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## THE AGE STRUCTURE OF R&D PERSONNEL AS FACTOR OF UKRAINE'S SCIENTIFIC SYSTEM VIABILITY



*The dynamics of age structure of scientific personnel in Ukraine for the period from 1995 to 2014 have been analyzed. The age profiles of researchers in Ukraine and Russia has been compared. A new trend in the national science has been identified: since 2005, while the average age increasing, the share of researchers aged 30–39 years has been growing and reached 22%, in 2014 (at the same time, the youngest age group of under 29 accounted for 37%). This means that the concept of "total aging" and the resulting loss of productivity of Ukrainian science is too simplified to mirror the existing situation, and confirms that the current age structure of scientific personnel is still able to ensure a rapid improvement of capacity if the government provides support in effective manner.*

*Keywords: age structure of scientific manpower, age profile, sustainability of scientific institution, innovation development, and attraction of research labor.*

Under conditions when the staff potential of Ukraine's science has suffered unprecedented losses as the number of scholars and researchers decreased four times, the age structure of science workers is an aspect of paramount importance in the view of viability of science and R&D in Ukraine.

The influence of age structure of research teams on the operation of scientific system has been studied by many researchers [1–8], where an ascending trend of the aged staff share in the total number of researchers of Ukraine is reported and construed as general aging of Ukraine's science. As the analysis has showed, the most significant transformations of age structure of Ukraine researchers were recorded during the last decade (for example, [8] that focuses on changes in the age structure of highly qualified research personnel). The mentioned research shows that the conception of total aging and loss of productive capacity of Ukraine's science is, at least, a rough simplification of very

tough situation. The average age of researchers has been proved not to be a reliable and adequate parameter of capabilities of scientific teams. Therefore, the age structure of highly qualified staff cannot hamper the scientific progress. If supported by the government it can ensure a quite rapid R&D capacity growth.

In the view the critical importance of correlations and mutual influence of the age structure and the viability of research teams, the aim of this research is to study the dynamics of this structure and the factors effecting it with respect to Ukraine's science. In this case, the authors do not take into consideration a very worrisome trend of dropping absolute quantitative indicators of the scientific potential which, unfortunately, continues and even has started to jeopardize the existence of science in Ukraine.

It is necessary to establish when and why the age structure has changed drastically. Till 2005, despite a decrease in the number of researchers the age structure of Ukraine's R&D personnel (per-

