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Phenomenology of the scientific system of Kazakhstan: a study of social and economic effects through the Hofstede’s five-dimensional model of cultural space and beyond

Abstract. The cultural model of science and the scientific system of Kazakhstan are theorized and updated for the first time in our research, and this study extends Hofstede’s five-dimensional model of cultural space specifically in the context of the scientific system. The methodology involves employing Hofstede’s dimensions - Power Distance, Individualism versus Collectivism, Masculinity versus Femininity, Uncertainty Avoidance, and Long-Term versus Short-Term Orientation - as a heuristic tool to evaluate the attributes of scientific culture in Kazakhstan. In this way, we shed light on how scientists in Kazakhstan interact with the prevailing cultural norms and expectations, offering a detailed view of culturally embedded scientific practices. To clarify, the five dimensions are adapted in the following manner:
Firstly, Scientific Power Distance pertains to the degree of hierarchical authority within scientific institutions. High power distance in this setting implies a significant disparity between junior and senior researchers, thereby affecting the dynamics of collaboration and innovation.
Secondly, Scientific Individualism-Collectivism measures the extent to which the scientific culture either fosters individual achievement and originality or prioritizes group cooperation.
Thirdly, Scientific Masculinity-Femininity assesses the predominance of either competitive (Masculine) or collaborative (Feminine) traits within the scientific community.

Fourthly, Scientific Uncertainty Avoidance deals with the community's tolerance for uncertainty and ambiguity, indicating whether there's a preference for structured environments.
Lastly, Scientific Long-Term Orientation gauges the focus of scientific endeavors, whether they aim for immediate outputs or invest in long-term research.
The Kazakhstan scientific system is thus situated within this adapted framework of five dimensions, providing an intricate mapping of how cultural attributes impact scientific pursuits in the country. The importance of cultural phenomenology in the scientific domain comes from its focus on the observation and interpretation of the cultural factors that influence scientific thinking, progress, and implementation. It recognizes that science is not an isolated activity but is deeply entrenched in societal and cultural systems. In the specific context of Kazakhstan, a country experiencing rapid socio-economic changes, the scientific system is not only shaped by various facets of cultural identity but also makes substantial contributions to socio-economic development.
Regarding the empirical findings of this study, the data illustrates the profound economic impact of the scientific system in Kazakhstan. From increased R&D investment to job creation and attracting significant Foreign Direct Investment (FDI), the scientific system appears to make a direct and meaningful contribution to the nation's economic growth and development. In conclusion, these findings suggest that there is a positive trajectory for the scientific culture in Kazakhstan, contributing both to socio-economic conditions and to the global scientific community.
Keywords: Culture; Science; Model; Dimension; Attribute; Cultural Universals; Kazakhstan; Hofstede
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Феноменологія наукової системи Казахстану: дослідження соціально-економічних ефектів на онові адаптованої моделі культурного простору Хофстеде

Анотація. Культурна модель науки та наукова система Казахстану вперше теоретизуються та оновлюються на сучасному етапі. Наше дослідження розширює п'ятивимірну модель культурного простору Хофстеде конкретно в контексті наукової системи на прикладі Казахстану. Методологія передбачає використати виміри моделі Хофстеде (відстань влади, індивідуалізм проти колективізму, маскулінність проти жіночності, уникнення невизначеності та довгострокова орієнтація проти короткострокової) як евристичний інструмент для оцінки атрибутів наукової культури в Казахстані. Таким чином ми проливаємо світло на те, як учені в Казахстані взаємодіють із переважаючими культурними нормами й очікуваннями, пропонуючи детальний огляд культурних наукових практик. П'ять вимірів Хофстеде адаптовані нами наступним чином: по-перше, дистанція наукової влади відноситься до ступеня ієрархічної влади всередині наукових установ. Висока дистанція влади в цих умовах передбачає значну нерівність між молодшими та старшими дослідниками, що впливає на динаміку співпраці та інновацій. По-друге, науковий індивідуалізм чи колективізм вимірює ступінь, до якого наукова культура або заохочує індивідуальні досягнення й оригінальність, або надає пріоритет груповій співпраці. По-третє, наукова маскулінність чи жіночність оцінює переважання або конкурентних (чоловічих), або колаборативних (жіночих) рис у науковому співтоваристві. По-четверте, наукове уникнення невизначеності пов'язане з толерантністю спільноти до невизначеності та двозначності, вказуючи на те, чи надається перевага структурованому середовищу. Нарешті, наукова довгострокова орієнтація визначає спрямованість наукових зусиль залежно від того, чи спрямовані вони на негайні результати, чи інвестують у довгострокові дослідження.

