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Co-authorship patterns of Russian computer scientists in the UK and scientific diaspora engagement policies

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Background

In an effort to boost the development of Russian science and technology, the Russian government is keen to establish contacts with Russian scholars abroad, to consolidate the Russian scientific diaspora, and to promote active cooperation between Russians in Europe and US and researchers based in Russia. This intention is repeatedly expressed in official statements, and is increasingly translated into a range of governmental initiatives. In one of his recent statements, Dmitry Livanov underlined the significance of scientific interaction across borders in a period of political confrontation and economic sanctions. He observed that *“relationships with the Russian scientific diaspora are becoming more important”* (Zayats, 2014) and demonstrated a readiness to increase the funding of Russian science *“despite difficult situation in the world and partly because of it”* (Medvedev, 2014). Particular measures in this respect were introduced in 2008 in a new Federal programme "Research and teaching personnel of innovative Russia for 2009-2013" (Government of the Russian Federation, 2008) and included two-year team research projects under the guidance of a Russian-speaking scholar from abroad and the creation of university laboratories under the guidance of leading scholars from around the world (so called “megagrant” projects) as main forms of cooperation.

In addition, the government is taking a more active part in the work of organizations uniting academics and highly skilled professionals of Russian origin abroad. The government was involved in the establishment of RusSciTech (RuSciTech, 2016) association in 2012 and became a constant partner in a range of its endeavors, providing support for annual forums and consulting its members for expert advice. Ministry officials also regularly meet RASA (RASA, 2016) representatives and discuss various issues related to the scientific and technological development of Russia. These meetings have already resulted in a programme of internships for young researchers and the opening of an RASA research centre at St Petersburg and Tomsk (RASA Spring Newsletter, 2015). Interaction with compatriot associations is complemented by events for wider circles of scientists such as forums of the scientific diaspora held in 2010 and 2014 (Conferences of Russian scientific diaspora, 2010, 2014.), congresses of compatriots and alumni of Russian universities which took place in 2010 and 2011 (Second Congress of compatriots-alumni, 2011) and more specialized meetings and gatherings conducted both in Russia and abroad, which are devoted to innovation, technology or to the development of individual industries (Days of Russian innovations, 2009).

In trying to build bridges with the Russian intellectual diaspora, the state tends to rely on the assumption that scientists who have made a career overseas have an inherent interest in working with their Russian colleagues at home. Yet, migrant scientists are not universally eager to cooperate with their native country, they do not respond to state initiatives with unanimous enthusiasm, and typically express ambiguous attitudes towards Russian science. The

scientific diaspora forum held in Dec 2014 was illustrative in this respect as it demonstrated how deeply divided the diaspora community is: while some researchers barely find any space for effective collaboration and do not see much chance for positive development of science in Russia nowadays, others are willing to contribute to its revival. Some observe that *“maintaining connections is getting more difficult”* and international collaboration might find itself under strain when *“fear and intimidation interfere with everything in this country”* (Schiermeier, 2014). Others are ready to invest their time and help in Russia at a time when the country is experiencing difficulties: *“I do worry about the sanctions and the growing economic problems here, but I could never forgive myself if Russia needed me and I was not there.”* Similar division of opinions can be traced in some empirical studies of Russian scientific diaspora. For instance, Dezhina states that there are groups, who are attracted by the prospects of collaboration, and those who think *that “there are no professionals in Russia, with whom it would be interesting to develop cooperation”* (Dezhina, 2010). She also found that while the majority expressed profound dissatisfaction with the organization of science in Russia and quality of life, some scientists are still emotionally attached to their homeland and are looking for opportunities *“to work for their country”* (Dezhina, 2010) Thus, scientific diaspora expresses divergent opinions and evaluations of the prospects of Russian science and their readiness to cooperate also varies.

As a result, scientific diaspora engagement policies face certain tensions between governmental intentions to establish fruitful cooperation with the Russian intellectual community abroad on one hand and existing attitudes of diaspora representatives on the other. In addition to the scientists' attitudes and opinions, diaspora engagement policies should take into account, and preferably rely on, the available structure of formal and informal ties between migrant and home scientists. As Yevgeny Kuznetsov pointed out in one of his interviews, the main principle for developing such policies is that they should not be started *“from scratch, but on the basis of the informal networks, which already exist”*, illustrating it with cases of alumni networks of well-known Russian universities (Sterligov, 2007). Irina Dezhina also recommends *“engaging those resources and connections, that are formed without government involvement”* and namely social networks and professional associations emerged on the basis of disciplinary or regional criteria and which migrant scientists create and maintain themselves (Dezhina, 2010). Yet, though trying to work with diasporic professional associations, the state does not pay sufficient attention to the existing connections of the Russian scientific diaspora. This seems to be a regrettable omission as the analysis of these connections and patterns of scientific cooperation might be very helpful if one intends to find out how widespread and strong the actual collaboration is between Russian scientists abroad and their colleagues at home and whether in fact Russians have a preference for working with each other as is often assumed. This paper seeks to partially fill this gap and suggests exploring professional connections of Russian computer scientists (RCS) in the UK as a specific part of the Russian scientific diaspora, looking at their publications and tracing their co-authorship ties.

But what is known about the Russian scientific diaspora and its professional contacts, including ties to the home country, from scientific research? Since the brain drain in 1990s and acute public concern about the problem, a number of studies have been conducted devoted to this population. They often focus on such issues as the size of Russian scientific diaspora, its structure and characteristics (Ivakhnyuk, 2006; Egerev 2007; Dezhina 2002, 2010; Korobkov, 2012; Osina, 2013), they analyze foreign experience of engaging diasporas for the benefit of the country of origin (Borisenko, 2013, Osina, 2013) or explore existing relations of collaboration and suggest possible ways of strengthening cooperation with diaspora members (Ignatov, 2013; Dezhina, 2010; Korobkov, 2012; Dezhina et al., 2015).