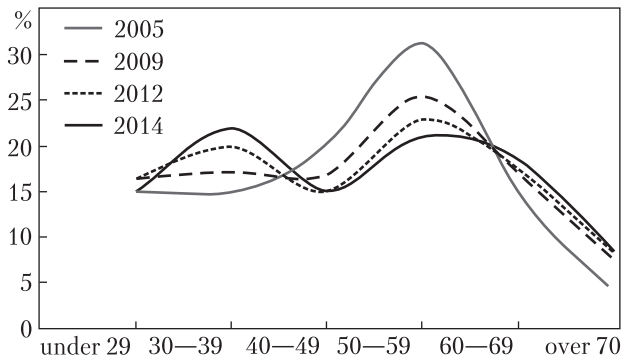


Fig. 1. Change in the age structure of Ukrainian researchers

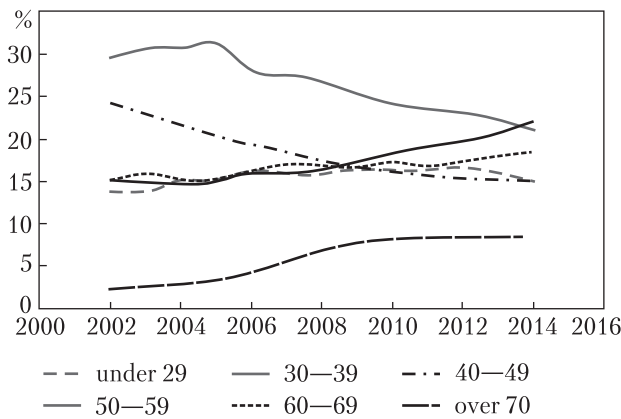


Fig. 2. Change in the share of the age groups, by year

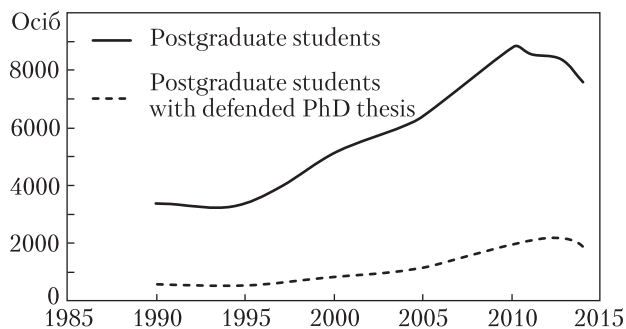


Fig. 3. Dynamics of postgraduate student in Ukraine

centage) remained fixed. Since 2006, the share of 20–29 and 30–39 year-old groups started to grow, whereas that of 40–49 and 50–59 year-old groups was falling (till 2013).

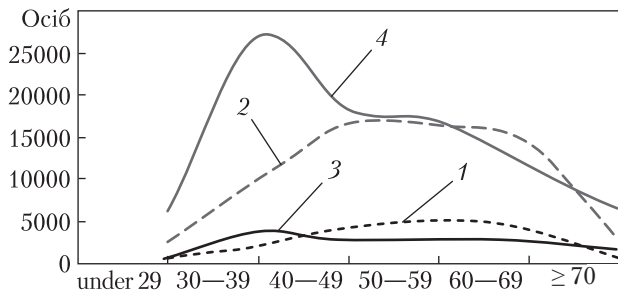
In 2009, an increase in the number of the researchers younger than 39 years was reported,

with the maximum corresponding to age of 30–39 years (Fig. 1). Later, this maximum grew and so did the minimum (corresponding to the group of 40–49 years old). Fig.2 shows the dynamics of the mentioned changes more vividly.

The eldest age group (over 70 years old) showed a considerable increase till 2010. Later, the pace slowed down. At the same time, the youngest age group (younger than 29) slightly grew; since 2006, one can see a stable increase in the 30–39 years old. However, last two years, (2013 and 2014), the share of the youngest (under 29 years old) started to go down. It should be noted that the share of the age group 30–39 in the total number continues to ascend after 2012; however, in absolute terms, it starts dropping. This means it grows at the expense of other age groups.

This trend in a certain way correlates with the number of post-graduates (Fig. 3). After 1995, the number of post-graduates showed a vigorous upward trend; since 2006, its annual growth reached maximum. This confirms that post graduate courses were an important source to replenish the research personnel, even if not all the graduates defend their Ph.D. thesis immediately. In any case, the majority of them continued research activities. While in 2000–2005, against the background of powerful personnel potential, this replenishment was not very essential, since 2005, when the research personnel decreased almost twice (down to nearly 100 thousand), with annual yield of postgraduate courses exceeding 6 thousand (in 2010, it reached 8.8 thousand), the effect became noticeable (especially, for the group of 30–39 years old totaling 18.9 thousand).

It should be pointed out, that within the period from 2006 till 2010, more than 8 thousand post-graduates defended Ph.D. thesis. If, at least, half of them could have belonged to the group of 30–39 years old, they would contribute to the growth of this group even if only 10% of them continued research activities. This assumption is confirmed by analysis of the evolution of age structure of Ph.D. holders (Fig. 4.). One can see from the diagrams that the majority of young Ph.D. holders



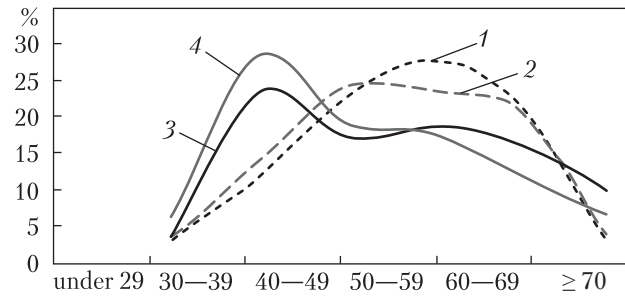
**Fig. 4.** Comparison of change in the distribution of PhD holders, 2002–2014: 1 – in research institutions (2002); 2 – in the economy (2002); 3 – in research institutions (2014); 4 – in the economy (2014)

after the defense have left the R&D to seek jobs in various industries thereby bringing fresh blood to the talent pool of the latter. Figs. 1 and 2 show an increase in the share of researchers younger than 39, which is a direct proof of viability of the national R&D, insofar as both the productive capacity of research teams and the prospects for their development in the future are determined by the human resources of the most productive age groups. Thus, until this growth is going on we can be optimistic with respect to the future of the Ukrainian R&D.

