organization type (%)

As to mobility potential, researchers employed by organizations other than research institutes and universities consider changing their principal job more often too (table 2). Note that this group has bigger shares of those who have already made the decision, and those still thinking about it alike; plus, only this sector has a significant (5,2%) share of people who are not sure that they would be able to find a new job.

Tab. 2. Distribution of answers to question "Are you planning (would you like) to change your principal job?" by organization type (%)

	Research institutes	Universities	Industrial and service sector companies
Yes, will probably do so soon	2,1	2,0	2,6
Yes, may do so soon	3,8	2,6	8,6
Yes, but I am not doing anything about it yet	12,9	13,4	16,3
Yes, but I don't think I'd be able to find another job	2,8	2,0	5,2
I'd like to stop working (retire, housework, etc.)	1,4	1,6	1,3
No, I am not planning to change job	73,8	74,9	64,4
Other	3,1	3,6	1,7

R&D personnel may pursue either an academic career (at research institutes or universities) or a non-academic one, working at design bureaus, engineering or industrial companies, and in the service sector. In most cases the choice of an academic career is due to the

need to obtain a doctorate degree: in the age group under consideration (30-49 years) three quarters of research institutes' employees were doctorate holders (PhD or Doctor of Science). The relevant figure for university staff was over 90%, but for those who have opted for a non-academic career it was just 12,9%. Having a doctorate degree is also a qualification requirement for taking management positions in the academic sector; note that for researchers who have opted for an academic career, being a doctorate holder is a much less important factor of securing a management position.

In addition to doctorate degree, an academic career implies a high publication activity – while researchers employed in the non-academic sector typically do not publish at all, or do so rarely. If, at the time of the survey, 85,7% of research institute and university staff had more than 10 academic publications to their credit, for industrial and services sector companies' employees the relevant figure was just 16,5%. In the academic sector, research institute staff typically publish more often than their university colleagues, including foreign language publications: on average, during the previous 5 years a research institute member had approximately 6 such publications, while a university employee – less than 4.

Patenting is not generally common for Russian researchers: most of them did not patent any inventions during the previous 10 years. However, researchers employed in the academic sector tend to be somewhat ahead of their industrial and service sector colleagues in terms of patenting activity.

The higher education sector has the biggest share of staff who have received awards for their academic and professional achievements (figure 2).

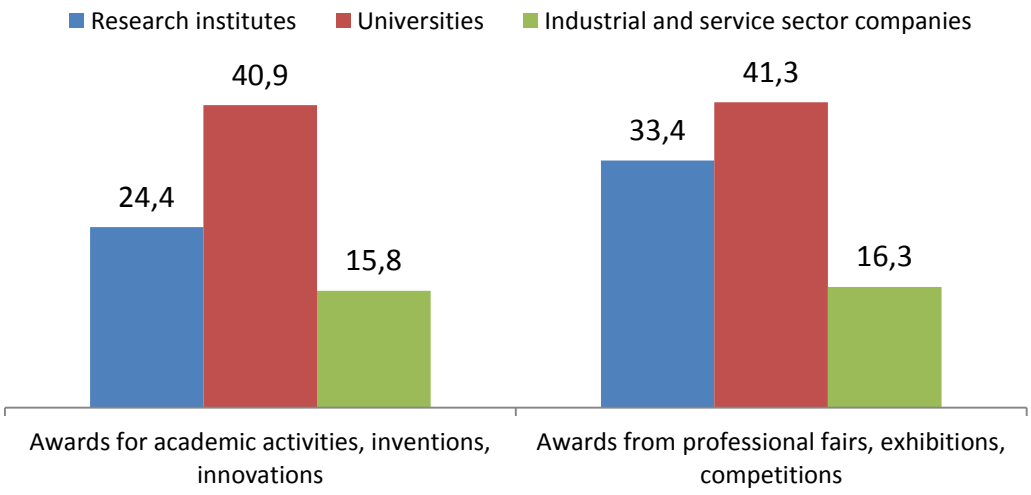

Fig. 2. Researchers who reported having awards, by organization type (%)

Membership in expert councils and professional associations is more common for researchers who have chosen academic careers; note that if in terms of membership in Russian organizations university staff are ahead of research institute employees, the latter employ a bigger share of researchers – members of international organizations.

