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Where Did Post-Doctorates Go? A Factorized Analysis on Chinese Postdoctoral Program for Innovative Talent

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Abstract

Young scientific and technological talents, as the core force of scientific research and innovation, have increasingly drawn academic attention regarding their career trajectories and the effects of policy interventions. The postdoctoral experience is becoming an indispensable stage. This study, based on empirical data from China's National Postdoctoral Program for Innovative Talent (NPPIT), systematically analyzes the basic characteristics, academic mobility, and title promotion of the NPPIT fellows by integrating scientific metrology methods and multiple logistic regression models. The findings are as follows: (a)There is a gender imbalance among NPPIT postdocs, with the age group predominantly ranging from 27 to 31 years. The majority of doctoral institutions are Project 985 universities. Already, 16.05% of the postdocs have obtained senior-level treatment, and the proportion of fellows securing tenure-track positions after program completion is higher than 65%. (b)The academic mobility exhibits significant stratification: the migration rate of postdocs from 985 universities to 211 and other general universities reaches 30.94%, reflecting the "competitive crowding-out effect" and the trend of resource reallocation. (c)The accelerated effect of the promotion path: 52.74% of early-funded fellows achieve senior titles within 6-8 years, indicating that the NPPIT significantly shortens the professional cycle. (d)Title and the type of doctoral institution are significant factors influencing academic mobility, while gender and tenure do not show significant correlations.(e)Alma mater sentiment plays a role in career choices, with many NPPIT postdocs choosing to stay at or return to their undergraduate or doctoral institutions, although it is not the decisive factor.(f)The academic mobility of NPPIT postdocs reflects the competitive academic job market and the importance of institutional reputation and resources in shaping career decisions.The contribution of this study lies in revealing the interactive effects of institutional factors, such as the pre-tenure and tenure systems and individual strategies, such as alma mater sentiment. Additionally, the study offers policy recommendations for optimizing the postdoctoral training system, including hierarchical evaluation, mobility incentives, and data-driven decision-making.

Introduction

Scientific and technological innovation serves as the core driving force of social and economic development, a process heavily reliant on the innovative capabilities of young scientific and technological talents. Classic studies indicate that scientists' productivity between the ages of 35 and 40 accounts for more than 70% of their significant lifetime achievements (Lehman, 1953). Young scientific and technological talents, defined as individuals under 40 years old who are in the early stages of their careers and possess significant research potential (Chen, 2022; Li et

al., 2024), have a direct impact on the effectiveness of national science and technology strategies (Zhang et al., 2024). Although countries universally cultivate young scholars through funding programs, such as the "Career" program by the U.S. NSF and the Starting Grants by the European Research Council (ERC), China's unique National Postdoctoral Program for Innovative Talent (NPPIT) has received little attention from the international academic community.

The program not only represents the highest national recognition of postdoctoral research capabilities but also establishes early identification criteria for young scientific and technological talents through a "selecting the best from the best" mechanism. Since its implementation in 2016, it has cumulatively funded more than 3,300 top postdoctoral researchers under the age of 31(approximately 1% of China's total postdoctoral recruits), providing a unique sample for analyzing the growth paths of young scientific and technological talents. Analyzing the characteristics of its fellows can offer empirical evidence for addressing the "35-year-old anxiety" among young talents and optimizing postdoctoral training policies. Existing scientometric research often focuses on mature talent programs such as the Nobel Prize (Rodríguez, 2022; Chan et al., 2018), NSFC Distinguished Young Scholars Fund and Excellent Young Scholars Fund (Li et al., 2024; Liu et al., 2022; Yuan et al., 2018; Yin et al., 2017), but there is a lack of systematic analysis of NPPIT fellows.

As a core force in national scientific and technological innovation, the postdoctoral community plays an irreplaceable strategic role in promoting academic progress, fostering interdisciplinary integration, and responding to global technological competition (Ma, 2023). Especially against the backdrop of the “Double First-Class ” initiative and the strategy of innovation-driven development, postdocs serve not only as the main force in university research but also as a vital bridge for international academic exchange (Liu et al., 2023). Moreover, the postdoctoral system functions both as a talent cultivation mechanism and a regulator of the academic labor market, making its dynamic evolution and optimization pathway crucial to enhancing national technological competitiveness. Therefore, studying the postdoctoral community is not only related to individual career development but also involves systematic issues of higher education governance, research innovation ecosystems, and talent policies.

Over the past decade, the global postdoctoral scale has expanded significantly, but the imbalance between supply and demand in the academic labor market has intensified, making career prospects uncertain a widespread challenge (Gao et al., 2022). In China, despite the postdoctoral experience being proven to significantly increase the probability of obtaining elite faculty positions by enhancing the quality and impact of research outputs (Xu et al., 2024), postdocs still face multiple challenges in their professional development: ambiguous role positioning, such as the conflict between “teacher” and “student” identities (Jiang et al., 2024), low job satisfaction with only 40% satisfied with the academic environment (Zhu, 2014), insufficient economic security (Yang et al., 2024), and mental health risks. Additionally, international comparisons show that Chinese postdocs exhibit a "low investment-high utilization" model, with their professional development capabilities significantly below the global average (Zhao et al., 2023), while overseas experience

significantly enhances their competitiveness in the academic market. These realities highlight the urgency of optimizing the postdoctoral system and improving the professional ecosystem.