Existing professional contacts with Russia was one of the objects under attention and investigations included questions on popular forms of cooperation, motives and interests of diasporic scientists, conditions stimulating or impeding cooperation and so on. As a result, it was found that the majority of diasporic academics maintain ties to their colleagues in the home country. Though estimations vary, it was generally underlined that these connections *“cemented by the common language, personal friendships and common professional background”* (Yelenevetskaya & Fialkova, 2009) often have informal character. Thus, the study conducted by Dezhina showed that *“ties with Russia on the personal level have all [...] organizationally established cooperation is much rarer”* (Dezhina, 2010). The latest and most comprehensive investigation of the Russian diaspora similarly demonstrated that the majority of diasporic scientists (84%) are engaged in collaboration outside of governmental programmes or specific organizations (Dezhina et al., 2015). In a study of the Russian technological diaspora it was stated that 71% of informants have professional links to the home country, with authors stressing *“predominantly informal character of the existing linkages”* and adding that *“networks, cultural values, personal attitudes rather than organizational hierarchies and established rules often guide the interests of our respondents”* (Freinkman et al., 2013). At the same time, in a study of the Russian diaspora in social and economic sciences it was revealed that only half of the respondents (48%) maintain professional connections in the country of origin (Popov et al., 2011).

Partly the discrepancy in figures might be explained by the different relevance of Russian science for different disciplines – for example, findings in Russian physics and mathematics are still highly regarded by diaspora members, while developments in biotechnology are considered to be of comparatively low value (Dezhina, 2010). Another factor is the self-selection of academics who take part in surveys and interviews: typically they represent the most active part of the diaspora who are interested in sustaining or renewing contacts with Russia. But the major drawback of such studies is that they concentrate on the responses of diaspora members as almost the only source of information on cooperation, without examining their professional connections as such. Even in the most recent and substantial investigation one can only find data on cooperation activities as they are reported by the diasporic scientists themselves: thus, 40.3% stated that they are conducting research and publish together with their Russian colleagues (Dezhina et al., 2015), but actually

publications are not included in the analysis and as a result the study provides very little information about scientific connections as such, and their characteristics, participants, and outcomes. When authors pay attention to publications, they do not go into detail and only refer to them in a wider statement, for instance, when mentioning an increase in the level of internationally co-authored papers in Russia as a sign of the growing internationalization and cooperation with colleagues abroad (Dezhina, 2012). Apart from publications, sometimes one may encounter a description of an individual case of collaborative research between a diasporic academic and his/ her Russian-based compatriots. For example, Allakhverdyan and Agamova give a story of Russian molecular biologist who involved his Moscow colleagues in a long-term research programme and invited them to the US, which resulted in his laboratory having 15 Russian-speaking investigators out of 20 (Allakhverdyan & Agamova, 2012). But such cases represent only colorful illustrations, are not explored and analyzed in detail or compared to other cases, therefore they remain quite limited and no generalizations can be produced.

The aim of the paper is to offer and demonstrate a different approach to the matter, exploring the connections of RCS in the UK as part of the Russian scientific diaspora and using co-authorship data as a reliable and widely recognized indicator of cooperation. This way the paper intends to provide an example of examining actual collaboration patterns as potentially containing valuable insights for reflecting on and updating scientific diaspora engagement policies, especially if they target and address a certain part of scientific diaspora as RCS. In particular, in the paper I seek to find answers to the following questions: whether Russian computer scientists in UK demonstrate a certain preference for working with Russian researchers at home; what are the key features of such diasporic scientific connections; what are their potential consequences and implication for governmental policies and Russian science, including their effect on brain drain.

Data, methods and sampling

For the detection of RCS in the UK, I applied to Web of Science data from 1985 to 2014¹. The initial list of RCS with British affiliation was verified and refined on the basis of various open Internet sources². RCS were identified by common origins (Russia or former USSR countries), Russian language (as

¹ Web of Science data was provided and processed by Ex-visu within the project "RCS at home and abroad". A specific search algorithm was used to detect persons with typical Russian surnames ending with "-ov/ ev, -ova/ -eva", "-ky/ -kiy", "-ko", "-ich/ otch", "-in/ an/ un", "-uk/ ak" etc, publishing papers in different computer science areas: artificial intelligence, information systems, software engineering, hardware architecture and other fields up to the interdisciplinary applications like medical image computing, bioinformatics etc.

² I applied to specialized publications databases (The DBLP Computer Science Bibliography, ACM Digital Library, IEEE Xplore Digital Library), professional social networks (LinkedIn, ResearchGate, ZoomInfo), university and research centres websites, personal webpages, as well as special online services on authors and their publications (Google Scholar, Microsoft Academic Search, ArnetMiner) and electronic publications and conference proceedings when necessary.

native or education (secondary and/ or higher) in Russian), scientific activity in computer science (publishing papers, occupying research and/ or teaching position in British universities/ research centres). As a result, a list of 197 computer scientists was composed, including 190 university scholars (139 current and 51 former) and 7 scientists in research centres (5 current and 2 former). Affiliations analysis for RCS in British academia shows that scientists are employed by highly ranked institutions, with the majority (126 RCS out of 190 or 66,3%) working for Top 30 universities in computer science out of 104 (The Guardian University Guide, 2016). It is also noteworthy that half of RCS academic population (102 or 53,7%) concentrates in just 10 universities across the country, which we call major universities as they contain a considerable number of Russian-speaking academics. These universities include Royal Holloway University (20 scholars), Newcastle University (15), University of Manchester (14), University of Cambridge (12) and University of Oxford (12), University of Liverpool (9), University of Warwick (6), University College London (6), University of Cardiff (5) and Birkbeck College, University of London (5).