As to international academic cooperation, the share of internationally mobile researchers (i.e. those who have studied or worked abroad for three months or more) outside the academic sector is just 6,2%, while for research institute staff it's 16,3%, and for university employees – 11%. In terms of short-term trips abroad, for research purposes, or to take part in scientific events, research institute and university staff display more or less equal activity (68,9% and 75,2% of the respondents took part in some form of international cooperation in 2013-2015, respectively). Note that members of research and educational organizations tend to participate in different international cooperation formats (figure 3). University staff more often go to read lectures or attend training programmes at foreign organizations, while members of research institutes more frequently participate in international projects, or publish jointly with foreign co-authors.

Fig. 3. Shares of researchers participating in various forms of international cooperation between 2013-2015, by organization type (%)

Building academic careers at research institutes and universities has certain specific features, which is reflected by different values of certain employment, productivity, and

international cooperation indicators. Researchers who have opted for a non-academic career frequently tend to be "excluded" from the academic environment: they publish less often, patent less frequently, and less actively participate in international academic cooperation. However, in terms of other professional development criteria a career outside research institutes and universities provides certain advantages. First of all it's a higher rate of pay, stability, reliable prospects, and involvement in accomplishing important practical objectives. Industrial and service sector companies' employees participate in the practical application of research results no less often than their academic sector colleagues do. Researchers' subjective assessments of how their work contributes to accomplishing major, important objectives and applying their ideas in practice are also quite similar for both types of organizations.

Ultimately, despite all the differences in their employment conditions, researchers employed by different types of organizations gave very similar answers to the question "Please rate your satisfaction with your principal job's opportunities to win recognition and achieve decent social status" (figure 4); note that most of the respondents seem to be satisfied with their opportunities.

Fig. 4. Distribution of answers to question "Please rate your satisfaction with your principal job's opportunities to win recognition and achieve decent social status", by organization type (%)

Thus, despite significantly different values of numerous variables describing researchers' employment and productivity, people who have opted for different career paths assess their chances to win recognition more or less similarly. Obviously it means that researchers interpret the concept of "recognition" differently, and apply different criteria to assess their career prospects. Success of a research career cannot be measured using a single variable because the

relationship between different parameters describing a research career is not straightforward. This implies the need to choose specific parameters of research career success (or lack of it), and take into account several variables at the same time to analyse not just their specific distributions, but also their interaction.

In line with the suggested theoretical model, and on the basis of the toolset applied in the scope of the OECD CDH project (and its Russian segment), 20 variables were selected to describe research careers:

- doctorate degree;
- principal job changing;
- occupation (including team and project management responsibilities);
- average monthly salary at the principal job (including all bonuses and benefits);
- total number of papers published throughout the career;
- number of papers published in foreign languages during the previous 5 years;
- academic supervision experience (master thesis, PhD dissertations);
- membership in professional associations and expert councils;
- experience of managing research and/or education projects, practical implementation of results;
- experience of practical application of innovations and research results;
- patent activity (for the previous 10 years);
- awards from professional exhibitions, competitions, etc.;
- honorary titles (awarded for professional or S&T achievements, inventions, innovations, etc.);
- creativity and innovativeness of work;
- ability to realise professional potential (knowledge, experience, abilities);
- ability to pursue and develop own ideas for the sake of extending knowledge;
- training experience at Russian organizations (leading R&D and S&T centres);
- training experience at international organizations (leading R&D and S&T centres);
- international mobility experience (working or studying abroad for three months or more);
- participation in international cooperation (during the previous 3 years).

Factor analysis was conducted to identify common important factors affecting success of research careers. The components were selected using the Kaiser criterion; the Varimax rotation

method was used to calculate the inverted coefficient matrix; coefficients above 0.4 were selected. Based on the factor analysis results, 5 main components were identified that describe R&D personnel careers (the factor loads matrix after rotation is presented in Attachment 1).