Existing research on postdoctoral fellows predominantly employs quantitative analysis, with a minority using qualitative methods such as regression models (Liu et al., 2022), text analysis, and mixed methods. Some studies have also introduced cross-national comparisons and policy evidence-based analysis (Liu X et al., 2023) to enhance the universality and practical orientation of the conclusions. The core issues can be summarized into the following four categories: (a) Career Pathways and Market Returns: This focuses on the impact of postdoctoral experience on academic promotion, revealing the heterogeneity of postdoctoral experience on faculty position acquisition through tracking data analysis and propensity score matching (Ye et al., 2024). (b) Institutional Design and Training Effectiveness: Qualitative analysis explores the management of postdoctoral mobile stations, funding systems, and the optimization of classification and evaluation mechanisms (Chen et al., 2023; Ma, 2023). (c) Mental Health and Organizational Support: Based on structural equation modeling, this analyzes how mentor support and job meaning mitigate professional burnout, emphasizing the critical role of organizational support and psychological capital (Jiang et al., 2022, Zhao et al., 2022; Cai et al., 2022). (d) Role Conflict and Identity: Utilizing role theory and in-depth interviews, this deconstructs the tension of multiple identities of postdoctoral fellows and their institutional roots (Li et al., 2019; Song et al., 2022).

In general, the existing research tends to focus on how postdoctoral experiences influence the acquisition of academic positions, the best practices for optimizing training systems, and strategies for mental health interventions. However, there are three prominent limitations in the current body of research: Firstly, the unique growth trajectories of elite postdoctoral scholars, particularly their academic mobility and its determinants, are often overlooked. Secondly, there's a lack of exploration into the cumulative benefits that early-stage research projects, such as NPPIT, confer on postdoctoral scholars' academic careers. Thirdly, there's an excessive dependence on cross-sectional data, which hinders the thorough analysis of longitudinal career data. These research gaps present opportunities for this study to delve into. Specifically, will postdoctoral scholars funded by NPPIT secure academic positions? If not, what institutions do they move to? What factors influence their academic mobility? And what do these movements reveal about the academic landscape? This study aims to provide insightful answers to these questions.

Data and methods

Firstly, the list of NPPIT fellows for the years 2016-2024 was obtained. Starting from November 2024, our research team downloaded the list of NPPIT fellows for the years 2016-2024 from the official website of the China Postdoctoral Science Foundation, which included names, host institutions, primary disciplines, and funding numbers. Since the official website of the Postdoctoral Science Foundation no longer publicizes the names of fellows in defense and military systems from 2022 onwards, there has been no public channel to obtain the list of fellows in these sectors.

Subsequently, through various means such as personal homepages, institutional official websites, search engines, the China National Knowledge Infrastructure database, author searches in Web of Science, ORCID, ResearchGate, and others, we gathered the curriculum vitae information of 3,371 NPPIT postdocs from 2016 to 2024, including gender, date of birth, current institution, current department, PhD award date, PhD institution, field of study, work experience, master's degree award date, master's institution, bachelor's degree award date, and undergraduate institution. The information collection period was from November 2024 to January 2025. Finally, the collected NPPIT postdoc curriculum vitae (CV) information was input into a unified format data table in preparation for subsequent data processing and cleaning; the categorized information was quantitatively encoded to construct a comprehensive postdoctoral innovative talent CV database.

The postdoctoral experience is increasingly becoming a necessary condition for young innovative talents pursuing academic careers. Typically, most doctoral students start their academic careers after graduation, and in the context of a scarcity of faculty positions, a postdoctoral position is the optimal choice. It provides a transitional and cumulative opportunity for PhD holders, allowing for periods of free exploration that can lead to formal faculty positions, associate senior titles, or even senior titles. What characteristics are common among postdoctoral innovative talents who successfully secure promotions? Factors such as job changes, reasons for job choices, and educational backgrounds are crucial for observing the mobility of young innovative talents. Gender, age, educational background, field of study, and academic mobility are important factors for observing the promotion of young innovative talents. Chi-square tests and multiple logistic regression analyses were used to examine the relationship between these variables and title levels. Considering the research questions and the presence of missing data, we selected the CV information of 2,468 NPPIT postdocs with clearly defined positions as the sample for analyzing the mobility and promotion of young innovative talents.

A scientific CV is a true reflection of a researcher's academic career, documenting their growth trajectory, including fields of study, educational level, institutional changes, international experience, research output, and collaborative teamwork. It provides a new method and perspective for the study of postdoctoral innovative talent policies. Existing research indicates that gender, age, academic background, international experience, institutional nature, and frequency of mobility are important variables affecting talent development. However, since NPPIT applicants are required to be under 31 years old with similar lengths of education, most NPPIT postdocs are of similar age, so this study does not focus on age as a primary indicator but instead uses the time since funding was received as an important grouping variable for observation. Therefore, this study uses gender, educational origin, and academic mobility as the main indicators for empirical analysis of the group characteristics of NPPIT postdocs and their relationship with growth.

Results

Overall analysis

Firstly, we conducted statistics on the funding years, hosting institutions, and disciplines of the 3,371 NPPIT postdocs in 2016, there were 200 fellows, 300 in 2017, and 400 each year from 2018 to 2021. In 2022, 2023, and 2024, there were 367, 450, and 454 fellows, respectively. Among these NPPIT postdocs, 2,116 were affiliated with Project 985 institutions (China's initiative to build world-class universities, launched in 1998), accounting for 62.77%, the; 485 were affiliated with the Chinese Academy of Sciences (CAS), accounting for 14.39%; 432 were affiliated with Project 211 institutions (the national program focused on developing 100 key universities and disciplines for the 21st century, initiated in 1995), accounting for 12.82%; 162 were affiliated with other Chinese universities, accounting for 4.81%; 128 were affiliated with other Chinese research institutes, accounting for 3.80%; and 39 entered the defense and military industries, and 9 entered Chinese enterprises, accounting for 1.16% and 0.27% respectively. The top ten institutions with the most NPPIT postdocs were Tsinghua University, Peking University, Fudan University, University of Science and Technology of China, Shanghai Jiao Tong University, Zhejiang University, Xi'an Jiaotong University, Sun Yat-sen University, Wuhan University, and Tongji University. The majority of their postdoctoral experiences belonged to the natural sciences, with the top five disciplines being biology, materials science, chemistry, clinical medicine, and physics. Only 4 NPPIT postdocs belonged to the social sciences, specifically 1 in psychology, 2 in applied economics, and 1 in statistics.