As my interest lies in examining RCS collaboration connections for the prospective benefit of the home country, attention is primarily directed towards academics employed in research intensive universities with high profiles in the field of computer science. These RCS may be considered as valuable potential collaborators for scholars based in Russia as they are engaged in cutting-edge productive scientific activity, which is recognized in the professional community as being at the forefront of innovative research. Several criteria were used to identify research intensive universities: Russell Group member list (Russell Group, 2014), the latest Research Excellence Framework data (2014) on research quality in British universities for computer science and informatics (Research Excellence Framework, 2014), Research Excellence Framework ranking (2014) of Times Higher Education, both general and for computer science and informatics (Times Higher Education, 2014). As a result, lists of the leading ten (Top 10), twenty (Top 20) and thirty institutions (Top 30) in computer science research were composed.

Another intention was to embrace a large part of the high profile RCS population, identify cases with significant level of diasporic collaboration and examine them in more detail. Therefore, data on research intensive institutions was juxtaposed with data on RCS affiliations and it was found that major universities with a large number of Russian scholars also often represent top universities in computer science research. Thus, UCL, WAR, UOM, CAM, OXF and NCL have the highest level of world-leading research in computer science (>45%) and are ranked within Top 10 out of 89 for the research quality in this subject, constituting 81,8% of all RCS affiliated to the best ten institutions for this subject in the UK.³ In addition, they occupy very high or rather high positions in the general REF ranking (OXF – 4, CAM – 5, UCL – 8, WAR – 8, UOM – 17, NCL – 26, RH – 26 (out of 128)) and, except for RH, are members

³ For convenience here and further on I use abbreviations for universities' names: UCL – University College London, WAR – University of Warwick, UOM – University of Manchester, CAM – University of Cambridge, OXF – University of Oxford, NCL – Newcastle University. RH – Royal Holloway University

of the influential and prestigious Russell Group association, famous for its research output and impact. Therefore, I chose for the analysis major universities, containing considerable share of RCS population in the UK, which are also research intensive institutions with high profiles in computer science: UCL, WAR, OXF, CAM, UOM, NCL and RH⁴.

It is important that scholars working in these institutions represent the greater part of Russian computer scientists engaged in cutting-edge innovative scientific work in the UK: they constitute 65,9% (83⁵ out of 126) of RCS employed in Top 30 universities according to Guardian 2016 ranking for computer science (CS), 66,4% (83 out of 125) – in Top 30 according to REF CS 2014 ranking and 74,8% (83 out of 111) – in Top 30 according to REF 2014 general ranking. It means that, though not strictly representative, the analysis of co-authorship connections in the chosen major universities covers the substantial proportion of research-oriented and high status RCS population. Therefore I would posit that the identified co-authorship patterns in these institutions embody the main features of collaboration and diasporic cooperation relevant for all RCS in high profile institutions.

The first stage of analysis was to find out the level of diasporic collaboration for RCS in the chosen universities and identify institutions where diasporic collaboration plays an important role in overall scientific work. Looking at publications⁶, I determined the number and proportion of papers written with Russian-speaking scholars, the character of diasporic ties and their place in larger collaboration networks. A paper was considered as having been written in diasporic collaboration if one Russian-speaking researcher or more were present in the list of co-authors. In addition I traced the amount and proportion of papers, which included exclusively Russian-speaking authors. I also paid attention to the affiliations of RCS and their co-authors to determine the level of intramural collaboration, collaboration within the UK/ Europe and with the home country. Thus, co-authorship connections were examined for the chosen seven universities, with a more detailed investigation undertaken for RH, NCL and UOM as these universities have the largest Russian-speaking computer science communities in the UK with a marked orientation towards diasporic cooperation. For these institutions, I also traced RCS academic positions, which were found to be associated with the size and diversity of diasporic scientific network.

Researchers in temporary positions in the UK institutions with a significant level of diasporic collaboration (RH, NCL, UOM) were found to be mostly involved in intramural diasporic networks, in contrast to scholars in permanent positions, who were engaged in a wider range of connections to Russian-speaking scientists. For this reason, in the second stage of analysis I narrowed down the research focus to examine co-authorship ties of two

⁴ Though RH has lower standing in computer science compared to other institutions (Guardian CS – 28, REF general – 26, REF CS – 24, with 30% of world-leading research), it has the largest number of RCS (20) therefore was necessarily included into the analysis.

⁵ The number is 83 instead of 85 because two scientists have double affiliations having worked for two British universities at focus during their career (UCL/ UOM and UOM/ OXF).

⁶ I generally used data from The DBLP Computer Science Bibliography database, but in some cases I referred to list of publications on ResearchGate or scholars' university webpages.

leading scientists⁷. They were selected from the universities in focus⁸ as the most appropriate cases as they have multiple connections and the most diverse diasporic co-authorship network. There are 17 scientists in permanent positions in these universities in total⁹, but among them only 6 with many publications and extensive network of diasporic contacts¹⁰. Vladimir and Anatoly¹¹ were chosen out of these six as they have a large number of diasporic connections (18 and 20) with maximum diversity, with co-authors representing different academic positions and different countries¹², and a comparatively small share of intramural ties (6 and 9 respectively). Therefore, though covering limited data, analysis of diasporic connections for the chosen scientists enables to encompass as wide a range and variety of diasporic ties as possible and helps to compose a larger characteristic of diasporic co-authorship relevant for RCS working in research-intensive institutions. In addition, as I am looking for ties to the home country among other diasporic contacts, it is more probable that one finds them in a heterogeneous network. Diasporic connections for the selected scientists were characterized according to several parameters: intramural or extramural character, productivity and durability, the positions held by co-authors in academia (professor, senior researcher, research fellow, research associate, PhD student) and their country of residence at the moment of cooperation (UK, Russia, other European country). Brief biographical trajectories were also composed for the members of ego-networks to trace the origins of co-authorship connections between RCS¹³.

