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Exploration of a scientific career development: case of Kazakhstan

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Abstract

The article examines academic career trajectories, highlighting the evolving dynamics between academia and industry. The findings indicate that intrinsic factors, such as motivation and personal aspirations, are complemented by external influences, including financial incentives, mentorship, and institutional support. The use of a quantitative survey was justified by the necessity for statistical analysis of the relationships between career development variables and influencing factors, ensuring empirical rigor. The quantitative approach was complemented by providing a balanced summary representative of the targeted academic population. The study identifies three main dimensions affecting career trajectories: economic and institutional factors, personal and sociocultural motivators, and academic pressures. An understanding of the complex interplay of these factors is crucial for developing supportive policies and practices that accommodate the diverse career aspirations of scholars, fostering an environment capable of sustaining scientific innovation and growth.

Keywords: scientific career, career choice, academic environment, career trajectory, motivation.

Introduction

The development of a scientific career has been studied for many decades. The commitment level of scientists to a specific research area demonstrates a high level of competence and knowledge in a particular area; therefore, it requires persistence and long-term contribution to the field. A career in science depends on a variety of factors that include individual, organizational, and external factors, depending on policies in a particular country. In this regard, the context of a country that will contribute to the career trajectory becomes critical in either enhancing career development in academia in particular or impacting fresh PhD graduates or junior researchers to seek careers outside academia. Exploration of various factors linked to career success and general market demand, and the development of economy in a particular area and country are also contributors to career development.

The evolution of scientific careers over recent years has been marked by significant shifts driven by multifaceted influences ranging from personal aspirations to global economic trends. This paper seeks to delve into the complexities of career development in the scientific field, exploring how various external and intrinsic factors contribute to shaping the career choices of today's researchers. The analysis of the literature suggests a comprehensive understanding of the scientific career choices and their development.

Career choices have external factors that create them from the policy-making perspective and externalities that contribute to career development, as well as intrinsic related to socio-cultural factors, motivational factors and personal factors. The trajectory of scientific careers is increasingly influenced by a complex array of factors beyond the traditional academic pathway.

We explore the analysis of scientific career choices through the perspective of several key factors that create a comprehensive understanding of the study.

Historically, careers in science were largely academic, with a clear trajectory towards tenure-track positions. However, recent trends show a shift towards more diversified career paths, including industry, government, and non-profit sectors. This shift is driven by both an oversupply of PhD graduates and a mismatch between doctoral training and the evolving needs of the job market (Walters et al., 2020; Seo et al.,

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2020). Akhmetova et al. (2020) discuss the systemic transformations within the Russian scientific establishment, including the reorganization of the Russian Academy of Sciences and the shift from fundamental to applied research focuses. These structural changes directly impact young scientists by altering career trajectories and influencing the choice between academic and industry positions, potentially leading to a crisis in the reproduction of scientific personnel.

It is important to understand that the development of a scientific career depends a lot on the field of study and the relevance of the skills obtained to the job market. While STEM fields traditionally offer more direct pathways into industry, leading to potentially more lucrative opportunities outside academia, social sciences and humanities PhDs often face more significant challenges due to limited non-academic opportunities (Walters et al., 2020). The recent technological advancement has created a lot of STEM jobs outside academia where skills and knowledge obtained through PhD programs and a scientific career are relevant and essential for success in the industry.

Another important factor contributing to the career path choices is related to economic and institutional factors. Flexibility offered by academic jobs is not comparable with industry jobs to the more rigid corporate environment. According to Etmanski et al. (2017), job market changes had forced temporary and flexible academic labor over full-time positions. However, this might only be a case where personal life choices and expectations from the career development are aligned. The lack of mentorship and institutional support can lead to dissatisfaction and underemployment, impacting the long-term sustainability of scientific careers.

Support system itself that is created for scientific career development has a major role in young talent development and retention of scientists in academia after completion of academic programs on a graduate level. Science capital (science-related social and cultural capital) and family habitus significantly influence STEM career decisions among youth (Nugent et al., 2015; Jones et al., 2020). Mentorship and institutional support play crucial roles in shaping career paths. Effective guidance can steer graduates towards fulfilling careers inside or outside academia. However, a lack of support and mentorship can lead to career dissatisfaction and underemployment (Seo et al., 2020). This might have a negative impact on sustaining scientific directions in particular laboratories, academic institution, and long-term impact might have a challenge in contributing to the knowledge development. Youtie et al. (2013) argues that fast promotion within academia is a strong predictor of recognition both in Europe and the U.S.

Gender inequality and marital status have various influences on any career. However, in academia and science often encounter significant barriers, including work-life balance and institutional biases, which may deter them from pursuing tenure-track positions. This creates a gap in gender equality and presence in science. According to Seo et al. (2020), married graduates, particularly those with supportive partners, are more likely to pursue stable, long-term careers in academia. Carpes et al. (2022) define the systemic barriers that exacerbate gender disparities in science, such as the prolonged productivity impacts post-childbirth and institutional biases that hinder career advancement for female scientists.

Sustaining of scientific career is a major factor that is emphasized by the role of publication pressures and funding challenges in shaping and sustaining scientific careers (Kwiek, 2022).

Moreover, there is evidence of gender bias in scientific awards and recognition, with men winning a higher proportion of awards for scholarly research than women, relative to their representation in the nomination pool (Lincoln et al., 2012).