Secondly, we statistically analyzed the gender, ages in funding year, current institution, and current title of the 2,468 NPPIT postdocs with clearly defined positions, as shown in Table 1 and Figure 1. In terms of gender distribution, the proportion of women in the NPPIT postdocs group was small, with only 526 females, accounting for 21.31%, which is similar to the gender ratio of recipients of China's Excellent Young Scientist Fund Program (Chen, 2022). The trend of female representation among high-level talents is consistent with the observation that higher talent levels have fewer women, with the proportion of female Excellent Young Scientists ranging from 18.32% to 23.33% between 2012 and 2020. However, as shown in Figure 1(a), the proportion of women has shown a fluctuating increase over time, indicating a positive trend in the proportion of female young innovative talents. Regarding birth year and age at the time of receiving NPPIT, the Postdocs were born between 1985 and 1998, with ages in funding year ranging from 27 to 31 and an average of 29.1 years, with exceptions such as Associate Professor Wang Panding from Beijing Institute of Technology, who was selected for NPPIT at the age of 24.

Table 1. The overall distribution of sample NPPIT postdocs (*p<0.05, **p<0.01, ***p<0.001).

Variable		*Total (N=2,468)*	*Unanalyzed subsample (N=1,104)*	*Mobility subsample (N=1,364)*		
				Mobility group (N=422)	*Non-mobility group (N=942)*	*Test*
Gender (%)	Male	78.69	76.90	77.49	81.32	χ^2=2.45, p=0.12
	Female	21.31	23.10	22.51	18.68	
Avg.age in funding year (Mean ± SD, years)		28.98 (1.49)	29.29 (1.50)	28.76 (1.48)	28.96 (1.52)	t=0.68, p=0.50
Current institution (%)	Institutes	14.71	20.20	12.80	9.13	χ^2=17.31, p=0.0006 ***
	Other univs	9.12	5.89	23.22	6.58	
	Project 211	17.38	9.33	27.73	22.19	
	Project 985	58.79	64.58	36.26	62.10	
	Postdoc	44.73	100.00	0.00	0.00	
Current title (%)	Junior	0.16	0.00	0.24	0.32	χ^2=14.72, p=0.002 **
	Intermediate	8.31	0.00	12.09	16.35	
	Deputy senior	30.75	0.00	35.78	57.32	
	Senior	16.05	0.00	51.90	26.01	
Tenure (%)		44.45	0.00	79.15	80.68	χ^2=0.34, p=0.56

Regarding the current institutions and types, the top ten institutions hosting the largest number of NPPIT postdocs are Tsinghua University, Peking University, Fudan University, Xi'an Jiaotong University, Zhejiang University, University of Science and Technology of China, Shanghai Jiao Tong University, Sun Yat-sen University, Tongji University, and Wuhan University. In this context, we categorize universities overseas and those in Hong Kong, Macau, and Taiwan as "other universities," which represent all universities outside of Project 211 and Project 985. CAS, other Chinese research institutes, Chinese enterprises, and the defense and military industries are collectively referred to as "research institutes." As shown in Figure 1(b), over time, there is a trend towards NPPIT postdocs being increasingly affiliated with more Project 985 universities, with a decrease in the proportion of Project 211 universities and other universities, and a symmetrical fluctuation in the proportion of research institutes, remaining stable at the beginning and end. However, looking at the NPPIT recipients from a reverse chronological perspective, it suggests a future trend where NPPIT recipients from 2020 to 2024 are likely to move to Project 211 universities and other universities.

Overall, among the 2,468 NPPIT postdocs 1,451 are currently affiliated with Project 985 universities, accounting for 58.79%, the highest proportion; 429 with Project 211 universities, accounting for 17.38%; 363 with research institutes, accounting for 14.71%, of which CAS accounts for 11.06%; and the other research institutes, Chinese enterprises, and the defense and military industries account for 3.16%,

0.41%, and 0.08% respectively. Additionally, 225 are affiliated with other universities, accounting for 9.12%, including 8.83% Chinese other universities, 0.20% overseas universities, and 0.08% universities in Hong Kong, Macau, and Taiwan. Compared to the proportion of postdoctoral institution types, the proportion of Project 985 universities has decreased, and if we consider only the NPPIT postdocs who completed their programs from 2016 to 2021, this proportion would drop to 54.89%. The proportion of CAS has decreased, while the proportions of Project 211 universities and other Chinese universities have increased. This is related to the employment situation for postdoctoral fellows, as there are fewer lifetime tenure positions in Chinese universities and research institutes, with many adopting the international practice of fixed-term contracts. Project 985 universities and CAS have abundant resources and better research conditions but high assessment requirements and intense competition, leading to those who fail assessments moving to Project 211 universities and other universities. Data also shows that the proportion of NPPIT postdocs moving to Hong Kong, Macau, Taiwan, and overseas is low, indicating that the postdoctoral innovation support program is effective in supporting young scientific and technological talents.