Diasporic co-authorship: RCS in research-intensive British universities

Analysis of publications demonstrates research-intensive universities can be divided into two groups, one group with insignificant level of diasporic collaboration, where it plays a minor role in RCS scientific endeavors, and another one with a substantial level of diasporic collaboration, when it occupies a meaningful place in RCS scientific activity. The first group includes four universities (WAR, OXF, CAM and UCL), representing 43,4% of RCS population covered by this study (36 out of 83). Generally RCS in these institutions have rather few connections to other Russian-speaking scholars, if they have any at all, and these ties do not generate a considerable number of publications. These connections are for the most part intramural, one can also

⁷ Scientists, professors with more than 150 publications, 2000 citations and h-index higher than 20.

⁸ Full names of the scholars as well as their university affiliation are not disclosed for anonymity purposes as even the name of the institution might lead to personal identification.

⁹ RH (7), UOM (5) and NCL (5)

¹⁰ The number of publications varies from 129 to 241, with number of contacts ranging from 9 to 23.

¹¹ Here and further on I use fictional names for anonymity purposes.

¹² Other RCS with multiple diasporic contacts (17-23) have a more homogeneous network, constitutes by more than a half by their university colleagues (intramural collaboration). There is also one professor whose diasporic network is considered as an exceptional case and therefore excluded from the current analysis: almost all of his Russian-speaking co-authors are represented by former or new colleagues in the home country, mostly by scientists in alma mater university.

¹³ Information was acquired through open Internet sources listed above and partly from the interviews.

find ties to RCS in the UK, Europe and other developed countries and only in rare cases ties to researchers based in Russia are prominent.

Thus, in WAR only 18,6% of all RCS publications (57 out of 307) were written in some collaboration with Russian researchers. A closer look shows that five out of six scholars working in WAR have Russian-speaking co-authors, with three scientists cooperating primarily with colleagues from their university (with 77-100% of intramural co-authorship). Another scholar has a rather low proportion of diasporic co-authorship (9 publications out of 68 or 13,2%) and has written the majority of these papers (7 out of 9) with his colleague from a German research institute. One more scholar has a higher level of diasporic co-authorship (24 papers out of 117 or 20,5%) and many Russian-speaking co-authors (11). In contrast to other RCSs, he managed to preserve connections to his alma mater colleagues in Russia (4 co-authors) which resulted in 12 joint publications, though a significant part of the publications (10 out of 24) were also produced with RCS from WAR and other UK universities.

In OXF only six out of 12 scholars have Russian-speaking co-authors, while for the other half they are totally absent. Among those with co-authors, two scholars have a rather low level of diasporic collaboration (16,4% and 18%) and few Russian co-authors (2 and 4 respectively), with the majority of their papers in diasporic co-authorship (8 out of 9 and 7 out of 9 respectively) produced with RCS from developed countries (Germany, France, US). Another researcher spent most of his professional life in Moscow and was employed in OXF only for a year (2010-2011). During this time he published 12 papers, including 3 with Russian-speaking colleagues, and then returned to Russia to work for a large IT company and subsequently in academia. In contrast, the remaining three scientists are engaged in active diasporic collaboration: the proportion of their publications with Russian-speaking colleagues ranges from 33,3% to 100%. They are young scholars who form a research group and include two core scholars engaged in long-term and intensive collaboration with each other (46 joint publications in 2010-2015) and one more researcher, who was attracted to OXF from University of Edinburgh. The important feature of their diasporic co-authorship is its incorporation in wider scientific networks: thus, RCS triad is not closed upon itself, but exists inside connections to colleagues in OXF, Germany and Sweden.

In CAM the majority of scientists (9 out of 12) do not have any Russian co-authors and only three are engaged in some diasporic collaboration. But for two of them this collaboration occupies a quite insignificant place: it consists of 1-2 papers with 1-2 Russian co-authors and constitutes a small share of their publications (4% and 15,4%). Even for the third researcher, who has 28,6% of papers written together with other Russian-speaking colleagues, diasporic cooperation hardly makes a meaningful contribution to his scientific work, resulting in a few publications (4 articles) and being confined to a short period in the past (2002-2007).

In UCL, though only three out of six scientists have connections to other RCS, the general level of diasporic cooperation is higher, with 48,6% of papers (105 out of 216) produced together with Russian-speaking scholars. But the average level per individual is much lower (21,8%), varying from 16,7% to 67,4%, and diasporic ties remain typically few in number and limited in their character. Thus, one scholar has only 5 papers written together with three other RCS, who are affiliated to American universities. A scholar with 67,4% of diasporic co-authorship in fact has published all these papers with his colleague from UCL. And only one researcher has multiple co-authors (9) and diverse diasporic connections, cooperating largely with scientists from different universities across the UK (UCL, Imperial, Reading, Sussex) and US, but also preserving some ties (2 co-authors) to the home country.

Summarizing, we see that only half of RCS (18 out of 36) in the research-intensive institutions analyzed above are engaged in diasporic collaboration, generally they have professional connections to a few Russian co-authors and it results in a rather small number of joint publications. Russian colleagues from the same UK institution as well as Russian scientists from other British and European universities remain the most common collaborators, while ties to scholars in the home country are maintained quite rarely. Thus, diasporic collaboration can be characterized as occasional, fragmented and peripheral to RCS scientific activity.

Second group includes research-intensive universities where RCS are involved in a substantial cooperation with Russian-speaking scholars and where diasporic co-authorship constitutes a considerable share in their overall scientific output. I identified three such universities (RH, NCL and UOM), representing 59%¹⁴ of the RCS population in this study (49 out of 83). As they have much higher level of diasporic collaboration, a greater number of Russian-speaking co-authors and more diverse diasporic ties, analysis of their publications helps to achieve a more complex and detailed picture of RCS diasporic collaboration.