Allenov et al. (2021) highlight how factors, such as aging, cognitive load, and emotional stress, compounded by socio-economic variables like job satisfaction, career growth, and educational opportunities, influence professional longevity and success. These factors are further complicated by challenges in maintaining work-life balance and navigating institutional hierarchies.

However, career path dependence is a factor that needs to be considered. The literature suggests that choice and academic path after graduating with a PhD depends on several factors, one of them being competencies obtained at a doctoral level: general and transferable skills, analytical skills, and problem-solving capabilities (Lee et al., 2010). The competencies allow individuals either to launch a career in a specific industry or continue their academic path after graduating with a PhD degree from a university. Canolle (2021) has studied the PhD holders who did not choose the academic path and work in companies. The findings demonstrate epistemic work carried out by doctoral students later contributes to their knowledge and skills acquisition. An important factor that contributes to a career path in academia is linked to conditions that have been developed and nurtured at the early stage of career development as it affects career structure, success and failures that influence academic career. Norkus et al. (2016) studied the German context for young career researchers, where the context of academic career is highly competitive and where availability of external funding in projects contributes positively to research career. Independence and individual creativity become contributors to the ability of scientists to contribute to a specific research field. In this regard PhD student and supervisor relationship becomes extremely important in building independence and, at the same time, skills for the future career trajectory of a PhD holder (Parsali et al., 2024).

The need to publish regularly and frequently to secure research funding, career promotion might have a negative impact on an interest early-career researchers, given the pressure that exists in academia towards shifting career trajectory for industry positions, where the pressure may be perceived as less intense and the rewards more immediate. The highest-impact work in a scientist's career can occur at any time, influenced by productivity, luck, and an inherent quality unique to each scientist (Sinatra et al., 2016). This challenges the notion that major accomplishments only happen after long periods of work in the field.

The contemporary landscape of scientific careers is increasingly shaped by a myriad of both intrinsic and external factors that extend well beyond the traditional academic paths. The shifting dynamics in career trajectories are influenced by an oversupply of PhD graduates and the evolving needs of the job market, leading to a diversification into industry, government, and non-profit sectors alongside traditional academic roles.

Recent structural transformations, such as those within the scientific community, underscore a move from fundamental to applied research, directly affecting young scientists' career choices between academia and industry. This shift is further exemplified by the growing emphasis on STEM fields, where technological advancements have created new opportunities outside academia, making skills acquired through PhD programs highly relevant and sought after in various industries.

Understanding the complex interplay of these factors is crucial for developing supportive policies and practices that accommodate the diverse career aspirations of modern scientists, thereby fostering a robust environment that can sustain scientific innovation and growth (Painsi et al., 2025).

Despite extensive research on factors influencing academic career choices, limited studies have comprehensively explored the intersection of intrinsic and extrinsic motivators across gender and age groups at different career stages. Moreover, the role of institutional support, including mentorship and leadership, remains underexplored in diverse contexts. Finally, there is a lack of clarity on how financial incentives, social environments, and training opportunities collectively shape long-term career trajectories in academia. The context of Central Asia and post-Soviet legacy has its impact on scientific career choices and drivers of career choices inside or outside academia.

The literature review identified a set of key factors influencing the choice and development of an academic career. These include subjective motivations (such as interest in science, the status of a scientist, work flexibility, etc.), institutional support at the university, supervisor influence, financial and administrative support, as well as factors related to career success and international collaboration (Table 1).

Table 1. Conceptual Definitions of Scientific Career Factors

Category	Definition	Sources
Subjective Factors	Internal motivations and personal circumstances that influence the decision to pursue an academic career, including early interest in science, perceived prestige and income potential of the profession, family and social influence, flexibility of academic work, and lack of alternative employment opportunities	(Walters et al., 2020; Seo et al., 2020; Nugent et al., 2015; Etmanski et al., 2017)
Support at the University	Institutional and educational assistance provided during higher education, such as mentorship by faculty and access to scholarships for graduate and doctoral programs, which facilitate entry and retention in the academic path	(Jones et al., 2020; Seo et al., 2020; Youtie et al., 2013; Norkus et al., 2016)
Supervisor Influence	The academic, motivational, and professional support provided by a scientific supervisor, encompassing feedback, accessibility, role modeling, and facilitation of academic and career networks	(Parsali et al., 2024; Canolle, 2021; Lee et al., 2010)
Financial Support	Monetary resources that enable individuals to pursue and sustain an academic trajectory, including scholarships, stipends, postdoctoral funding, paid internships, and salaries from research projects or academic positions	(Akhmetova et al., 2020; Norkus et al., 2016; Walters et al., 2020; Allenov et al., 2021)

Continuation of the table 1

Category	Definition	Sources

Administrative Support	Organizational backing from institutional leadership and peers, including managerial and collegial support structures that foster teamwork, career development, and a productive research environment	(Carpes et al., 2022; Lincoln et al., 2012; Allenov et al., 2021)
Career Success	The realization of professional goals in science, expressed through the choice of a scientific career, contribution to research advancement, and participation in international scientific collaborations	(Kwiek, 2022; Sinatra et al., 2016; Canolle, 2021; Seo et al., 2020)
Note – compiled by authors based on the sources		

Based on the above-mentioned factors we have identified that supporting and external factors play a crucial role in ensuring that academics strive in their career. The following research questions were identified.

