

International Mobility Trends of Chinese Researchers (Postprint)

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Abstract

[Purpose/Significance] Based on the standardization and reconstruction of Chinese researchers' ORCID curricula vitae, this study conducts an in-depth analysis of the trends and characteristics of international mobility among Chinese researchers, providing empirical evidence for national talent policy formulation. [Method/Process] By fully utilizing author affiliation information from scientific literature and employing data mining methods to reconstruct the personal curricula vitae of Chinese researchers, this paper discusses their international mobility trends in depth from perspectives including geographical distribution, mobility patterns, temporal trends, and mobility benefits. [Results/Conclusion] With the advancement of China's scientific and technological innovation capabilities, talent mobility patterns in China have gradually diversified. China and countries along the "Belt and Road" have formed a talent circulation dynamic, with a notable trend of talent return in the past five years, as China welcomes a peak of overseas students returning for employment. However, overall, the phenomenon of brain drain in China remains serious, with weak attractiveness to high-quality talent, primarily manifested in the imbalance between the number of Chinese researchers recruited and those lost, and there is room for improvement in the quality of internal and external talent exchange.

Full Text

A Study on the International Mobility Trends of Chinese Researchers

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Abstract: This study standardizes and reconstructs the ORCID biographies of Chinese researchers to analyze their international mobility trends and characteristics, providing empirical evidence for national talent policy formulation.

By leveraging author affiliation information from scientific publications and employing data mining methods, we reconstruct comprehensive career profiles of Chinese researchers and examine their international mobility patterns from perspectives of geographic distribution, flow patterns, temporal trends, and mobility benefits. Our findings reveal that as China's scientific and technological innovation capacity has improved, researcher mobility patterns have gradually diversified. China has established a talent circulation dynamic with countries along the "Belt and Road" initiative, with a significant talent return trend emerging in the past five years, marking a peak in overseas students returning for employment. However, China continues to face severe brain drain overall, with weak attractiveness to high-quality talent, manifested by an imbalance between the number of researchers recruited and lost, and considerable room for improvement in the quality of both inbound and outbound talent exchanges.

Keywords: Chinese researchers; mobility trends; research biographies; scientific literature

2. Conceptual Definitions

(1) Chinese Researchers. The primary subjects of this study refer to researchers who have educational or professional experience in China, comprising two groups: researchers of Chinese nationality who have studied or worked in China, either currently or previously; and foreign researchers who have studied or worked in China, either currently or previously. This study collectively refers to both groups as Chinese researchers.

(2) Researcher Mobility. In this study, researcher mobility refers to the process of researchers transferring from one institution to another through academic advancement or career changes. International mobility indicates that the countries affiliated with the institutions before and after the move differ. Currently, researcher mobility can be categorized into three types based on flow patterns: brain return, brain circulation, and brain drain. Brain return describes researchers who move abroad and subsequently return to their home country for specific reasons. Brain circulation refers to complex bidirectional or multidirectional flows of researchers across multiple countries [1]. Brain drain denotes the unidirectional and permanent flow of highly skilled individuals from less developed to more developed regions [2]. In this paper, researcher loss refers to internationally mobile researchers who leave their home country and ultimately settle in another country, representing a net loss of talent for the home country.

3. Literature Review

3.1 Research Methods for Analyzing Researcher Mobility

Curriculum vitae (CV) analysis is a crucial approach for studying and evaluating researcher mobility trends and academic achievements, widely adopted in cur-

rent domestic and international research. The earliest CV analysis project was Georgia Tech's Research Value Mapping initiative, which assessed researchers' academic contributions across different institutions by analyzing their CVs [3]. A key challenge in CV analysis is obtaining researchers' biographical data. Early studies relied on email surveys [4] and interviews [5], which proved highly limited for large-scale mobility research. With the widespread adoption of Open Researcher and Contributor ID (ORCID), utilizing ORCID to study researcher mobility has become a prominent trend. J. Youtie et al. examined the applicability of ORCID identifiers for tracking talent mobility, suggesting that ORCID's potential for mobility research would grow with increasing user adoption [6]. G. Bohannon analyzed the ORCID profiles of three million researchers, demonstrating ORCID's effectiveness for mobility analysis [7]. Comparative studies analyzing the suitability of Author ID, ResearcherID, and ORCID for tracking scientists' international mobility found ORCID superior for identifying international migration, though data incompleteness in ORCID can affect research accuracy [8]. Primary causes of ORCID data gaps include infrequent updates and researchers merely registering accounts without maintaining their profiles.