In RH, containing the largest proportions of RCS in the UK (20 scholars in total, including 10 current and 10 former researchers), almost half of papers (401 items out of 825 or 48,61%) are written in some collaboration with Russian-speaking colleagues. If one looks at publications featuring only Russian co-authors, they also occupy a substantial place in scientific cooperation, counting up to almost 30% (231 item or 28%) or one third of all published texts of RCS in this university. And it is noteworthy that the overwhelming majority of diasporic collaboration ties is found within the same institution that the RCS work for: the share of intramural collaboration is 78,61%, with 308 papers out of 401 co-authored with Russian-speaking colleagues affiliated to RH. It implies that the cooperation between RCS takes place within the UK, with Russian scholars as British colleagues within the same institution.

¹⁴ The sum of the percentages for the first and second group is above 100% as two scholars have double affiliations and are counted twice.

There are marked differences in diasporic co-authorship between scholars of different status in the academic hierarchy. Scientists on permanent positions (lecturers, professors) publish on average much lower proportion of papers with Russian-speaking colleagues than PhD students and researchers on temporary contracts (research associates). Though for both groups the share of texts written together with other RCS is substantial, for the first group it constitutes less than half of their overall number of publications (40,38%), while for the second group it is the largest part (67,74%) of their papers. The same trend is observed for exclusively diasporic co-authorship: while lecturers and professors published less than one fifth of their texts (18,89%) only with Russian-speaking scholars, for PhD students and research associates this proportion is much higher, amounting to almost half of the papers (49,19%). But both groups are rather similar in respect to intramural collaboration, which dominates their co-authorship with Russian colleagues, constituting 70% and 86,31% of all papers respectively. Therefore the inference is that RCS on permanent positions have multiple, more diverse and heterogeneous co-authorship connections. Though they rely to a significant extent on diasporic ties, which are predominantly of intramural character, collaboration with other RCS is often incorporated in larger scientific networks of British and European colleagues. By contrast, PhD students and researchers on temporary contracts demonstrate much more dependence on diasporic co-authorship ties, publishing overwhelmingly and, in a half of cases only, with Russian-speaking scholars. Taking into account that these scholars are also for the most part their colleagues at the university, it means that the collaboration network of the second group is closely tied to one institution and rarely extends beyond its walls.

Similar features of diasporic co-authorship can be found in other British universities where the population of RCS concentrates. In NCL, the institution with the second largest number of RCS (15 scientists, including 11 current and 4 former researchers), the share of papers produced in diasporic co-authorship is very close to the figure found for RH. Out of the total number of publications (650) a little more than half of them (377 items or 58%) were written in collaboration with Russian-speaking colleagues. But the proportion of papers only with Russian co-authors is lower and constitutes only one fifth of all texts (131 or 20,15%). It means that diasporic scientific ties of RCS in NCL are more involved in non-diasporic collaboration networks and therefore are less closed on themselves. If one looks specifically at publications with RCS, one will observe that similarly to RH, the tendency is to collaborate with Russian scientists working at the same university. If the paper is co-authored by Russian-speaking scientists, then in the prevalent majority of cases (250 items or 74,18%) it is co-authored with the colleague or several colleagues from NCL. Summarizing, one can tell that RCS maintain quite a substantial level of diasporic collaboration and it occupies an important place in their scientific activities, but it is mostly confined to NCL as an institution where they cooperate as university colleagues.

It is a common characteristic for both RH and NCL that academic position makes a difference for the diasporic co-authorship. Scientists in permanent positions in NCL publish not so extensively with other RCS as PhD students

and researchers on temporary contracts: for the first group, the share of papers co-authored with Russian-speaking is 44,89% in comparison to 86,96% for the second group. The second group is also more actively engaged in exclusively diasporic collaboration, producing almost half of all papers together with only Russian colleagues (46,74%), while for the first group the proportion of such papers constitutes only 16,02%. But the common pattern for both groups is the dominance of intramural cooperation in their diasporic co-authorship ties. The tendency is somewhat less pronounced for lecturers and professors, who publish 74,12% of papers co-authored with other RCS in collaboration with their university colleagues, and more marked for PhD students and research associates, for whom publications with their co-workers amount to 83,75% of texts co-authored with other Russian scholars. Thus, the analysis of publications for NCL RCS reveals that scientists on permanent positions sustain more diverse and dispersed collaboration networks, incorporating diasporic co-authorship in the broader circle of their scientific connections. For researchers in temporary employment and PhD students, co-authorship ties with other Russian-speaking scholars are of much more importance and consequence - as they present the main part of their scientific contacts and are accountable for the overwhelming majority of their publications. Again one observes the preference for intramural diasporic collaboration for both groups of RCS, but while for scientists in higher positions it serves as only one of the important foundations of their scientific work, researchers in lower positions become closely tied and confined to the narrow network of diasporic co-authorship connections, mostly limited to and localized at one institution.

In UOM, the institution with the third largest number of RCS in the UK (14 scientists, including 6 current and 8 former scholars), diasporic co-authorship is also rather substantial, though not so significant as in RH and NCL. The share of papers written with Russian-speaking scholars is 40,21% (152 out of 378), with a rather high percentage of publications produced exclusively with Russian co-authors (24,87%, 94 out of 378), which makes up the greater part of all works in diasporic collaboration. But, in contrast to the previous two universities where all RCS are engaged in diasporic collaboration, in UOM there are two scientists having no Russian-speaking co-authors at all. This university is also different with regards to the level of intramural ties in diasporic collaboration: whereas in RH and NCL publications with Russian colleagues working for the same university constitute 78% and 74% of all papers with RCS respectively, in UOM the share of intramural publications is 61,18% (93 out of 152) . In addition, in UOM the difference in intramural collaboration between researchers is much greater: it varies from 0 to 100%, being quite insignificant for three scholars (4,5%, 12,5%, 12,5%) and amounting to more than 50% for the remaining six scientists.