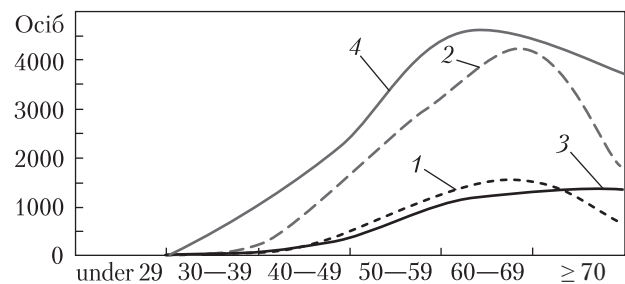
At the same time, the fact that during the period under review the share of 40–49 years old has not showed any gain but gone down (see the minimum on the curves, Fig. 1)<sup>1</sup> cannot but raise concerns. Notwithstanding all unfavorable trends the age structure of Ukrainian researchers as of 2014 testifies to the fact that the national science has been keeping high creative capacity for almost all productive age groups having noticeable shares in its structure.

The adverse trend is growing group of over 70 years old. Within the period from 2002 till 2014, it increased 3.7 times. This gives reasons for concern not only because it is too large (especially in the view of the fact that since 2010, the absolute number of researchers in this groups has been de-

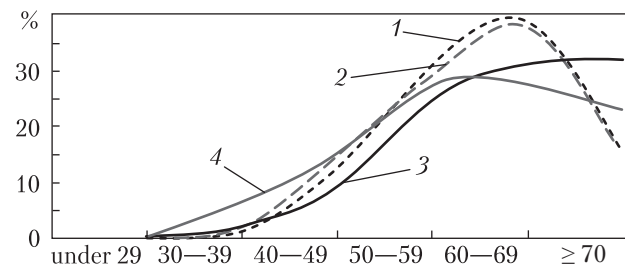
<sup>1</sup> This is explained by the fact that a large part of young CSC leaves the R&D institutions soon after the defense of Ph.D. thesis to find a well-paid job, inasmuch as it is very difficult to keep family for a salary of junior researcher, in Ukraine.



**Fig. 5.** Change in the age profiles of PhD holders, 2002–2014: 1 – in research institutions (2002); 2 – in the economy (2002); 3 – in research institutions (2014); 4 – in the economy (2014)

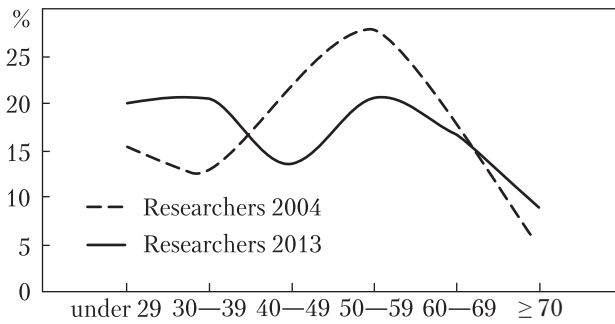


**Fig. 6.** Comparison of the total number of DSc in the respective age group, engaged in R&D sector, and their total number in the Ukrainian economy, 2002–2014: 1 – in research institutions (2002); 2 – in the economy (2002); 3 – in research institutions (2014); 4 – in the economy (2014)