Research Questions:

(1) How do intrinsic and extrinsic factors influencing the choice of a scientific career differ across gender and age groups at various stages of career progression?

(2) How does support from scientific supervisors and organizational leadership influence the choice of an academic career?

(3) How do external factors, such as financial incentives, social environment, and work flexibility, affect the decision to pursue an academic career?

(4) What is the role of scholarships, internships, and training opportunities in motivating individuals to choose an academic career?

Hypotheses:

(1) There are differences among the factors influencing the choice of an academic career based on gender and age.

(2) Support from scientific supervisors and organizational leadership significantly influences the choice of an academic career.

(3) External factors, including financial incentives, social environment, and work flexibility, have a significant impact on academic career decisions.

(4) Access to scholarships, internships, and training programs positively correlates with the likelihood of pursuing an academic career.

Methodology

The survey method was employed to quantitatively investigate the academic career trajectories and the factors influencing them. This approach facilitated the systematic collection of data from a large sample of scholars, providing a comprehensive overview of career-related experiences and perceptions. The survey instrument was designed to include a range of question types, both closed-ended for quantitative analysis and open-ended for qualitative insights. This approach aligns with recommendations for applying quantitative analysis in studies of professional and career trajectories. The survey instrument was developed following a comprehensive review of existing literature on academic careers and influential factors, ensuring that all pertinent variables were incorporated.

The questionnaire included the following structured items grouped into six main factors and corresponding subitems: Subjective Factors (e.g., interest in science since school, high status and salary of scientists, influence of family, flexible work, and lack of industry opportunities); Support at the University (e.g., academic support during studies, scholarships for Master's and doctoral programs); Supervisor Influence (e.g., supervisor feedback, motivation, accessibility, and assistance in networking); Financial Support (e.g., stipends, postdoctoral programs, internships, grants, and salaries); Administrative Support (e.g., leadership and collegial support, teamwork in research groups); and Career Success (e.g., choice of a scientific career, research contributions, and international collaboration). Descriptive statistics for each factor are presented in the Appendix (Table 1).

The survey underwent pre-testing with a pilot group of scholars to evaluate clarity, relevance, and reliability. This process ensured that the questions were comprehensible and that the survey collected data consistent with the study's objectives. The pilot survey comprised 21 participants, of whom 16 were female, constituting 76.2 % of the total, and 5 were male, representing 23.8 %. The predominant age groups were 31–39 and 40–49, collectively accounting for more than half of the participants.

To assess the internal consistency of the proposed constructs, Cronbach's alpha coefficients were calculated for each factor and its subitems (Table 2). The reliability indices indicate acceptable to excellent internal consistency: Subjective Factors (α = 0.831), Support at the University (α = 0.800), Supervisor

Influence (α = 0.953), Financial Support (α = 0.941), Administrative Support (α = 0.888), and Career Success (α = 0.615). The overall reliability analysis indicated a high level of internal consistency, with a Cronbach's alpha coefficient of 0.852.

Table 2. Internal Consistency of Factors and Subfactors Based on Cronbach's Alpha

Factors	Overall Cronbach's Alpha	Subfactors	Cronbach's Alpha if Item Deleted
1	2	3	4
Subjective Factors	0,831	A.1 Interest in science since school and/or university	0,811
		A.1 High status of a scientist	0,795
		A.1 High salary	0,829
		A.1 Flexible working hours and ability to combine work with childcare	0,834
		A.1 Influence of scientist parents	0,841
		A.1 Influence of environment	0,809
		A.1 Lack of vacancies in the industry job market	0,805
		A.1 Established scientific groundwork for academic career	0,814
		A.1 Promotion opportunities	0,802
		A.1 Coincidence	0,804
Support at the University	0,8	A2 Support from teachers during studies and subsequent employment at the university	0,904
		A2 Scholarship for Master's studies	0,603
		A2 Scholarship for doctoral studies	0,578
Supervisor Influence	0,953	B1 Feedback (advice, comments, reviews) from the supervisor	0,929
		B1 Motivational personality model of the supervisor	0,938
		B1 Accessibility of the supervisor for guidance	0,94
		B1 Assistance of the supervisor in academic and professional networking	0,949
Financial Support	0,941	B2 Scholarship for Master's studies	0,936
		B2 Scholarship for doctoral studies	0,916
		B2 Postdoctoral programs	0,929
		B2 Research internships	0,928
		B2 Grant projects, programs	0,928
		B2 Salary	0,939
Administrative Support	0,888	B3 Support from the head of the organization/department	0,863
		B3 Support from the head of the unit	0,903
		B3 Support from colleagues	0,812
		B3 Teamwork within the research group	0,832
Career Success	0,615	C.1 Choosing a scientific career	0,497
		C.2 Contribution to science development through research projects	0,526
		C.3 International collaboration (joint publications, project implementation)	0,531
Note – compiled by authors based on the sources			