Concerning academic position of the scholar and its influence on the diasporic cooperation, one observes no such difference between researchers in permanent and temporary positions in UOM as in RH and NCL. The level of diasporic co-authorship is approximately the same in both groups (39,09% and 45,07% respectively) as well as the proportion of papers produced exclusively with Russian scientists (23,78% and 29,58%). Considerable difference is

found only for the share of intramural cooperation, with researchers in temporary positions being more often engaged in collaboration with their Russian-speaking university colleagues than scholars on permanent ones (78,13% in comparison to 56,67%). Similarly to RH and NCL, it indicates that scientists on permanent and higher positions are involved in and maintain more diverse diasporic contacts, while researchers in lower positions are more confined to the ties with their colleagues from the same institution.

Diasporic co-authorship: Russian professors and their networks of scientific contacts

It was demonstrated that RCS in lower status in research-intensive British universities with significant level of diasporic co-authorship, though deeply integrated in diasporic networks, collaborate predominantly with Russian-speaking UK-based scientists from their own institution. As scientific diaspora engagement policies seek to target those scholars who sustain some connections in the country of origin and wish to continue or renew collaboration with their colleagues at home, one should direct attention to RCS occupying higher positions in the universities under study as they have more heterogeneous networks of diasporic contacts. I examine diasporic scientific ties for two scholars from the second group of research-intensive universities as exemplary cases which were selected on the basis of scientific productivity and impact, plus number and character of connections to other Russian-speaking scientists (see more details on that in the data and methods section).

Vladimir¹⁵ is a professor at The School of Computer Science in A. University, one of the leading universities in the UK. He moved to the UK and joined this institution in 1999, but this was not his first experience of academic migration. His previous working place was a computer science department in one of the universities in Sweden, where he was employed for several years, and earlier in 1990s he spent a year in computer science research centres in Germany and France. Vladimir's scientific career started in Russia, Novosibirsk: he graduated from Novosibirsk State University and defended a PhD thesis there, subsequently becoming involved in the work of two research centres in Novosibirsk and published his first co-authored paper in 1988. By 2015 the whole amount of his publications amounted to 182, including 84 works written in cooperation with other RCS, constituting 46,15% of all the publications.

Vladimir's diasporic collaboration network consists of 18 connections, with more than half of co-authors (10) being based in the UK or other developed countries (Sweden, US) and outnumbering scholars from Russia (8 collaborators). Cooperation ties with Russian-speaking researchers in Britain and other countries are not only more numerous, but are distinguished by more productivity. Only 11 papers were written in co-authorship with RCS working in

¹⁵ Here and further on I use fictional names; full names of the scholars as well as their current university affiliation are not disclosed for anonymity purposes as even the name of the institution might lead to personal identification.

Russia, on average 1,38 with each co-author, which constitutes only 13% of Vladimir's publications with Russian-speaking colleagues and only 6% of the overall number of papers. In contrast to this figure, with Russian colleagues living outside of Russia, Vladimir published 73 papers, on average 7,3 with each collaborator, which represents 87% of all common works with Russian scholars and 40% of the overall number of publications. In addition, diasporic connections with RCS outside of Russia tend to be more long-term and durable: the average length of cooperation is 4,3 years, ranging from 1 to 13 years, but generally lasting from 3 to 8 years. Collaboration with researchers based in Russia seems to be occasional and fragmentary, typically not extending beyond one joint paper; only with one colleague the connection was sustained for 8 years, resulting in 5 co-authored papers.

Examining the temporal dynamics of Vladimir's diasporic co-authorship, one observes that collaboration with Russian colleagues abroad was particularly intensive from 1995 till 2005. It began from common work with Russian researchers in a Swedish university and continued in the UK on the basis of ties with former colleagues from Sweden, who had moved to Britain a couple of years earlier than Vladimir. He sustained these co-authorship connections in his new working place and started to form new ones, attracting several Russian PhD students into A. University. By contrast, collaboration with RCS living and working in Russia took place in the early stage of Vladimir's academic career (1988, 1993, 1996) and then was almost completely dropped off with the development of fruitful scientific cooperation with Russian scholars in Sweden and subsequently in the UK. Only after 2007 it started to get revived, with the appearance of more publications with new co-authors based in Russia.

Examining the origins of Vladimir's co-authorship connections with Russian-speaking scientists, one finds that in most cases they appeared after he left Russia and were established in Sweden or in the UK. The noteworthy fact is that the majority of Vladimir's co-authors share his migration and work experience, or have similar educational backgrounds. Thus, his most productive collaboration relations with Dmitry, now a professor in another British university, with whom Vladimir published 20 papers in 8 years (1995-2003), started in the university in Sweden, where they both were research fellows recently migrated from their home country. Another productive co-authorship was formed with Nikolai and Roman, younger generation researchers, with whom Vladimir prepared 19 (in the period of 2000-2013) and 12 articles (1999-2005) respectively. Both scholars are graduates of Novosibirsk State University, the institution Vladimir attended, but due to the difference in age, they are unlikely to have met while studying at the university. Roman was also Vladimir's colleague in the Swedish university, where they worked for a common project, and afterwards became his PhD student and afterwards a research associate in A University in the UK. Nikolai initially came to the UK to do a PhD as well, and also specifically to A. University to work under the supervision of Vladimir. After receiving a degree he remained as a research associate in the same university and then in a few years obtained the position of lecturer.

Common origins of similar kinds are traced in Vladimir's other connections formed abroad: two more of his collaborators are also graduates of Novosibirsk State University. Fedor (2 joint publications) entered A. University in the UK in 2000 as a PhD student, while Raya (7 joint publications) came to this university as a research associate in 1999, having defended a PhD in Novosibirsk in late 1980s. Raya also shares common work experience with Vladimir in Sweden as well as Daniil who also then worked for a couple of years in A. University and published 5 papers with Vladimir.

As for co-authors based in Russia, these ties are also somehow connected to Vladimir's educational background and location in the home country: thus, he has been collaborating with professors and lecturers who are working or who have worked in Novosibirsk State University, Novosibirsk branch of Russian Academy of Sciences, research institutes in Novosibirsk or who defended their PhDs in these institutions. Therefore only a few diasporic connections are not marked by common migration/ work experience or education background.