3.2 International Mobility Trends of Researchers

As global integration advances, researcher mobility patterns have grown increasingly diverse and complex [17], manifesting in three primary modes: Brain return. The main returnees are overseas students. European countries such as Spain and Greece have shown significant return tendencies over the past decade [18], and Asian researchers who earned doctorates in developed countries like the US and Europe also demonstrate clear return trends [19]. Brain circulation. This primarily involves developing countries like China gradually shifting from unidirectional brain drain to bidirectional talent circulation with developed countries [20]. N. Robinson-Garcia et al. found that returnees constitute the largest proportion among mobile researchers [21]. Brain drain. Since the 1960s, brain drain has been a major pattern of international researcher mobility. G. Laudel discovered that among 1,523 ISI highly-cited scholars, 31.9% had different countries of birth and residence, with three-quarters moving to the United States [22]. Brain drain occurs through cross-border employment and students not returning after graduation [23]. Early research indicated that students from developing countries prefer to remain in developed countries after obtaining degrees [24]. Chinese scholar Ni Pengfei et al. note that brain drain now challenges all nations, particularly developing countries [25].

In terms of geographic distribution, the primary flow direction is from developing to developed countries, with major clusters in the US and northern European nations [10]. The US has long held a dominant position in global talent competition as the primary destination for researcher mobility [11-13]. The trend of Chinese researchers flowing to the US is particularly pronounced among highly-cited researchers and students. Analysis of 233 Chinese highly-cited authors in the ESI database revealed that they mainly originate from the US, UK, China, Singa-

pore, and Switzerland [14]. Some scholars have even suggested that China's Peking University and Tsinghua University serve as training bases for American doctoral programs [15]. Since the 21st century, as China's scientific and technological innovation capacity has strengthened, its attractiveness to researchers has increased significantly. UNESCO student mobility data (2000-2015) shows that the global center of student mobility has gradually shifted eastward, with China becoming a major destination for international students [16].

3.3 Impact of International Mobility on Researchers

International researcher mobility facilitates the dissemination of scientific knowledge and technology, benefiting innovation in both origin and destination countries. It also impacts researchers' scientific capacity in two ways: Research productivity. Mobile researchers publish more papers than non-mobile researchers [26]. M. Fontes' analysis of Portuguese scientists found that mobility increases research output [27], and G. Scellato et al. confirmed that international mobility promotes research innovation [28]. Academic influence. B. Bozeman used journal impact factors to verify that international mobility enhances researchers' academic influence [29]. Chinese scholar Huang Haigang empirically demonstrated that Chinese researchers with overseas experience publish higher-quality papers [30].

4. Research Design

4.1 Research Approach

ORCID has alleviated challenges in literature retrieval, author name disambiguation, and CV data acquisition for talent recruitment. However, ORCID's operational mechanisms often result in incomplete and inaccurate profiles, affecting research validity. To leverage ORCID's rich registration data for analyzing Chinese researchers' international mobility, this study comprises two phases: In the CV construction phase, we standardize ORCID profile content using rule-based and machine learning methods, then supplement and update incomplete ORCID profiles with author information from published academic papers to achieve CV reconstruction. Through analysis of international mobility aggregation patterns, we summarize characteristics of Chinese researchers' mobility to provide empirical support for China's medium- and long-term talent policy formulation.

4.2 Data Sources

(1) **ORCID Dataset.** ORCID [31], launched in November 2009 at a summit convened by Thomson Reuters and Nature Publishing Group, addresses author name ambiguity in academia. Researchers can voluntarily provide personal information, educational experience, employment history, publications, and funding details during registration. We obtained all ORCID accounts registered before January 1, 2019, extracting 127,578 accounts belonging to researchers

with at least one educational or professional experience in China to construct a Chinese researcher CV dataset.

(2) Web of Science Publication Data. Considering data completeness and accessibility, we sourced publication data from the Web of Science citation database. On August 26, 2019, we retrieved 619,339 publications by these 127,578 researchers from the Web of Science Core Collection without time restrictions.