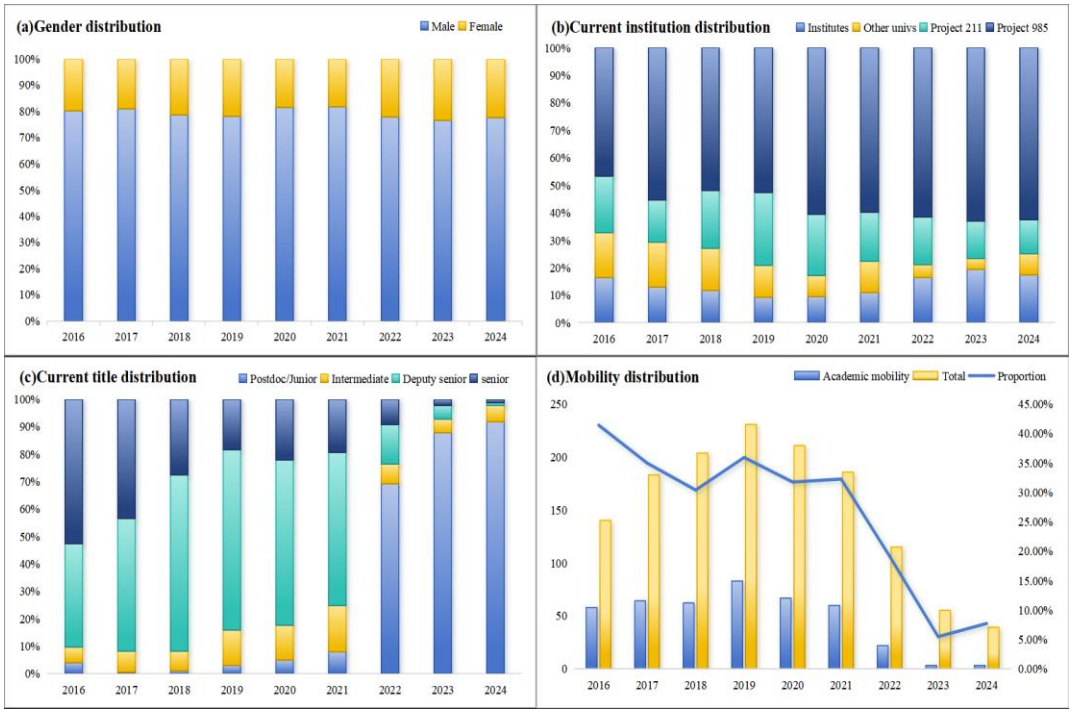

Figure 1. The overall and mobility distribution of sample NPPIT postdocs.

In terms of current titles and whether they hold lifetime tenure, this study includes both permanent and non-permanent senior and associate senior positions in the new title system. Overall, 396 NPPIT postdocs have achieved senior positions, accounting for 16.05%, while 759 have achieved associate senior positions, accounting for 30.75%. Intermediate titles account for 8.31%, and there are 1,108 at

the junior level or still in postdoctoral positions, accounting for 44.89%. Over time, as shown in Figure 1(c), the proportions of senior and associate senior positions among NPPIT postdocs from 2016 to 2021 are both higher than 75%, indicating that the titles of NPPIT postdocs who received funding earlier have significantly improved. The proportion of senior positions among the 2016 NPPIT postdocs has reached 52.74%, and comparing this with the NPPIT postdocs from 2022 to 2024, it is evident that half of the NPPIT postdocs can achieve senior positions within 6-8 years, which is much faster than the average 10-12 years typically required for postdoctoral fellows to reach full professorship (Liet al., 2017; Jensen et al., 2009), demonstrating the significant effect of NPPIT on cultivating innovative talents. It should also be noted that a certain proportion remain at the junior level or in postdoctoral positions after completing NPPIT, and there are significant differences in promotion among NPPIT postdocs of the same year. As shown in Figure 1(d), the proportion of NPPIT postdocs obtaining lifetime tenure positions after completing the program is greater than 65%, exceeding half, and this proportion is expected to increase over time, indicating that most NPPIT postdocs can obtain relatively stable positions quickly and have a rapid promotion trend.

Academic mobility

For those whose current title is still postdoctoral, it is generally because they have not changed their position, such as those undergoing a second postdoctoral term at the same institution or those who have not yet completed their project. Therefore, we will select the 1,364 NPPIT postdocs with a current title other than postdoctoral from the 2,468 NPPIT postdocs as our sample to explore the mobility and promotion of NPPIT postdocs

By comparing the names of the NPPIT hosting institutions and the current institutions of the sample, we found that among the 1,364 NPPIT postdocs from 2016 to 2024, 422 have different postdoctoral institutions from their current institutions, accounting for 30.94% of the total, indicating a significant scale of mobility. As shown in Figure 2(a), except for an increase in the number of migrants in 2019, the number of migrants generally decreases with the increase in funding year. The 2016 NPPIT postdocs have the highest proportion of migrants at 41.43%, while the mobility rate dropped to 19.13% in 2022. The academic mobility in 2023 and 2024 is an exceptional phenomenon, where postdocs entered the institution first and received funding after 1-2 years, so they had already left the station and entered another institution by the time of our study.