The sample for the survey of scholars was constructed based on socio-demographic characteristics (gender, age) and research field. According to the Bureau of National Statistics of Kazakhstan, the distribution of research specialists by gender is 46 % male and 54 % female, proportions that are reflected in our sample. The survey encompassed 288 participants, with men comprising 46 % (132 individuals) and women 54 % (156 individuals). The largest proportion of respondents falls within the 35–44 age group (27 %), followed by the 25–34 group (25.2 %) and the 45–54 group (18.6 %). The smallest proportions are among those under 25 years (5.8 %) and over 65 years (8.5 %). Regarding the distribution of research specialists across different fields, the largest proportions are in natural sciences (30.9 %) and engineering and technology (24.5 %). Smaller proportions are observed in the humanities (16.7 %), social sciences (10.4 %), agricultural sciences (9.4 %), and medical sciences (8.2 %), aligning with official statistics. The survey was disseminated via electronic mail and academic networks, utilizing institutional databases and professional platforms to maximize reach. The survey period encompassed eight weeks, with follow-up reminders to enhance response rates. The utilization of a quantitative survey was justified by the necessity to statistically analyze the relationships among career development variables and influencing factors, ensuring empirical rigor. The quantitative approach was complemented by ensuring a balanced summary representative of the targeted academic population.

We employed Principal Component Analysis (PCA) with Varimax rotation and Kaiser normalization in SPSS 25 to elucidate the primary factors influencing scientific career choices. PCA facilitated dimensionality reduction, transforming correlated variables into uncorrelated principal components, each representing distinct thematic domains. This methodological approach enabled the identification of three main components, elucidating the underlying structure and key determinants in respondents' academic career trajectories.

Results

Profile of the respondents'

The sample of 288 respondents demonstrated a diverse set of demographic and professional characteristics, with academic qualifications, countries of degree acquisition, career duration, research areas, and other socio-demographic factors well-represented (Table 3). The largest group by academic degree consisted of candidates of sciences (32.7 %), followed by PhD (26.7 %) and doctoral students (17.4 %), with a smaller proportion holding a doctor of sciences title (5.7 %) or having no academic degree (17.6 %).

The majority of specialists defended their degrees in Kazakhstan (78 %), with nearly half completing their dissertations within 4 years (48.9 %), while a third (33.5 %) have not defended yet. The prevailing H-index in Scopus is 1-3 (59.5 %), while only 2.1 % have an H-index of 10 or higher. Most individuals earn between 200,000 and 400,000 tenge, with 16.7 % earning over 600,000 tenge.

Table 3. Profile of Academic and Professional Indicators

Question	Option	%
Country of defended degree	Kazakhstan	78,0
	Russia	4,5
	Kyrgyzstan	1,4
	European countries	4,4
	No degree	11,8
	Total	100,0
Years for defend dissertation	up to 4 years	48,9
	5–7 years	9,6
	from 8 years	8,1
	Not yet defended	33,5
	Total	100,0
H index in Scopus	1	12,2
	1	11,1
	1–3	59,5
	4–5	6,9
	6–9	8,2
	10 and above	2,1
	Total	100,0
Monthly income	Up to 200,000 tenge	13,8
	From 200,000 tenge to 300,000 tenge	24,2
	From 300,000 tenge to 400,000 tenge	18,8
	From 400,000 tenge to 500,000 tenge	17,6
	From 500,000 tenge to 600,000 tenge	8,7
	From 600,000 tenge and above	16,7
	Total	99,8
Note – compiled by authors		

Socio-demographic factors showed that the majority of respondents were married (72.4 %), with others being single (15.7 %), divorced (9.4 %), or widowed (2.4 %). Professional experience levels were also diverse; 56.5 % reported having over 20 years of total work experience, while 26.4 % had between 11–19 years, 10.9 % had 6–10 years, and 6.3 % had 1–5 years. In terms of scientific experience specifically, 37.9 % reported over 20 years, while smaller groups had 11–19 years (25.3 %), 6–10 years (18.2 %), and 1–5 years (18.6 %). Language proficiency scores, rated on a scale of 1 (weak) to 5 (excellent), showed that 47.8 % rated their Kazakh proficiency at level 5, 36.1 % rated their English proficiency at level 3, and 53.2 % rated their Russian proficiency at level 5.

The distribution of respondents by place of work and employment status shows that the largest groups are employed full-time in research institutes (37.1 % of responses, 42.6 % of cases) and universities (36.2 % of responses, 41.4 % of cases). Part-time positions are less common, with 8.7 % of responses (10.0 % of cases) for part-time roles in research institutes and 9.6 % of responses (11.0 % of cases) for part-time university roles. Employment in enterprises is comparatively lower, with 4.7 % of responses (5.4 % of cases) for full-time and 3.7 % of responses (4.2 % of cases) for part-time. The total response count is 332, with a cumulative percentage of cases at 114.6 %, indicating that some respondents hold multiple affiliations or part-time positions.

These results provide a comprehensive profile of the respondents' socio-demographic, academic, and professional backgrounds, illustrating a highly educated group with significant diversity in experience, research focus, and language skills. The data support an understanding of the factors influencing academic career trajectories in this context.

Career path-dependency

Table 4 summarizes how various factors influenced respondents' choice of a scientific career at different stages: immediately after obtaining a degree, after 5 years, and after 10 years.