(3) Institutional Name Data. Employment histories in ORCID profiles are self-reported, leading to varied institutional name formats due to differences in country, educational background, and writing conventions. To standardize institutional names, we integrated data from the Global Research Identifier Database (GRID), Wikipedia, and Web of Science’s “Enhanced Organization Information List” to create a standardized institutional name dataset.

4.3 Chinese Researcher CV Construction

The CV construction process consists of three steps, as shown in Figure 1 [Figure 1: see original paper]. The core challenge addressed in this phase is standardizing institutional names in researcher CVs to prevent construction errors caused by different name formats for the same institution.

(1) Data Preprocessing. To improve ORCID profile accuracy and standardization, we unified all profile languages to English. We cleaned spelling errors, partial abbreviations, and meaningless strings or numbers using automated methods supplemented by manual review, then performed part-of-speech tagging for subsequent institutional name standardization.

(2) Institutional Name Standardization. We combined rule-based and machine learning methods to identify institutional name hierarchies based on name structure and word parts of speech, retaining only top-level institutions (e.g., converting “Wuhan University School of Stomatology” to “Wuhan University”). We then integrated multiple institutional name datasets using rule-based methods to match and identify different name formats for the same institution in ORCID profiles. For names that could not be standardized through rules or external data, we applied machine learning clustering. Specifically, we first clustered city names under identical country abbreviations to generate city categories, then applied DBSCAN algorithm to cluster institutional names within each city cluster.

(3) Chinese Researcher CV Reconstruction. To address incomplete profiles due to infrequent ORCID updates [32], we extracted author information from publications to supplement and update ORCID profiles, reconstructing CVs across temporal and employment sequence dimensions. The primary strategy involved matching institutional names from author addresses in publications with standardized names in ORCID profiles using rule-based methods. The final reconstructed CVs include researchers’ countries, cities, institutions,

employment periods, publication counts, and citation counts for each career stage.

5. Research Findings

5.1 Geographic Distribution of Chinese Researcher Mobility

Using the location of researchers' first career stage as their origin country, we analyzed the recruitment and loss of researchers from China. Between 1955 and 2019, 21,563 researchers left China for other countries (origin China, final destination another country), distributed across 103 countries on five continents. Overall, the geographic distribution of Chinese researcher loss is uneven, with destinations concentrated in developed regions of North America, Europe, and Oceania (see Figure 2 [Figure 2: see original paper]). The US receives the largest number of Chinese researchers (11,331, accounting for 52.5% of total outflows). Europe is the second major destination, with the UK receiving 8.3% of Chinese outflows. Additionally, BRICS countries have become a second-tier mobility destination for Chinese researchers. Russia and India recruit more Chinese researchers than Brazil and South Africa (1.5 times higher), while South Africa accounts for 20.8% of Chinese researchers in Africa, and Brazil accounts for one-third of Chinese researchers in South America. Under the Belt and Road initiative, researcher inflows from participating countries to China have become significant, with 46 such countries sending researchers to China, representing 27% of China's total researcher recruitment. Although China remains at a disadvantage in talent competition with developed countries (see Figure 2), it leads in attracting talent from Belt and Road countries. Pakistan ranks second globally in sending researchers to China, with China recruiting five times more researchers from Pakistan than it loses to Pakistan (see Figure 5 [Figure 5: see original paper]).

5.2 Analysis of Chinese Researcher Mobility Pathways

(1) Mobility Pathway Identification. Among 39,569 researchers with international mobility experience, we identified six mobility patterns, as shown in Table 1. In the table, A represents the origin country, B represents the first destination country, and {C} represents the set of other countries visited (non-empty). Patterns I and II represent unidirectional flows. Patterns I, II, V, and VI constitute brain drain for the origin country, while patterns III, IV, V, and VI involve brain return.

Between 1955 and 2019, China lost 21,563 researchers while recruiting 5,986 from abroad—a 3.6:1 ratio. Researchers returning after one international move outnumbered those returning after multiple moves by 4.86 times, indicating that return intentions decrease after multiple international relocations. Patterns V and VI represent returnees who left again, with popular pathways including “China→US→China→US,” “China→UK→China→UK,” and “US→China→US→China,” reflecting circular mobility between China and

developed countries. Among researchers circulating between China and the US, six times more ultimately remained in the US than in China, suggesting Chinese researchers with US experience strongly prefer to stay.