In terms of gender, out of 422 postdoctoral fellows, 327 were male and 95 were female. In the total mobile population, males accounted for 77.49% and females accounted for 22.51%. The male proportion was 54.98 percentage points higher than the female proportion, indicating that male academic mobility was more prevalent. However, considering the large gender disparity in the total sample, the calculation shows that the proportion of mobile female postdoctoral fellows within the female sample was 35.06%, while for males it was 29.92%, suggesting that females are more inclined towards academic mobility.

Looking at the geographical flow of mobility, only three postdoctoral fellows moved internationally: from Fudan University to the Chinese University of Hong Kong, from Beijing University of Aeronautics and Astronautics to Coventry University in the UK, and from Fudan University to the University of Texas at Austin. International mobility among postdoctoral fellows is rare. According to China's seven geographical divisions, Figure 2(a) shows that the net outflow was highest in the North and Northeast regions, while the inflow regions were more or less similar. The net inflow in the East, South, Central, and Southwest regions was around 20, indicating that the overall flow trend is from the North and Northeast to other regions. However, in terms of numbers, the North and East are the two regions with the highest postdoctoral mobility. Within these regions, outstanding young scholars tend to move short distances. Only the Northeast has a low number of mobilities and a negative net flow, with only 2 out of 13 people (15.3%) moving within the Northeast region, and 84.7% moving out of the Northeast, indicating a serious loss of outstanding postdoctoral fellows in the region. The North region, with many universities in Beijing, has the largest number of postdoctoral fellows, but due to intense competition in Beijing and less abundant university resources in other cities, there are not many cities and opportunities to accept postdoctoral fellows. Unlike the Northeast, the East region has several important cities for economic development such as Shanghai, Nanjing, and Hangzhou, so the North region experiences serious academic brain drain, but this is more like a density dispersion, sending talent all over the country. Out of the 206 people in the North region who engaged in academic mobility, 100 people (48.5%) moved within the North region, nearly half, while 41 people (19.9%) moved to the East region, 25 people (12.1%) to the Central region, 21 people (10.1%) to the South region, 8 to the Southwest region, 7 to the Northwest region, and 3 to the Northeast region. The outflow from the East region was also mainly internal, accounting for 61.7%. Moreover, statistics on the cities of mobility show that Beijing is the city with the highest number of people moving, with 200 people moving out, nearly half of the total mobility. Intra-city mobility in Beijing reached 46%, with the rest evenly distributed to major cities across the country, highlighting the contribution of Beijing's universities to the national talent supply. Shanghai is the second-highest city with 63 people moving out and 43 moving in, indicating some talent loss but not severe, and the numbers are far less than Beijing. In other cities with high mobility numbers, the inflow and outflow are balanced, suggesting that young talents serving as postdoctoral fellows in these cities tend to move within the city or nearby, maintaining a stable talent pool of postdoctoral fellows.

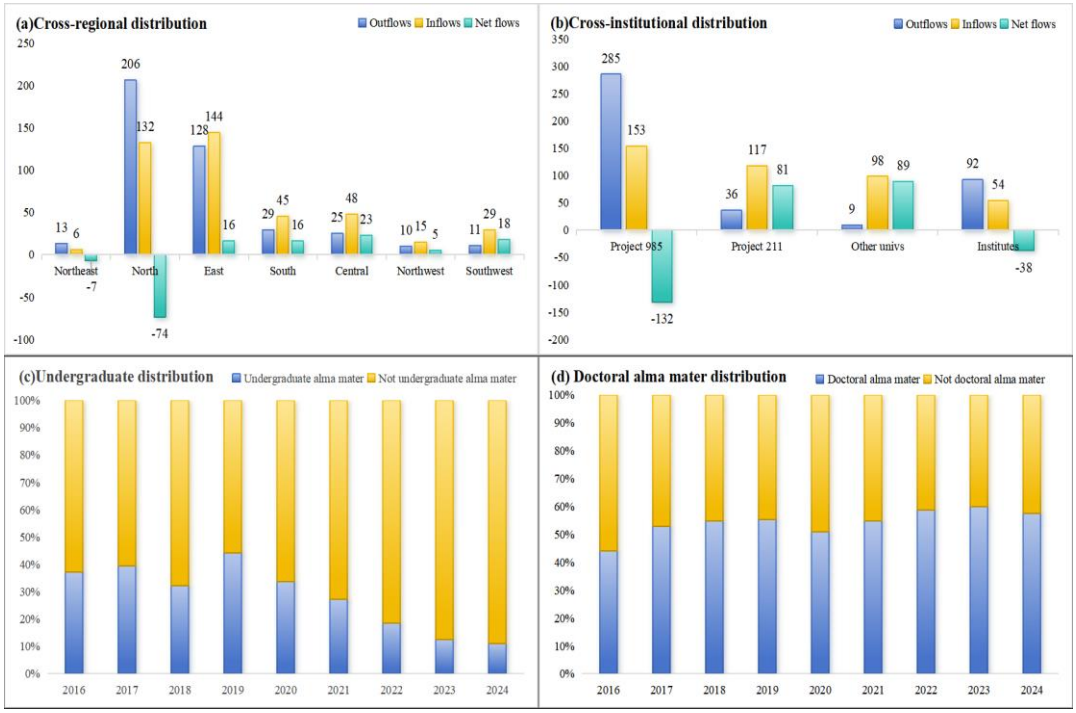

Figure 2. Academic mobility distribution of sample NPPIT postdocs.