Table 4. Changes in Career Motivational Factors Over Time, means

Factor	Immediately After Degree	5 Years After	10 Years After
Interest in Science (from school/university)	3,9	3,71	3,9
High Status of Scientists	3,31	3,37	3,71
High Salary	2,91	3,15	3,5
Flexible Work Schedule and Childcare Compatibility	3,47	3,58	3,72
Influence of Scientist Parents	3,01	3,09	3,38
Environmental Influence (social circles)	3,29	3,41	3,74
Lack of Industry Job Vacancies	2,69	2,89	3,22
Established Academic Foundations	3,53	4	4,2
Career Advancement	3,17	3,43	3,85
Chance or Serendipity	2,86	2,8	3,12
Note – compiled by authors			

The factors influencing respondents' choice of a scientific career reveal evolving motivations over time. Intrinsic interests, such as a long-standing passion for science from school or university, and established academic foundations, consistently hold a strong influence across all career stages. However, the importance of extrinsic factors, like high salary and career advancement opportunities, gradually increases, reflecting a shift toward more practical considerations as respondents progress in their careers. Additionally, environmental influences, including the impact of social circles and the flexibility of a scientific career for family life, become more significant over time. Notably, chance or serendipity plays a minor but fluctuating role, indicating that some aspects of career choice may be shaped by unexpected factors. Overall, while foundational motivations remain stable, the growing emphasis on professional growth and external influences suggests a dynamic interplay between personal drive and career development in the scientific field.

This strongly demonstrates path-dependence and commitment to the chosen career path and interest in developing in a certain field. However, opportunities to exit career from academia do not exist and make other career choices less accessible.

The ANOVA analysis revealed notable findings regarding the influence of gender on various factors shaping career decisions. Among the analyzed variables, a significant difference was observed in the impact of "Interest in Science from School/University" between male and female respondents ($F = 8.384$, $p = 0.004$), indicating that this factor plays a differing role based on gender. Additionally, the "Influence of Scientist Parents" demonstrated a marginally significant difference ($F = 3.382$, $p = 0.067$), suggesting a potential trend where gender might influence its importance.

The ANOVA results revealed significant group differences in factors that influence age on academic career choices, particularly in areas such as financial incentives ($F = 8.108$, $p < 0.001$), work conditions ($F = 4.698$, $p = 0.001$), social and environmental influences ($F = 6.906$, $p < 0.001$), and professional opportunities ($F = 4.724$, $p = 0.001$). Factors like parental influence ($F = 3.109$, $p = 0.016$) and career advancement ($F = 2.978$, $p = 0.020$) also showed variability, highlighting their importance. However, perceptions of high status of a scientist ($F = 2.094$, $p = 0.082$) and chance ($F = 1.961$, $p = 0.101$) did not differ significantly across groups.

These findings emphasize the diverse drivers of academic career motivation, with notable contributions from financial, social, and professional factors (Appendix) Table 2.

The multiple comparisons analysis revealed significant differences across age groups for several factors. Younger respondents (“Under 30”) reported lower perceptions of high pay for labor compared to older groups, particularly those aged “50–59” (Mean Difference = 2.526, $p < 0.001$). Older respondents, especially those “60 and older”, placed greater importance on a flexible working schedule (Mean Difference = 2.080, $p = 0.001$), environmental influence (Mean Difference = 1.774, $p = 0.010$), and the lack of vacancies in the labor market (Mean Difference = 2.154, $p = 0.005$). Additionally, career advancement was rated significantly higher by older age groups, with the “50–59” group showing notable differences compared to “Under 30” (Mean Difference = 1.566, $p = 0.036$). These findings highlight the evolving priorities across different age cohorts, with older respondents emphasizing financial stability, career flexibility, and external factors more strongly than younger ones.

Factors of scientific career

The Component Score Coefficient Matrix derived from the Principal Component Analysis (PCA), employing Varimax rotation and Kaiser normalization, elucidated primary components that exert influence on scientific career choices and development.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.876, indicating that the data is highly suitable for factor analysis. Bartlett’s test of sphericity was statistically significant ($\chi^2 = 7051.300$, df = 435, $p < 0.001$), confirming that the correlation matrix is not an identity matrix and that the variables are sufficiently intercorrelated (Table 5). These results validate the appropriateness of proceeding with factor analysis.

Table 5. KMO and Bartlett’s Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,876
Bartlett’s Test of Sphericity	Approx. Chi-Square	7051,3
	Df	435
	Sig.	0,00
Note – compiled by authors		

The Principal Component Analysis (PCA) identified three primary components that collectively explain 56.76 % of the total variance in the dataset after rotation.

The rotated component matrix highlights three key components influencing academic career trajectories, with associated factor loadings providing detailed insights (Table 6).

The first component, mentorship and organizational support, captures the influence of scientific advisors and institutional backing. Notable loadings include “Feedback from scientific advisors” (0.844), “Role model effect of the advisor” (0.837), “Accessibility of the advisor” (0.795), and “Support from leadership” (0.717, 0.726). These results emphasize the vital role of mentorship and organizational encouragement in fostering academic success.

The second component, intrinsic motivation and social influence, reflects personal and environmental motivators. Key variables include “Sustained interest in science” (0.579), “High status of being a scientist” (0.732), “Flexible working conditions” (0.621), and “Parental influence” (0.738). These findings demonstrate how intrinsic drivers and social factors interact to shape both the initiation and sustainability of scientific careers.