(2) Return Trend Analysis. As science and technology advance and global dynamics shift, return trends among Chinese researchers have become increasingly prominent. Figure 4 [Figure 4: see original paper] shows return trends from 1968-2018. Overall, return flows have grown alongside expanding international mobility scale. Return rates exhibit cyclical patterns: Phase 1 (1980-1994) saw steady growth post-1949, with return rates increasing 1.8-fold over 15 years. Phase 2 (1995-2007) featured policy incentives encouraging overseas students to return, with annual return rates exceeding 28% and rapid growth, marking a “sea turtle” wave. Phase 3 (2008-present) shows consistently high return rates as China’s comprehensive national strength continues to grow.

Researchers with return experience account for 32.8% of all internationally mobile Chinese researchers. Among the top 10 mobility pathways (see Table 2), eight involve returns from developed countries to China, indicating a significant return trend. The US contributes the most returnees (33.3% of total returns), with 1,516 Chinese students returning after obtaining US degrees (in our sample), representing China’s new generation of scientific and technological innovators. Among US-China returnees, 44.9% moved from the US to China for employment changes, while only 16% returned after earning US degrees, suggesting distinct mobility purposes: Chinese researchers tend to study abroad then return to work, while Western researchers prefer local education.

5.3 Evolution of Chinese Researcher Mobility Trends

We analyzed changes in Chinese researcher recruitment and outflow across four periods: pre-1989, 1990-1999, 2000-2009, and 2010-present. To facilitate analysis, we selected the four most frequent mobility countries from each continent (with only Australia and New Zealand represented from Oceania). Figure 5 [Figure 5: see original paper] shows the dynamic balance between researchers recruited from China and those lost to each country from 1961-2018, with each subplot representing one country’s talent exchange with China. For example, the US subplot shows a total flow of 10,044 person-times, with the bar chart indicating the balance across the defined periods.

Developed countries in North America and Europe maintain long-term advantages in global talent competition. Chinese outflows to European countries reached 8,423 person-times, double the outflows to Asian countries, yet European inflows to China were 25.8% lower than Asian inflows, placing China at a disadvantage in recruiting European talent. Within Asia, Japan and Singapore have been popular destinations for Chinese researchers over the past 30 years. Except for small talent surpluses with Singapore and New Zealand before 1989, most Chinese researchers have flowed to major developed countries.

Over the past decade, China has significantly increased researcher recruitment.

First, China's attractiveness to Africa, South America, and developing Asian regions has risen, with inflows from these regions accounting for 12.7% of total recruitment. Since 2000, Pakistan and India have sent far more researchers to China than they recruit from China. Second, China has gradually gained advantages in talent competition with developed countries, with recruitment growth rates surpassing those of Europe and the US post-2000, gradually escaping the unidirectional outflow 困境. However, brain drain remains severe, with outflows to Europe and North America still exceeding inflows over the past decade—2.28 times more Chinese researchers flow to the US, UK, Germany, Sweden, and New Zealand than are recruited from these countries.

5.4 Academic Impact Comparison of Internationally Mobile Chinese Researchers

When assessing China's talent attractiveness, quality matters as much as quantity. Publications represent researchers' primary work output, and citation counts reflect academic influence. We selected the top five countries recruiting Chinese researchers and the top five countries sending researchers to China, comparing average citation counts of papers by researchers moving in each direction (see Table 3).

Overall, Chinese researchers who emigrated have higher average citation counts than those recruited to China. Among the ten countries analyzed, only Australia, Nigeria, and India show higher citation counts for researchers flowing into China than for those China recruits. Chinese outflows to the US, UK, Canada, Germany, and Pakistan exhibit significantly higher per-paper citation rates than corresponding inflows.