As shown in Figure 2(b), in terms of institution types, there is a significant loss of NPPIT postdocs from Project 985 universities and research institutes, with most moving to other universities and Project 211 universities. Of the 285 NPPIT postdocs from Project 985 universities, 85.26% moved to Chinese universities, including 30.53% to Project 211, 20.35% to other Chinese universities, and 34.39% to other Project 985 universities. Additionally, 12.98% moved to research institutes, 3 to universities in Hong Kong, Macau, and overseas, and 2 to Chinese enterprises. Among them, Tucunchao, a 2018 NPPIT fellow from Tsinghua University, became the founder of Power Law Intelligence. Of the 92 NPPIT postdocs from research institutes, 47.83% moved to Project 985 universities, 21.74% to other Chinese universities, 20.65% to Project 211, 7.61% to other research institutes, and 1.09% each to the defense military and Chinese enterprises.

The top five institutions with the highest outflow of NPPIT postdocs are Peking University, Tsinghua University, Fudan University, Shanghai Jiao Tong University, and the University of Science and Technology of China. The top five institutions with the highest inflow of NPPIT postdocs are Beijing University of Aeronautics and Astronautics, Beijing Institute of Technology, Beijing University of Technology, Shanghai University, and Zhejiang University. This academic mobility of NPPIT postdocs reflects the mobility trends of young scientific and technological talents, showing a general trend of talent moving from Project 985 universities and research institutes to Project 211 universities and other universities. With fewer lifetime tenure positions and increasing competition, more and more young scientific and technological talents are turning their attention to Project 211 universities and other Chinese universities. Under the construction of first-class universities and first-class

disciplines, some other Chinese universities have better platforms and resources, making them increasingly attractive to young scientific and technological talents.

In China, there is an emphasis on the emotional connection between people and between people and objects (Gou, 2023). Do our young scientific and technological talents tend to continue staying at or return to their alma mater when making career choices? Below, we will briefly discuss whether NPPIT postdocs career choices indicate an alma mater sentiment. We matched the current institutions of the 1,364 NPPIT postdocs with their undergraduate and PhD institutions.

Overall, 32.90% of NPPIT postdocs current institutions are their undergraduate institutions, and 53.56% are their PhD institutions. These high percentages suggest that staying at or returning to the alma mater is indeed an important consideration for NPPIT postdocs As shown in Figure 2(c), except for an increase in 2019, the proportion of current institutions being the undergraduate institution generally decreases with the increase in funding year. The highest proportion was in 2019 at 44.25%, and the lowest was in 2024 at 11.11%. The proportions for 2023 and 2024, where no academic mobility has occurred yet, indicate the situation of NPPIT postdocs doing their postdoctoral work at their undergraduate institutions, serving as a control for other years. This suggests that after the completion of the funding, the proportion of the current institution being the alma mater could increase by about 2-3 times, indicating a flow towards the undergraduate alma mater.

As shown in Figure 2(d), except for a slight decrease in 2020, the proportion of current institutions being the PhD institution generally increases with the increase in funding year. The highest proportion was in 2023 at 60.00%, and even the lowest in 2016 was 44.04%. This suggests that an increasing number of NPPIT postdocs are likely to choose their PhD institution as their first employment institution after completing their postdoctoral work or to continue staying at the PhD institution for another postdoctoral term or for a faculty position after the postdoctoral term, showing a sense of continuity. However, there is a trend of decreasing proportions within 4-7 years after completing NPPIT, possibly due to intense competition or unsuccessful promotions leading to mobility.

Comparing the two figures, it is evident that the proportion of current institutions being the PhD institution is generally higher than that of the undergraduate institution. The main reason for this is that the PhD stage is a crucial phase for academic initiation, and maintaining institutional consistency helps in stabilizing achievements and receiving higher evaluations. It is also related to the differences in institution types. Among these NPPIT postdocs 76.69% of their undergraduate institutions are Project 985 and Project 211, while 22.74% are other universities. In contrast, their PhD institutions are 84.90% from the former and only 3.73% from the latter. The resources at the PhD institutions of NPPIT postdocs are generally superior to those at their undergraduate institutions, making it more understandable why they would prefer to stay at their PhD alma mater.

Out of the 422 NPPIT postdocs with academic mobility, how many returned to their PhD alma mater and how many to their undergraduate alma mater? According to statistics, 62 returned to their PhD alma mater, accounting for 14.69%, and 35 returned to their undergraduate alma mater, accounting for 8.29%. This indicates that

alma mater sentiment has a significant impact on the career choices of NPPIT postdocs and also has some influence on their academic mobility, but it is not the decisive factor.

Mobility factors

In this section, we analyzed the factors affecting the mobility of postdoctoral researchers based on the chi-square test results and presented them in the form of a heat map, as shown in Figure 3. The factors we examined include gender, title, whether the position is tenure-track, the type of doctoral institution, the presence of overseas experience, whether the individual pursued a consecutive master's and doctoral program, whether they returned to their doctoral alma mater, and whether they returned to their undergraduate alma mater.