The third component, financial support and career advancement opportunities, focuses on structured financial and professional resources. Significant loadings include “Scholarship for doctoral studies” (0.912), “Scholarship for master’s studies” (0.868), “Postdoctoral programs” (0.830), “Scientific internships” (0.650), and “Grant-funded projects” (0.479). These results underline the importance of financial incentives and career resources, especially at advanced stages of academic development.

Table 6. Rotated Component Matrix: Factor Loadings by Component

Factor	Component		
	1	2	3
B1 Feedback (advice, review, review) from the scientific supervisor	**0,844**	-0,172	
B1 Motivating personality model of the supervisor	**0,837**	-0,114	
B1 Assistance of the supervisor to academic and professional connections	**0,803**		
B1 Availability of the scientific supervisor for the management	**0,795**		
B3 Support of the head of the department	**0,726**	0,168	0,322
B3 Support of the head of the organization/department	**0,717**	0,124	0,306
B3 Teamwork within the team	**0,698**	0,234	0,249
B3 Support of colleagues	**0,671**	0,264	0,263
A2 Support from teachers during training and subsequent employment at the university	**0,605**	0,23	0,204
B2 Grant projects, programs	**0,557**	0,219	0,479
A1 Lack of vacancies in the labor market in the industry		**0,783**	0,164
A.1 High pay for labor		**0,78**	0,301
A1 Influence of the environment	0,14	**0,763**	0,161
A1 Promotion	0,147	**0,763**	0,236
A1 Influence of parents-scientists		**0,738**	0,159
A.1 High status of the scientist		**0,732**	0,16
A1 Chance		**0,651**	0,326
A1 Formed scientific background for work in the academic environment	0,118	**0,638**	0,266
A1 Flexible work schedule and the ability to combine with raising children	0,197	**0,621**	0,131
A.1 Interest in science from school and/or university	0,218	**0,579**	0,136
C.2 In promoting the development of science through scientific projects:	-0,168	**0,272**	
C.1 When choosing a scientific career:		**0,266**	
C.3 In international collaborations (joint publications, project implementation):		**0,144**	
B2 Scholarship for doctoral studies	0,117	0,11	**0,912**
B2 Scholarship for Master's studies		0,151	**0,868**
B2 Postdoctoral programs	0,105	0,224	**0,83**
A2 Scholarship for doctoral studies	0,146	0,201	**0,801**
A2 Scholarship for Master's studies	0,148	0,163	**0,773**
B2 Research internships	0,381	0,232	**0,65**
B2 Salary	0,347	0,346	**0,579**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 5 iterations.			

These three components collectively explain the dynamics of academic career development, highlighting the complementary roles of mentorship, intrinsic motivation, social influence, and financial support in advancing scientific engagement.

Overall, the findings suggest that a successful scientific career is shaped by a combination of institutional support, intrinsic motivation, and financial resources. For institutions aiming to attract and retain talented researchers, a focus on robust mentorship programs, financial support, and a conducive research environment is essential. Collectively, these elements create a foundation that supports long-term engagement and advancement in the scientific field.

Based on the conducted analyses, the research hypotheses were largely confirmed. Significant differences were found in several factors influencing academic career choices across both gender and age groups. The hypothesis stating that there are differences among the factors influencing the choice of an academic career based on gender and age was partially confirmed. In particular, the "Interest in Science from School/University" factor showed a significant gender difference ($F = 8.384$, $p = 0.004$), suggesting that the importance of early interest in science varies by gender. Age-related differences were significant in factors such as financial incentives, work conditions, social and environmental influences, and career advancement opportunities ($F = 8.108$, $p < 0.001$; $F = 4.698$, $p = 0.001$; $F = 6.906$, $p < 0.001$; $F = 4.724$, $p = 0.001$, respectively), highlighting the evolving priorities of individuals as they progress in their careers. However, no significant differences were found for some factors, such as the high status of a scientist and chance, across gender and age groups, indicating that these elements are less influential in shaping academic career decisions.

Moreover, the hypothesis that support from scientific supervisors and organizational leadership significantly impacts the choice of an academic career was supported by the findings. The analysis indicated that mentorship and organizational backing play a crucial role in shaping career paths, as evidenced by the high factor loadings of supervisor feedback, availability, and the motivating personality model in the Principal Component Analysis (PCA).

The hypothesis regarding the significant impact of external factors, including financial incentives, social environment, and work flexibility, was also confirmed. These external factors, particularly related to salary and work flexibility, became more prominent as respondents advanced in their careers, aligning with the findings that show an increased importance of these factors over time.

Lastly, the hypothesis that access to scholarships, internships, and training programs positively correlates with the likelihood of pursuing an academic career was supported. The PCA revealed that scholarships, postdoctoral programs, and scientific internships loaded strongly on the third component, underscoring the importance of these opportunities for advancing in the academic field.

In conclusion, the results substantiate the hypotheses, emphasizing the complex interplay of gender, age, mentorship, intrinsic and extrinsic motivators, and external opportunities in shaping academic career decisions.

Discussion

The findings from this study contribute significantly to our understanding of the factors influencing scientific career choices in Kazakhstan, aligning with global trends while highlighting unique contextual factors that shape academic career trajectories in Central Asia. The research underscores the evolving dynamics of scientific careers, where intrinsic and extrinsic motivators interact in complex ways, influenced by gender, age, and institutional support. Driven by unique factors of the academic environment in Kazakhstan, this study revealed several key components of career choice and career path-dependency in academia.