The resulting factor loads distribution allowed to identify variable groups broken down into 5 principle components, which can be interpreted as follows:

1. recognition by the academic community

The first component describes the status in the academic environment, or in the close-knit professional community; the accumulated social capital as recognition by colleagues; the position in the academic social environment. This component includes parameters specific to the R&D sphere, which are primarily important to people directly involved in research work. Having a doctorate degree, publications, experience of academic supervision, cooperating with researchers from other countries – these professional success criteria are particularly important in the narrow professional community of researchers. In other professions and activity areas they hardly apply at all, and are not seen as significant.

2. practical application of research results

The second component comprises indicators describing practical applicability of results obtained by researchers (in various spheres and areas), and social recognition of their work's usefulness. In this case, research results per se are not as important as the potential for their practical application by Russian organizations, for patenting and commercialization. Here the environment where the career success is measured, includes the wide range of organizations interested in applying relevant innovations.

3. pursuing personal research interests

The third component describes how much the current job allows the researcher to realise their potential, and how well it matches their specific research interests and priorities. A number of studies ([Lam, 2011; Boosten et al., 2014; Ryan, 2014; Shmatko, Volkova, 2017]) show that researchers, being highly skilled knowledge workers, tend to have high personal motivation related to their personal research interests, and aspirations to participate in accomplishing innovative objectives.

4. formal criteria of successful employment (salary, position level)

The fourth component comprises general formalized career success indicators applicable to any professional activity, such as salary size and level of position (in terms of management responsibilities). These indicators are used to assess employment and career not just in the R&D sphere, but in the whole society. It's the formal criteria which determine the social status and its stability, and serve as evidence of a successful career for a wide range of people.

5. mobility (including international one)

The fifth component describes researchers' mobility prospects, demand for their potential and achievements in other cities and countries. Opportunity to take part in international mobility not just in the format of short-term events, but also through long-term studies or work abroad is one of the criteria which determine the quality of R&D workers' careers, and importance of their professional achievements. Here the global academic community, as a whole, becomes the environment where results achieved by researchers are benchmarked.

It should be noted that the third principle component (pursuing personal research interests) comprises only variables which are based on researchers' subjective assessments: how creative and innovative they believe their work to be, how much it allows them to realize their professional potential, and how well it matches their personal interests. It can be argued that assessment of research careers' success in this case is based on the level of "personal recognition", or "self-recognition".

Conclusions

Publications in academic journals over the last 5-6 years reflect the current trends in studying the careers of doctorate holders. The authors analyse socio-economic processes evolving in the academic and non-academic labour markets. The main trend in the academic sector is a high supply combined with a low demand. Therefore, about fifty percent of newly minted doctorate holders, especially those specializing in natural and engineering sciences, choose not to continue their academic career and move on to other areas. When they do opt for academic employment, they have to accept short-term employment contracts at early career stages, which do not provide the full range of benefits and social insurance. They'll get a chance to secure a permanent academic position only after several years. Despite the fact that about half of postgraduate students leave academia, universities keep maintaining that they train postgraduates for an academic career. Accordingly, new doctorate holders frequently do not receive a sufficient amount of information and support from the university which would help them to pursue a career outside the academic sector.

The personal preferences of postgraduate students and the social skills they acquired during their studies along with specific professional competencies, significantly affect their initial career choices and subsequent professional development alike. Regardless of the career type, employers highly value general analytical skills and problem solving competencies that postgraduate students obtain while working on their dissertations.

The survey of Russian doctorate holders has largely confirmed the conclusions made in other countries (including those participating in the OECD CDH project) regarding factors affecting the choice of an academic or a non-academic career, and the decision to carry on with research work. These include publication activity, research field, previous professional development, availability of social capital, etc. At the same time, career success frequently depends not just on objective achievements but also on the subjective perception of one's success – i.e. how the "subjective career" develops in the academic and non-academic sectors.

Characteristics of researchers' employment obtained by the survey were quite different for academic and non-academic careers, while, within the academic sector, significant differences were revealed between research institutes and universities. Depending on the type of the organization, researchers have different salaries, demonstrate different publication and patent results, a different level of participation in international academic cooperation, and a different likelihood of receiving awards. However, despite these differences, all researchers estimate their chances to win recognition for their professional achievements at about the same level. Therefore, it can be concluded that researchers use different variables to measure "recognition", and no single parameter or universal criterion can be adopted to measure research career success.