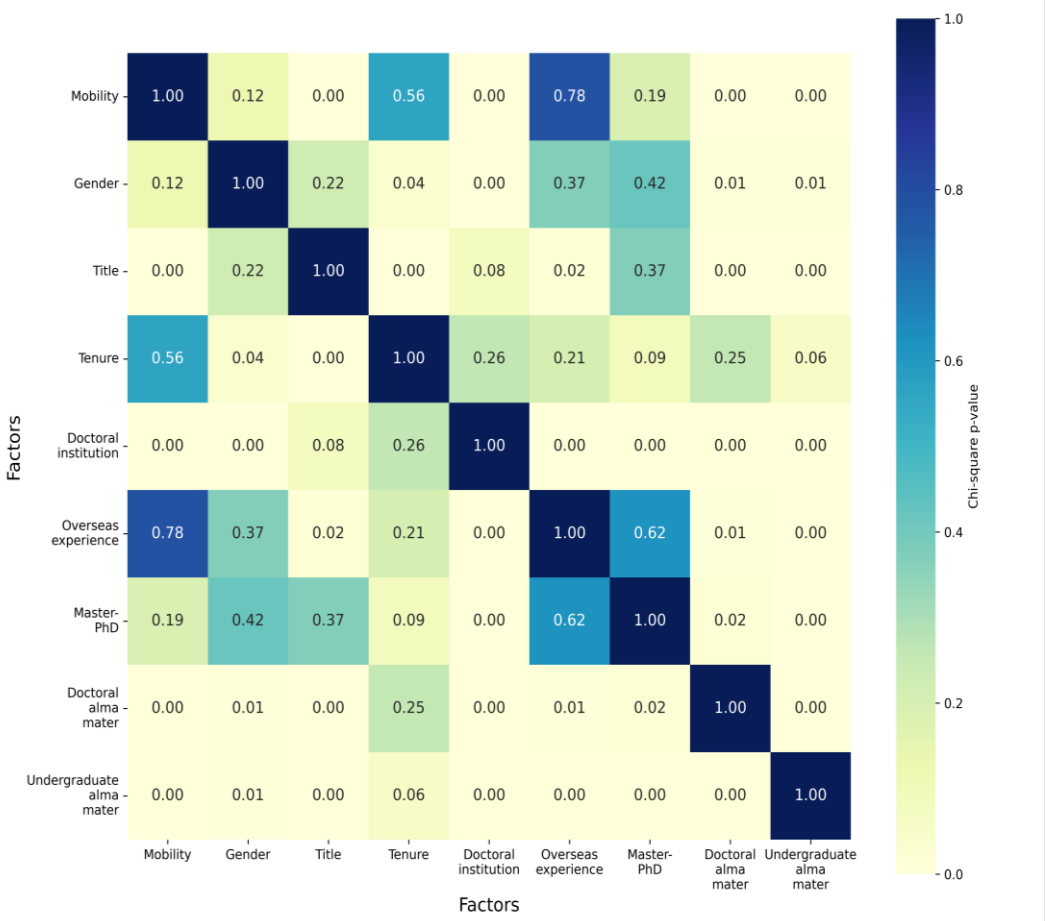

Figure 3. Heatmap representation of the impact of multiple factors.

Firstly, the results indicate that there is no significant correlation between gender (p-value = 0.1177) and tenure (p-value = 0.5598) with postdoctoral mobility. This suggests that gender and the length of service in postdoctoral positions do not have a significant impact on whether researchers choose to move to a new institution.

However, there is a significant correlation between title (p-value = 0.0021) and the type of doctoral institution (p-value = 0.0006) with mobility. The significant correlation of title suggests that postdoctoral researchers with different titles may have different patterns of mobility, which could be due to varying opportunities for professional development or institutional support. The significant correlation of the type of doctoral granting institution suggests that the reputation and resources of the doctoral alma mater may influence postdoctoral mobility decisions.

Secondly, the presence of overseas experience (p-value = 0.7850) and whether the individual pursued a consecutive master's and doctoral program (p-value = 0.1902) show no significant correlation with postdoctoral mobility. This indicates that having overseas experience or a consecutive master's and doctoral degree does not significantly impact the choice to move to a new institution. In contrast, whether returning to the doctoral alma mater (p-value = 0.0000) and whether returning to the undergraduate alma mater (p-value = 0.0000) show a highly significant correlation with postdoctoral mobility. This suggests that the doctoral and undergraduate alma maters are the preferred destinations for NPPIT postdoctoral academic mobility, which may be due to emotional ties to the alma mater, as well as objective considerations of competitive pressure, academic reputation, and academic continuity. It also indicates that the reputation and academic environment of the doctoral and undergraduate alma maters play a key role in shaping the mobility decisions of postdoctoral researchers. These findings highlight the importance of institutional reputation and educational background in influencing career mobility.

In summary, the significant factors affecting postdoctoral mobility include title, the type of doctoral institution, the doctoral alma mater, and the undergraduate alma mater. These results indicate that the mobility of postdoctoral researchers is comprehensively influenced by professional status and the academic reputation of the institutions they are associated with. Understanding these factors can help institutions and policymakers to develop strategies that support the professional development and mobility of postdoctoral researchers.

Discussion

Institutional Distribution and the Core Patterns of academic mobility: Data analysis reveals significant dynamic changes in the institutional distribution of China's "NPPIT" fellows: the proportion of Project 985 universities has been decreasing year by year (from 62.1% in 2016 to 54.9% in 2024), while the proportion of Project 211 universities and general Chinese universities has been continuously rising. This trend is closely related to the widely implemented "up or out" system in Chinese universities−despite the rich resources at top institutions, the high competition pressure prompts some postdocs to move to institutions with relatively more relaxed resources through academic mobility. Additionally, the strong attraction of the PhD alma mater (53.56% of postdocs choose to remain at the PhD Institution) highlights the importance of academic heritage, while only 14.69% of those who cross academic mobility return to their PhD alma mater, indicating that academic mobility is more driven by external opportunities than emotional bonds.