One should also note that Vladimir's diasporic co-authorship demonstrates orientation towards intramural collaboration. His most fruitful relations in terms of published papers were formed with those researchers, with whom he worked together in one university in Sweden (4 scholars, 44 publications) and then in the UK (6 scholars, 46 publications), maintaining scientific ties while moving from one country to the other. These connections account for a significant share of his publications with Russian-speaking scientists (60-61%), but still does not completely dominate diasporic collaboration; Vladimir's connections to other RCS remain quite diverse and dispersed, including Russian co-authors in other UK institutions, US, Sweden and Russia.

Summarizing, an analysis of Vladimir's diasporic connections shows that when RCS with permanent positions in UK research-intensive institutions take part in active diasporic collaboration, even in a case of a heterogeneous network of diasporic contacts, ties with Russian-speaking scientists based in the UK and Europe dominate and have more impact on their scientific activity. These connections were found to be more durable, stable and characterized by higher productivity resulting in a considerable number of publications. It is noteworthy that these ties are not inherited from the past, but are formed in the process of migration or are established after settling in the new country of residence, having roots in the common working experience abroad or educational background. By contrast, professional ties with RCS based in Russia are rather irregular, fragmented and lead to occasional publications without developing into a steady and fruitful collaboration, but common educational background and affiliation to an alma mater seem to matter for these connections as well.

The second case for analysis is Anatoly's network of co-authorship connections. He occupies the position of professor of computer science in M. University, a highly ranked British institution. He has been working there for almost 20 years, joining the department in 1996 as a research associate, but in 1993 he also spent a year in M. doing a postdoctoral internship. From 1996 Anatoly worked on temporary contracts for several years, until he successfully obtained the position of lecturer in 2000, with a subsequent promotion to professor. As for his

educational background, initially he graduated from Moscow State University, then he got appointed to a research institute in Kiev as a programmer and only much later defended his PhD in Saint Petersburg Polytechnic University. There he was teaching and doing research in the position of associate professor before coming to the UK, though his experience also included research visits to Italy and Switzerland.

From 1990 to 2015 Anatoly published 199 papers, including 47 papers in collaboration with Russian-speaking scientists, which constitutes almost one quarter (23,62%) of his works. Diasporic ties are for the most part of intramural character (27 items out of 47 or 57,45%). Publications with only Russian scholars amount to 45% of joint papers with RCS (21 items out of 41), so in more than half of cases, diasporic co-authorship connections are incorporated into the wider collaboration network. Anatoly's diasporic co-authorship network consists of 20 co-authors, with the majority of scientists working in the UK (11) or Europe (Finland – 3, Ukraine – 4), while connections with scholars based in Russia are very few (2 co-authors and 2 publications). As the latter date back to 1990-1992 and were discontinued after migration, I do not consider them in the analysis as contacts of any significance for Anatoly's scientific activity.

Interestingly, connections to a group of co-authors (4) in Ukraine are not rooted in Anatoly's previous work experience in Kiev. They were formed in early 2000s, which means several years after migration to the UK took place, and started from a meeting at a conference in Europe. They proved to be quite long-term and productive and resulted in 13 publications. Collaboration with Russian-speaking British and Finnish researchers was also established in the new country of residence, though two co-authors are former citizens of St Petersburg and the other two studied in Kiev. With the leader of the Finnish group, the acquaintance was made through a non-diasporic contact while working in a big European research project and was then developed into a steady and regular cooperation which has lasted since 2004 and brought 14 joint papers.

As for Russian-speaking co-authors in the UK, they are predominantly Anatoly's colleagues in M. University (9). The origins of these connections are different: with Evgeny and Vasily, Anatoly started to collaborate in common projects as members of a computer science department, but relations with the majority of researchers (7) began from the PhD programme, when they were recruited by Anatoly or Evgeny as promising students; subsequently they continued their career as research associates. The most productive connection was formed with Leonid, a former PhD student, with whom Anatoly has been cooperating since 2004 and written 28 joint papers. Thus, practically all diasporic co-authorship ties in Anatoly's network present newly established connections, which were initiated and developed into a durable and fruitful collaboration after migration to the UK. But, despite having multiple contacts with Russian-speaking scholars located in three countries, Anatoly is not engaged in any cooperation with Russia and scientists based in Russia.

Summarizing, an examination of RCS in high positions in research-intensive universities shows that even when they are intensively collaborating with Russian-speaking scientists and it constitutes a considerable part of their

scientific activity, this collaboration takes place predominantly with their university colleagues and scholars working in the UK and Europe, while ties to Russia remain very few and occasional, not developing into a durable and productive common work. For the most part these diasporic connections are formed in the process or after migration. In some situations common migration and work experience as well as educational background matter for the establishment of collaboration ties, but their role is unclear and needs to be investigated.

Implications for scientific diaspora engagement policies

Analysis of co-authorship of migrant RCS working in the UK was conducted through the examination of research-intensive universities which are highly ranked in computer science since there one finds Russian scientists engaged in the most cutting-edge and innovative research and they are considered the key audience for diaspora engagement policies. Two groups of institutions were identified, with insignificant and significant level of diasporic collaboration. Interestingly, substantial diasporic collaboration takes place mostly in universities where the biggest part of RCS population concentrates, including Royal Holloway University, Newcastle University and University of Manchester, with Russian scientists forming small research teams further building up into larger research communities, though some cases of intensive diasporic collaboration are observed in small research collectives in other universities¹⁶. It was also revealed that, though the level of diasporic co-authorship among RCS varies from its absence to constituting the main part of their publications, the majority of RCS maintains some kind of ties to other Russian-speaking scientists (75,9% or 63¹⁷ out of 83), while RCS who are not engaged in such collaboration are three times fewer in number (24,1% or 20¹⁸ out of 83). In addition, at least half of RCS in research-intensive universities (56,6% or 47 out of 83) demonstrate a considerable level of diasporic collaboration, which makes an important contribution to their scientific activity and constitutes a substantial share of their scientific output. Therefore, one can argue that there is indeed a certain preference or orientation of migrant RCS in high profile universities in computer science towards cooperation with their compatriots as governmental policies often imply.