6. Conclusions and Implications

6.1 Research Conclusions

Unlike previous studies focusing on specific groups such as high-level talent [1], international students [16], or university faculty [33], this study combines scientific literature attributes to update the ORCID profiles of 127,578 Chinese researchers. Analyzing mobility patterns from geographic, modal, and temporal perspectives, we comprehensively examined international mobility trends and their impact on researchers' academic performance. Key findings include:

- (1) **Brain drain remains severe, with weak attractiveness to high-quality talent.** The US continues to be the ultimate destination for global talent flows [29-30]. Our data confirms the concentration of Chinese researchers in developed countries, with 22% of internationally mobile Chinese researchers studying in the US. Economic conditions, academic environments, and living standards are primary drivers [34], along with developed countries' talent policies. US visa policies strongly support attracting global professionals, and technical immigration policies in Aus-

tralia (6.6% of Chinese recruits) and Canada (4%) also attract substantial high-level talent.

- (2) **Diversifying mobility patterns and a wave of returning students.** China's rapid economic growth has slowed unidirectional outflows to developed countries, with brain return and circulation emerging. Under the Belt and Road initiative, deepening political, economic, and cultural exchanges have increased researcher inflows from participating countries [35]. Our study finds that as the initiative progresses, the scale and number of researchers flowing from these countries to China continue to grow. Regarding brain return, Gao Ziping's survey of 1,132 overseas Chinese researchers found that 68.9% wished to return [36], a trend our data confirms. Returnees account for one-third of all mobile researchers, primarily overseas students. This return wave is closely linked to China's favorable talent policies.
- (3) **China needs to enhance attractiveness to international high-level researchers and urgently prevent domestic talent loss.** Existing studies measure national talent attractiveness using only recruitment and loss numbers, ignoring individual academic differences [26]. We compared the academic levels of researchers China loses versus recruits. Statistics show that emigrating researchers generally have higher average academic impact than those recruited, indicating China's disadvantage in competing for high-impact scholars. This suggests that recruitment efficiency should focus on quality, not just quantity. While intensifying efforts to recruit high-level researchers, China must also address the loss of its existing top talent.

6.2 Implications and Recommendations

- (1) **Improve China's talent system to achieve a "cultivation-utilization" 闭环 and slow brain drain.** As scientific globalization accelerates, international mobility and brain circulation have become prominent. Our findings show expanding overseas student populations and severe loss of high-level researchers, posing major challenges for talent cultivation and management. First, under the 14th Five-Year Plan, China should further optimize its education system to strengthen innovative and applied talent cultivation. To address high outflows at master's and doctoral levels, China should improve graduate training quality while accelerating targeted cultivation of urgently needed specialists. Simultaneously, China should encourage overseas students to return after graduation by establishing green channels and eliminating concerns about returning. Second, in talent management, China should integrate recruitment and utilization through incentive evaluation systems to stimulate researchers' enthusiasm and ensure they can fully apply their talents.

- (2) **Guide rational and orderly researcher mobility amid “de-establishment” reforms.** In global integration, international researcher mobility is inevitable and promotes tacit knowledge transfer. As “de-establishment” reforms continue, researcher mobility frequency has increased. While mobility drives innovation in both origin and destination countries, excessive unreasonable mobility affects work continuity and efficiency. We find Chinese researchers tend to flow to developed countries, with a significant “Matthew effect” and severe imbalance between recruitment and loss. China should learn from developed countries’ experiences, build an open and inclusive recruitment system, implement value-oriented incentive policies, and improve compensation, benefits, and social security to enhance attractiveness and achieve the goal of “recruiting, utilizing, and retaining” talent.
- (3) **Focus on high-quality talent recruitment and explore new recruitment models.** The “innovation-driven development” strategy has heightened demand for high-end scientific talent. However, China still faces brain drain and shortages of high-level researchers, with information asymmetry in recruitment: international high-level talent lacks timely, comprehensive information about Chinese institutions, while Chinese institutions struggle to fully assess candidates’ true academic levels, leading to mismatched compensation and capabilities, and uneven quality among recruited researchers. Therefore, China should prioritize recruitment quality, break the rigid “quantity-only” mindset, and achieve high-quality talent acquisition. China should also explore diversified recruitment models, including joint R&D projects and collaborative proposals. Particularly in the post-pandemic era, China should implement improved recruitment systems, streamlined processes, and favorable conditions to truly “gather talents from around the world for our use.”

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Note: Figure translations are in progress. See original paper for figures.

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