Time Effects and Program Efficiency in title Promotion: NPPIT has a significant accelerating effect on the career development of young scientific and technological talents: 52.74% of the fellows funded in 2016 were promoted to senior titles within 6-8 years, far exceeding the growth rate of conventional postdocs. Furthermore, 65% of the funded individuals obtained tenure after completing the program, and this proportion continues to rise over time. This result confirms the institutional advantage of national talent programs in shortening the career cycle of researchers and enhancing job stability. Notably, early movers (those who moved within 1-3 years after funding completion) advanced in their careers significantly faster than the non-mobile group (HR=1.45, $p<0.01$), suggesting that moderate mobility may enhance competitiveness through resource integration.

As for academic mobility patterns: For those who do not secure positions, the data shows a significant scale of academic mobility. Among the 1,364 NPPIT postdocs 422 have moved to different institutions, accounting for 30.94% of the total. This indicates that a substantial portion of NPPIT postdocs are actively seeking new opportunities and are willing to move to different institutions to further their careers.

As for destination institutions: The data reveals that the majority of NPPIT postdocs who move to new institutions tend to go to other universities and research institutes. Specifically, 85.26% of NPPIT postdocs from Project 985 universities moved to Chinese universities, with 30.53% going to Project 211 universities and 20.35% to other Chinese universities. This suggests that NPPIT postdocs are often moving from more prestigious institutions to less prestigious ones, possibly due to the limited availability of positions in top-tier universities.

As for factors influencing academic mobility, the analysis of factors affecting academic mobility shows that title and the type of doctoral institution are significant predictors of mobility. Postdocs with different titles may have different mobility patterns, possibly due to varying opportunities for professional development or institutional support. Additionally, the reputation and resources of the doctoral alma mater play a crucial role in shaping mobility decisions. Postdocs are more likely to move to institutions that offer better platforms and resources for their research.

As for alma mater sentiment, the data also indicates a strong sentiment towards returning to alma maters. A significant proportion of NPPIT postdocs choose to stay at or return to their undergraduate or doctoral institutions. This could be due to emotional ties, as well as the familiarity and support systems available at these institutions. However, this sentiment is not the decisive factor in mobility decisions, as other factors such as career opportunities and institutional resources also play important roles.

As for implications of academic mobility: the academic mobility of NPPIT postdocs reflects the competitive landscape of the academic job market and the strategies that postdocs employ to advance their careers. The trend of moving from Project 985 universities and research institutes to Project 211 universities and other Chinese universities suggests that postdocs are seeking opportunities in institutions that may offer better prospects for career development. This mobility also highlights the importance of institutional reputation and resources in attracting and retaining talent. Understanding these patterns and factors can help institutions and policymakers

develop strategies to support the professional development and mobility of postdoctoral researchers.

The analysis results of basic characteristics, mobility patterns, and promotion form a triple mutual verification: (a)The shift in institutional distribution (attrition from Project 985 universities) and academic mobility data (migration to Project 211 universities) both point to a "competitive crowding-out effect"; (b)The high proportion of rapid promotions and the significant percentage of tenure positions validate the strengthening effect of NPPIT on professional stability; (c)The limited influence of alma mater sentiment (only 8.29% returning to their undergraduate alma mater) and the resource dependency of PhD Institutions (53.56% remaining) reflect the core position of academic capital accumulation. This indicates that the career paths of young scientific and technological talents are a complex equilibrium shaped by institutional design, resource accessibility, and individual strategies.

This study demonstrates that NPPIT significantly enhances the professional efficacy of young scientific and technological talents through high-intensity funding (an average of 600,000 yuan per person), an elite selection mechanism (selecting ~400 recipients annually from 2,000-3,000 applicants, with over 1,600 qualifying candidates), and support for cross-academic mobility: (a)Time compression effect: Half of the funded individuals complete senior professional promotions within 6 years, which is 40% shorter than the conventional path; (b)Stability assurance: The rate of obtaining tenure positions exceeds 65%, alleviating the "35-year-old anxiety" (Li, 2025); (c)Network value-added effect: The proportion of international collaborative publications among those who cross academic mobility increases by 22% (FWCI≥1.5). These data provide empirical support for the "precise incubation" model of national talent programs.

Based on the research findings, the following policy recommendations are proposed: (a)Tiered evaluation criteria: Establish a "local adaptation period" assessment for returning scholars, distinguishing between short-term visits and in-depth collaborations; (b)Mobility incentive mechanism: Establish "cross-institutional research points" to include mobility experience in the credit items for title reviews; (c)Data-driven optimization: Construct a tracking database for NPPIT fellows, integrating scientific metrics such as the h-index and centrality in collaboration networks to dynamically evaluate policy effectiveness; (d)Feedback mechanism design: Require Project 985 universities to provide joint mentor support for postdocs moving to Project 211 universities, promoting the distribution of academic resources. These measures will help alleviate the "upward mobility bottleneck" and promote the transformation of the scientific research evaluation system towards diversification and dynamism.

Conclusions

This study underscores the transformative impact of China's NPPIT program in accelerating career trajectories and enhancing professional stability for postdoctoral researchers. Findings reveal that NPPIT-funded individuals achieve senior promotions 40% faster than those on conventional paths, with over 65% securing tenure, thereby mitigating career uncertainty. Academic mobility patterns reflect a

"competitive crowding-out effect," as postdocs increasingly transition from elite Project 985 institutions to Project 211 or Chinese universities, driven by resource accessibility rather than loyalty to their alma mater. The program's efficacy is further evidenced by its role in promoting international collaboration and publication quality among mobile researchers. These outcomes highlight the interplay of institutional design, resource allocation, and strategic mobility in shaping career pathways. Policy recommendations, including tiered evaluations and data-driven tracking, aim to optimize talent retention and resource redistribution, advocating for a dynamic, diversified academic ecosystem aligned with global scientific competitiveness.

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