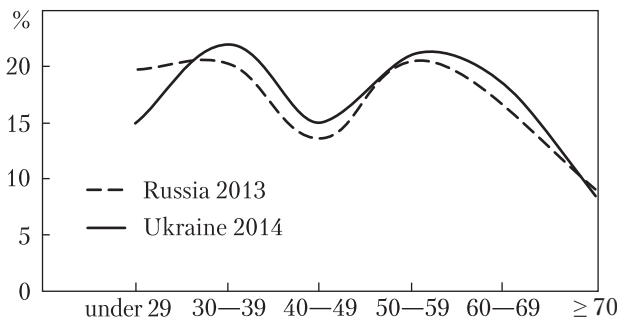


**Fig. 7.** Change in the age profiles of DSc in Ukraine (% of the respective age group), 2002–2014: 1 – in research institutions (2002); 2 – in the economy (2002); 3 – in research institutions (2014); 4 – in the economy (2014)

creasing with a stable pace (and so has been doing the group of 60–69 years old), although the relative share continues to ascend with a slower rate, but also due to the fact that the redistribution of weights of age groups in Ukraine's science is accompanied with a slow but stable decrease in the



**Fig. 8.** Change in the age profiles of Russian researchers (% of the respective age group in the total number)



**Fig. 9.** Comparison of the age profiles of Ukrainian and Russian researchers

number of researchers aged from 40 to 60 years old, who are considered quite productive as well.

The very growth in the eldest group is not deemed an extremely adverse factor. If there are enough young researchers and adequate facilities and resources, the erudition and rich experience of the aged colleagues can help to the youth in its professional development. According to Malitsky's [3, 4] conception of phase dynamics, the role of researcher in working environment changes with his/her age. Focusing on new functions and leaving the organizational activities the researcher continues to be involved in the creative process and to contribute to the development of respective field of science <sup>2</sup>.

In Figs. 4 and 5, one can see that for the time being, it is referring rather a structural youthification of Ukrainian Ph.D. holders.

<sup>2</sup> These dynamics should be backed by organizational measures.

Of course, this does not mean that we can neglect unprecedented losses of researchers including Ph.D. (see Fig. 4); however, it confirms that if the government significantly increases the investments in R&D, the money invested would rather ensure a rapid growth in the R&D personnel capacity. In any case, the current age structure of researchers is not an obstacle for its vigorous development. Fig. 5 shows that the majority of young Ph.D. prefers to be employed outside research institutes: the total number of young Ph.D. in Ukraine is higher than that in the research institutions. At the same time, the groups older than 60 have the larger share in the R&D. This can be explained by the fact that the CSc and DSc who worked as public servants and retired at the age of 60 migrated to the research institutions and departments of universities<sup>3</sup>. The same conclusion can be made by analyzing the structure of DSc (see Figs. 6 and 7). Till 2014, their total number even grew a little bit, with the number of all groups younger than 59 years old increasing. Despite the fact that the eldest group (older than 60 years old) has grown as well, the researchers of the most productive age (30–50 years old) still are prevailing.

At the same time, the DSc among the research personnel have got old (Fig. 7). One can see that as far as in 2002, the age structure of all DSc was practically the same as that of DSc in the research industry. The curve showing the age structure of DSc in 2014 has shifted to the left while that of DSc involved in research moved to the right. This means that the majority of fresh DSc who defended thesis in that period have left research institutions.

In general, this cannot be interpreted only as an adverse trend inasmuch as supply of qualified experts to all industries is one of the key objectives of research institutions. However, one can see once again that the profession of researcher, even DSc, has lost its attractiveness which cannot but raise concerns.

<sup>3</sup> According to the Ukrainian legislation, the public employee after reaching the retirement age can be employed only with research institution or education establishment as teacher.

In general, among the Ukrainian researchers of Ukraine, in 2014, 73% is aged younger than 59, as compared with 82.6%, in 2002. This is not a reason for rejoicing but it is too early to say that in Ukraine, the majority of researchers is pensioners.