One of the key findings is the evolving importance of intrinsic versus extrinsic factors across different career stages. Initially, intrinsic factors such as a long-standing interest in science and established academic foundations were paramount, while over time, extrinsic motivators like high salary, career advancement opportunities, and work flexibility gained more significance. This shift reflects the growing practical concerns of researchers and commitment to a certain career that is motivated by long-term investment of time and choices that include behavioral attributes. This confirms an individual’s dependency on previous choices and the importance of the chosen path for long-term success in a particular research field.

Moreover, the study confirms that gender and age play significant roles in shaping academic career decisions. The ANOVA results showed a marked difference in the impact of “Interest in Science from School/University” based on gender, indicating that men and women may perceive or experience the importance of early academic interest differently. Similarly, age-related differences were found in factors such as financial incentives, work conditions, and career advancement opportunities, suggesting that older researchers place more value on financial stability and career flexibility compared to their younger counterparts. These findings highlight differences in societal gender roles and different expectations. However, the long-term impact of such a difference should be a factor directly linking to the path-dependence and career choices.

Another critical finding pertains to the importance of mentorship and institutional support in shaping career choices. The Principal Component Analysis (PCA) revealed that mentorship, including feedback from supervisors, the role model effect, and institutional support, is crucial for fostering academic careers. This is consistent with existing literature, which highlights the vital role of mentoring in guiding early-career researchers and facilitating their career progression and level of relatedness to the field associated with supervisor and senior colleagues.

The study also sheds light on the significance of financial and career advancement opportunities. The increasing reliance on financial incentives such as scholarships, internships, and postdoctoral programs confirms the critical role of these resources in supporting long-term academic careers. This is particularly important in Kazakhstan, where access to funding and career development opportunities can directly influence researchers’ decisions to remain in academia. In addition, the significant role of social and environmental influences, including family background and the influence of scientist parents, emphasizes the importance of early socialization and the external networks that shape career trajectories.

Finally, the study confirms that access to scholarships, internships, and training programs significantly correlates with the likelihood of pursuing an academic career. This aligns with global trends that highlight the importance of structured financial and career advancement resources for sustaining academic careers. Access to resources from the early stages of career associated with more opportunities given to the scientists including additional funding to pursue academic career.

The findings from this study underscore the multifaceted nature of scientific career development, influenced by intrinsic motivations, external pressures, and institutional support systems. The dynamic interplay between these factors calls for targeted policy interventions and institutional reforms to create an environment that nurtures and sustains scientific talent. Specifically, strengthening mentorship programs, expanding access to scholarships and career development resources, and addressing gender and age-related disparities will be critical for improving the career trajectories of researchers in Kazakhstan and beyond.

Moreover, fostering international collaborations and exchange programs can enhance the global competitiveness of researchers while broadening their professional networks. Efforts to create inclusive and equitable research environments, coupled with investments in infrastructure and technology, are also essential for overcoming systemic barriers and enabling researchers to thrive.

The study further underscores the importance of cultivating a culture of innovation and recognition within institutions to retain talent and motivate researchers to contribute meaningfully to their fields. Policymakers and stakeholders should prioritize sustainable funding mechanisms to ensure the continuity of research efforts and provide opportunities for interdisciplinary collaboration.

Finally, the study highlights the need for further research into the long-term impacts of these factors on career sustainability and the overall health of scientific institutions. Such research could provide deeper insights into how systemic reforms and targeted interventions can create resilient scientific ecosystems capable of addressing both local and global challenges in an ever-evolving research landscape.

Conclusions

This study highlights significant factors influencing the choice of an academic career in Kazakhstan, while confirming global trends and revealing specific characteristics unique to the country. The findings underscore the complex dynamics of scientific career development, where both intrinsic motivational factors, such as interest in science and academic training, and external factors, including financial incentives, career opportunities, and the social environment, play crucial roles.

One of the key conclusions is the growing importance of external factors, such as high salaries, career advancement opportunities, and improved work-life balance, as individuals progress in their scientific careers. This suggests that, at later stages of their careers, scientists begin to prioritize practical considerations, such as financial stability, job security, and work flexibility. However, intrinsic motivators, such as a long-standing passion for science and the pursuit of knowledge, remain significant at all career stages, highlighting the enduring importance of personal commitment and academic achievements as foundational drivers in scientific careers.

The results also reveal the pivotal role of mentorship and institutional backing in shaping career trajectories. Support from scientific supervisors, availability of skilled mentors, and encouragement from department heads and colleagues have been identified as critical factors that contribute significantly to the successful development of academic careers. In particular, mentorship not only provides technical guidance but also fosters confidence, resilience, and a sense of belonging in academic institutions.

Furthermore, it is confirmed that access to scholarships, internships, and training programs positively correlates with the likelihood of pursuing an academic career. These resources are especially important for early-career researchers, offering opportunities to develop skills, build networks, and gain exposure to global scientific communities. Despite these positive trends, the findings also highlight the need for expanded, more inclusive access to these opportunities.

The study also underlines several challenges that require attention. The lack of robust institutional support systems, insufficient funding, and gaps in mentorship programs, particularly for early-career researchers, were identified as critical barriers. Addressing these issues will require coordinated efforts at both the policy and institutional levels. Strengthened mentorship programs that include structured training for mentors, increased funding for research initiatives, and the establishment of professional development programs can help mitigate these challenges.