Opting for a non-academic career frequently doesn't imply discontinuing R&D activities: data collected in the scope of the "Monitoring top-skilled R&D personnel" project (in 2010-2017) shows that more than a half of doctorate holders employed outside research institutes and universities were involved in research at their principal job. And out of those who at the time of the survey did not conduct research, the absolute majority (about 80%) did so previously. The main reasons of discontinuing research work include vague career prospects, low salary, and low prestige of such work in the society. I.e. employees of industrial and service sector companies abandon research work not because they are no longer interested in it, but because they believe carrying on would not advance their career. These reasons match one of the identified principle components ("formal criteria of successful employment") which determines the success of career in research.

The factor analysis of the empirical data confirmed the initial hypothesis that factors affecting career development can be ranked by their importance for "the individual / professional community / society as a whole." Parameters describing R&D careers can be grouped in line with the principle of extending the scope of professional realization and recognition: from the work matching the researcher's personal interests via recognition by the narrow professional community to a high status in the overall society (including in other subject areas and countries). Accordingly, various career success criteria can be divided into specifically professional ones,

primarily applied in the R&D sector, and more general ones, which can serve as measures of success in wider social circles too. Indicators applicable in any activity area, such as position level and salary size, comprise a particular component, quite separate from the variables which primarily describe research activities.

Subjective indicators are especially important at an individual level (measuring the scope for self-realisation and personal development at the current job) were identified as a separate important factor of success of the research careers, forming a personal (or individual) recognition level. In this case, when specific researchers assess to what extent their professional potential is realised, the level of their work matching their personal interests and goals serves as the reference point (as opposed to their organization's interests and objectives).

Opportunities to apply the obtained research results in practice, get a patent, receive public recognition for their efforts make another group of factors that are separate from academic performance indicators. Regarding the development of one's competences, upgrading qualifications is valued not for its own sake but as a chance to more fully realise one's potential in the professional environment, or among the people who participate in practical application or commercialization of research results.

Orientation towards mobility makes another important factor affecting the success of research careers. Note that aspirations to change jobs inside the country turn out to be closely linked with the participation in international mobility, and in academic cooperation. Recognition by domestic and international research communities are included in the same component. Thus, assessing the success of their career, researchers benchmark themselves not just against their immediate colleagues, but also against the overall academic community, including the international one.

Further research prospects

In the course of further research, we plan to supplement the analysis presented here with a study of education resources, the level and the mix of competencies, and new work formats (flexible hours, remote work). The applied methodology implies that obtaining a better understanding of research careers would require increasing the number of variables by including indicators measuring the current level of professional competences and their development prospects, and the degree of researchers' independence.

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Attachment 1. Factor loads matrix

Rotated component matrix

	Component				
	1	2	3	4	5
A doctorate degree	,808				
Principal job changing					,537
Occupation (including team and project management responsibilities)				-,655	
Average monthly salary at the principal job (including all bonuses and benefits)				,769	
Total number of papers published throughout the career	,812				
Number of papers published in foreign languages during the previous 5 years	,681				
Academic supervision experience (master thesis, PhD dissertations)	,630				
Membership in professional associations and expert councils	,544				
Experience of managing research and/or education projects, practical implementation of results	,448				
Experience of practical application of innovations and research results		-,456			
Patent activity (for the previous 10 years)		,452			
Awards from professional exhibitions, competitions, etc.		-,668			
Honorary titles (awarded for professional or S&T achievements, inventions, innovation, etc.)		-,431			
Creativity and innovativeness of work			,475		
Ability to realise professional potential (knowledge, experience, abilities)			,785		
Ability to pursue and develop own ideas for the sake of extending knowledge			,741		
Training experience at Russian organizations (leading R&D and S&T centres)		,611			
Training experience at international organizations (leading R&D and S&T centres)					-,635
International mobility experience (working or studying abroad for three months or more)					,706
Participation in international cooperation (during the previous 3 years)	,569				

Factor identification method: principle components analysis.

Rotation method: Varimax with Kaiser normalisation.
a. Rotation converged in 6 iterations.

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