The same processes take place Russia as well, albeit with a slower pace. There, in 2013, the share of researchers younger than 59 accounted for 74.5% versus 79.3%, in 2000. Fig. 8 shows that the age structure evolves in the same way as in Ukraine. One can see the minimum on the curve corresponding to the age group of 40–49. At the same time, it should be noted that a relative increase in the age group of younger than 29, in Russia, is more significant as compared with Ukraine. In 2013, 40.3% of Russian researchers were younger than 40 (26.4%, in 2000; 28.4%, in 2004), whereas in Ukraine, in 2014, their share made up 36.9% (28.9%, in 2002; 29.4%, in 2004). Hence, at the beginning of the period under review, the share of young researchers in Ukraine and in Russia was almost the same (in Ukraine, even a little bit higher); however, soon after that the situation in Ukraine aggravated.

Having analyzed the age structure of researchers in Russia on the basis of data for 2002, I.G. Dezhina [7] assumes that improvement of demographic situation in the Russian R&D is seeming, however, as can be seen from Fig. 8, in the next years, this effect was increasing and has led to a substantial rejuvenation of human resources in the Russian R&D.

Having compared the age structure of human resources of both countries one can see that they are similar (Fig. 9). This is an indication to a similarity of processes affecting the performance of the R&D: in both countries, the research personnel was going down albeit in Russia with a slower pace: in Ukraine, the number of researchers decreased more than four times, while in Russia, it fell a little bit less than trice. The funding of R&D was dropping as well: in Russia, it was cut down to 1.1% of GDP, whereas in Ukraine, it slumped to 0.66% of

GDP. Therefore, we understand the problems of Russian researchers, (see [10]), but, unfortunately, in Ukraine, the situation is even worse.

Notwithstanding, the present analysis gives reasons for cautious optimism. In spite of all troubles and challenges Ukraine's science is still alive, with its human resources tending to develop. If, in Ukraine, an innovation-driven government suddenly appears the research capacity would rather grow vigorously to secure for Ukraine a rightful place in the international scene. There are the young researchers and their aged colleagues who can help and guide the creative development of the former. The only thing needed is the government support.

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ВІКОВА СТРУКТУРА НАУКОВИХ КАДРІВ  
ЯК ФАКТОР ЖИТТЄЗДАТНОСТІ НАУКОВОЇ  
СИСТЕМИ УКРАЇНИ

Проаналізовано динаміку вікової структури наукових кадрів України від 1995р до 2014 р. Здійснено порівняння вікових профілів науковців України і Росії. Виявлено нову для вітчизняної науки тенденцію: після 2005 р. на фоні загального зростання середнього віку науковців почала збільшуватися частка науковців у віці 30–39 років, яка досягла у 2014 р. 22 % ( а разом з тими, кому 29 і менше, – 37 %). Це свідчить про те, що твердження про «тотальне постаріння» і зумовлену ним втрату потенціальної продуктивності української науки є щонайменше спрощенням у трактовці непростої ситуації, що склалася, а також підтверджує, що нинішня вікова структура наукових кадрів все ще здатна забезпечити швидке нарощення наукового потенціалу за умови дієвої підтримки з боку держави.

*Ключові слова:* вікова структура науковців, віковий профіль, вікова група, життєздатність наукового колективу, інноваційний розвиток, привабливість професії науковця.

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ВОЗРАСТНАЯ СТРУКТУРА НАУЧНЫХ КАДРОВ  
КАК ФАКТОР ЖИЗНЕСПОСОБНОСТИ  
НАУЧНОЙ СИСТЕМЫ УКРАИНЫ

Проанализировано динамику возрастной структуры научных кадров Украины в 1995–2014 г. Произведено сравнение возрастных профилей исследователей Украины и России. Отмечена новая для отечественной науки тенденция: после 2005 г. на фоне общего роста среднего возраста началось возрастание доли научных работников в возрасте 30–39 лет, которая достигла в 2014 г. 22 % (а вместе с теми, кому 29 и менее, – 37 %). Это свидетельствует о том, что нынешняя возрастная структура научных кадров все еще способна обеспечить быстрое наращивание научного потенциала при условии действенной поддержки со стороны государства. Аналогичные тенденции имеют место и в кадровой структуре науки России, с той разницей, что возрастание доли младших возрастных групп исследователей там еще более интенсивное.

*Ключевые слова:* возрастная структура исследователей, возрастной профиль, жизнеспособность научного коллектива, инновационное развитие, привлекательность профессии научного работника.

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