Additionally, the findings suggest the need for a more strategic approach to fostering a sustainable academic workforce. Enhancing the appeal of academic careers by offering competitive salaries, flexible work arrangements, and clear pathways for career progression could attract and retain talent in the scientific field.

At the same time, creating an inclusive and collaborative research culture will help bridge gender- and age-related disparities and ensure equal opportunities for all researchers.

In conclusion, this study provides valuable insights into the factors influencing academic career choices in Kazakhstan while drawing attention to both global patterns and localized challenges. By addressing these challenges through targeted interventions, including strengthened mentorship, expanded access to resources, and improved institutional policies, Kazakhstan can create a more supportive and dynamic environment for nurturing the next generation of scientists. These findings also serve as a foundation for further research into the long-term impacts of these interventions on scientific career sustainability and the broader advancement of academic institutions.

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Appendix

Table 1. Descriptive Statistics

		N	Mean	Std. Deviation
A.1	Interest in science since school and/or university	288	3,9	1,619
A.1	High status of a scientist	288	3,31	1,732
A.1	High salary	288	2,91	1,731
A.1	Flexible work schedule and the ability to combine with childcare	288	3,47	1,692
A.1	Influence of scientist parents	288	3,01	2,032
A.1	Influence of the social environment	288	3,29	1,739
A.1	Lack of vacancies in the industrial labor market	288	2,69	1,964
A.1	Existing scientific groundwork for working in academia	288	3,53	1,73
A.1	Career advancement	288	3,17	1,816
A.1	Coincidence/chance	288	2,86	2,034
A.2	Support from university professors during studies and subsequent employment at the university	288	3,37	1,715
A.2	Scholarship for master’s studies	288	3,08	1,832
A.2	Scholarship for doctoral studies	288	3,22	1,943
B1	Feedback (advice, review, critique) from the academic advisor	288	3,55	1,645
B1	Motivating personality model of the advisor	288	3,54	1,616
B1	Accessibility of the academic advisor for supervision	288	3,4	1,583
B1	Advisor’s support in building academic and professional networks	288	3,37	1,575
B2	Scholarship for Master’s studies	288	3,12	1,906
B2	Scholarship for doctoral studies	288	3,25	1,93
B2	Postdoctoral programs	288	3,26	2,001
B2	Scientific internships	288	3,46	1,75
B2	Grant-funded projects and programs	288	3,54	1,75
B2	Salary	288	3,34	1,707
B3	Support from the head of the organization/department	288	3,24	1,539
B3	Support from the head of the unit	288	3,34	1,522
B3	Support from colleagues	288	3,33	1,498
B3	Teamwork within the collective	288	3,31	1,521
Б.5	Do you believe that the academic environment provides the freedom to conduct research on any chosen topic?	288	2,57	1,077
Б.6	How would you assess the impact of collaboration with foreign researchers on the development of your scientific activity?	288	2,25	1,507
C.1	Choosing an academic career	288	1,95	0,874
C.2	Contributing to the development of science through research projects	288	2,53	1,219
C.3	International collaboration (joint publications, project implementation)	288	2,41	1,202
	Valid N (listwise)	288		

Table 2. ANOVA Results: Comparison Between Age Groups

		Sum of Squares	df	Mean Square	F	Sig.
1	2	3	4	5	6	7
A.1 Interest in science from school and/or university A.1 High status of a scientist	Between Groups	38,19	4	9,548	3,781	0,005
	Within Groups	714,536	283	2,525		
	Total	752,727	287			
A.1 High salary	Between Groups	24,769	4	6,192	2,094	0,082
	Within Groups	836,79	283	2,957		
	Total	861,56	287			
	Between Groups	88,492	4	22,123	8,108	0

		Sum of Squares	df	Mean Square	F	Sig.
1	2	3	4	5	6	7
A1 Flexible work schedule and the ability to combine it with raising children A1 Influence of parents-scientists	Within Groups	772,138	283	2,728		
	Total	860,63	287			
A1 Influence of the environment	Between Groups	51,21	4	12,802	4,698	0,001
	Within Groups	771,149	283	2,725		
	Total	822,359	287			
A1 Lack of vacancies in the labor market in industry A1 Formed scientific background for work in the academic environment	Between Groups	49,951	4	12,488	3,109	0,016
	Within Groups	1136,755	283	4,017		
	Total	1186,706	287			
A1 Promotion in position	Between Groups	77,258	4	19,314	6,906	0
	Within Groups	791,433	283	2,797		
	Total	868,69	287			
A1 Chance A.1 Interest in science from school and/or university	Between Groups	90,357	4	22,589	6,279	0
	Within Groups	1018,122	283	3,598		
	Total	1108,479	287			
A.1 High status of a scientist	Between Groups	53,843	4	13,461	4,724	0,001
	Within Groups	806,342	283	2,849		
A.1 High salary A1 Flexible work schedule and the ability to combine it with raising children	Total	860,184	287			
	Between Groups	38,257	4	9,564	2,978	0,02
	Within Groups	908,836	283	3,211		
	Total	947,093	287			
A1 Influence of parents-scientists	Between Groups	32,058	4	8,015	1,961	0,101
	Within Groups	1156,526	283	4,087		
	Total	1188,584	287			