The question is how can this preference be explained, what are its grounds and factors of influence? It might be a common educational background, specificity of Russian/post-soviet training in computer science and mathematics, similar experience of scientific socialization in the home country, as a result, Russian-speaking scientists may just find it easier to professionally understand each other. On the other hand, RCS might have pragmatic reasons and

¹⁶ For example, a triad of young scientists in OXF actively collaborating with each other.

¹⁷ Scientists with diasporic connections: 63 = 18 (the first group of universities) + 47 (the second group) – 2 (double affiliations)

¹⁸ Scientists without diasporic connections: 20=18 (the first group) + 2 (the second group)

considerations of economic rationality when, for example, it may be cheaper and easier for them to attract a highly qualified PhD student or research associate among young specialists in Russia and more convenient to work with them than to find appropriate candidates among British students and then to build professional relations with them. Of course, one should also take into account having a common language and cultural belonging as factors contributing to diasporic collaboration. But for a plausible explanation of RCS preference to cooperate with Russian-speaking scientists the analysis of co-authorship alone will not suffice and further investigation is necessary, based on a combination of publications data with data collected in interviews and surveys.

The examination of cases of substantial diasporic collaboration showed, though, that this preference is unevenly distributed and is linked to academic position: for RCS in permanent university positions (lecturers, professors) the proportion of articles written in diasporic co-authorship is much lower than for scientists on temporary contracts (research associates) and PhD students. The finding, that younger generation RCS are more involved in diasporic co-authorship, looks surprising as one might expect senior scholars, typically representing the older generation, to have more ties to Russian-speaking colleagues and to produce more work in collaboration with them. But taking into account that diasporic collaboration is mostly intramural, one sees that junior researchers are just deeply engaged in collaboration with their Russian-speaking university colleagues and have very few connections outside. At the same time senior scholars have more numerous and diverse professional contacts and produce a greater number of publications, therefore it is namely senior researchers who maintain a wide range of diasporic connections. They seem to be the persons who initiate, establish and develop diasporic co-authorship, using the resources of their position for inviting PhD students and hiring research associates from their homeland as well as sustaining relations with Russian-speaking colleagues in the UK and other countries. Therefore in diaspora engagement policies it might be useful to target RCS occupying permanent and senior positions in research-intensive British universities as the main figures in establishing and promoting collaboration with Russia.

The next important finding for diasporic collaboration irrespectively of its level is that there is a tendency toward intramural collaboration, with the majority of diasporic co-authors being RCS colleagues within the same university. Also a big part of RCS diasporic connections is represented by Russian-speaking scientists working in other UK as well as European and then American research institutions, while cooperation with colleagues based in Russia, with a very few exceptions, generally stays at the periphery of RCS scientific activities. Furthermore, examination of two prominent cases of diverse diasporic network demonstrates that Russian-speaking British and European colleagues do not represent former contacts of RCS from the home country, but are new collaborators, relationships with whom were developed in the process of migration or after migration to the UK. It is noteworthy that these new diasporic connections result in fruitful and long-term cooperation, far surpassing contacts in Russia in number, durability and productivity. These results are particularly interesting as they show that RCS in research-intensive universities, especially leading scientists on high positions, do not only exhibit certain preference to

collaboration with each other, but actually succeed in building and sustaining a collaboration network of diasporic connections across UK and Europe, sometimes forming research teams and diasporic professional communities in one university. And this collaboration proves to be efficient, generating a steady flow of new scientific ideas and new publications.

The question is why RCS cooperation with colleagues based in Russia remains so limited while it might be so successful as soon as scientists find themselves beyond the borders of their home country? There may be several potential explanations for this. My main assumption is that it is the conditions of scientific research funding and science organization, created in the UK, that open for Russian-speaking scholars many more opportunities for collaboration with each other abroad than in their native country. Another hypothesis is that the status of migrant scholar in the UK academy, its specificity, with certain constraints and boundaries it imposes, might lead diasporic scientists to initiate and sustain contacts with their compatriots. But what the particular conditions and factors are which encourage and stimulate diasporic co-authorship between RCS abroad is not possible to answer with publications analysis only, it needs a complex qualitative research with a range of methods, probably including a detailed case study of collaboration among Russian migrant scholars. Then one can provide policy recommendations regarding how Russia can benefit from the available network of diasporic ties between RCS in the UK and across Europe.

For the moment I conclude that the existing diasporic collaboration network hardly operates for the advantage of Russian science. Even when RCS actively collaborate with each other and produce a substantial amount of high quality scientific work, their diasporic connections remain mostly confined to the UK and Europe, and their achievements hardly spill over to their home country. The existing network also reflects a certain ineffectiveness of Russian diaspora engagement policies at least with regards to RCS. First, senior scholars, instead of potentially renewing and building connections in the home country, find themselves satisfactorily cooperating in a Russian-speaking academic community abroad, without a particular need to work together with colleagues in Russia. Second, in many cases when RCS preserve professional connections in the home country, senior scholars more often use them for informal communication and for recruiting young specialists for a PhD programme or a position of research associate than for scientific cooperation. This way they actually act as a force driving brain drain further, as by attracting talented young professionals they stimulate their migration from Russia and in many cases it means a permanent departure from Russia. Still, the future prospects of diaspora engagement do not look totally pessimistic as the majority of RCS demonstrate some inclination towards diasporic cooperation, and it means that migrant Russian-speaking scientists have much to contribute and share with one another. Harnessing this interest and directing it towards Russia might help to achieve the desired level of collaboration with the scientific diaspora, while knowledge of existing co-authorship patterns of diasporic academics might be useful for designing appropriate measures for that.

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