Казахстанська наукова система досліджується нами в рамках цієї адаптованої п'ятивимірної структури, що забезпечує складне відображення того, як культурні атрибути впливають на наукову діяльність у країні. Важливість культурної феноменології в науковій сфері випливає з її зосередженості на спостереженні та інтерпретації культурних факторів, які впливають на наукове мислення, прогрес та впровадження інновацій. У специфічному контексті Казахстану, країни, що переживає швидкі соціально-економічні зміни, наукова система не тільки формується різними аспектами культурної самобутності, а й істотно впливає на соціально-економічний розвиток.
Що стосується емпіричних результатів цього дослідження, то дані ілюструють глибокий соціальний та економічний вплив наукової системи в Казахстані. Від збільшення інвестицій у НДДКР до створення робочих місць і залучення значних прямих іноземних інвестицій (ПІІ), наукова система робить прямий і значущий внесок в економічне зростання та розвиток країни, що підтверджено даними нашого дослідження. На закінчення, наші результати свідчать про те, що наукова культура в Казахстані розвивається позитивно, роблячи свій внесок як в покращення соціально-економічних умов, так і в світове наукове співтовариство.
Ключові слова: культура; наука; модель; вимір; атрибут; культурні виміри; Казахстан; Хофстеде.

1. Introduction

The economic impact of the scientific system can be analyzed in various ways. Direct economic benefits come from increased activity in sectors such as education, research and development, and the technology industry. Indirect benefits come from the application of scientific research and innovation in various sectors of the economy, leading to improved productivity, creation of new industries, and better solutions to socio-economic challenges.

According to data from the Kazakhstan Ministry of National Economy, investment in research and development (R&D) has seen a steady increase over the past decade. The focus on innovation and technological development has stimulated job creation, particularly in the tech sector. Furthermore, knowledge transfer from scientific research has led to improved productivity and competitiveness in various sectors, such as agriculture, manufacturing, and services.

The level of science development is determined by the level of the society and state culture development. It is the level of culture that is the point of bifurcation, in which it is determined whether, for example, a quantitative increase in the number of scientists or funding will lead to a new qualitative state of «progressive and modern science» or whether this growth will lead to an even greater chaotization of Kazakhstan science.

Culture is a phenomenon which is vital to a synergetic effect in science.

This concerns the scientific system as a system with bureaucratic management and governance. The bureaucratic management style will never be able to achieve synergy with the scientific community. No matter how much the number of researchers, competence centers or the number of grants is increased. Synergy requires a management culture that is not associated with the bureaucratic management style of R&D and the products of scientific and (or) scientific and technical activities.

In this regard, culture is a phenomenon that ultimately determines the quality and effectiveness of Kazakhstani science. The culture of science consists of the following definitions: art of scientific cognition, ethics of a scientist, aesthetics of research, cultural behavior, corporate culture, cultural communication, research culture, culture of experimentation, management culture, ergonomics, competence, and so on. It is the culture that determines whether science is chaotic or organized. In this sense, science can be considered as an organized system with a certain level and value of entropy from the point of view of energy neoevolutionism.

Here it is culture that plays the role of an entropic factor that determines the quality and effectiveness of scientific activities. Culture reduces the entropy of the scientific system due to reasonable organization, correct procedures, authentic regulations, intelligent algorithms, and optimal control mechanisms. With a shortage of culture, the entropy of the scientific system increases, becoming chaotic, unintelligent and ineffective. This explains why at the head of any human system or structure, and especially scientific, should be primarily a cultured person, rather than a professional, careerist or conformist.

2. Methodology

The research methodology in this study has been meticulously crafted to integrate both qualitative and quantitative approaches, influenced by the guidelines stated in the «Principles and Structures of science advice: an outline. International Science Council & INGSA Special Report, March 2022.» These provisions furnish a solid framework for aligning our analytical tools with scientific advice and guidance, thereby ensuring that the study remains grounded in recognized methodological practices. Within this overarching structure, particular attention has been devoted to dovetailing Hofstede's five-dimensional model of cultural space to create a unique investigative framework tailored for the scientific system of Kazakhstan.

The methodology incorporates multiple data sources to substantiate the proposed model's reliability and validity. These include statistical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (BNS ASPR RK), abstract databases and rankings (SCOPUS, SCImago Journal & Country Rank), national reports on science, and external audit reports of scientific organizations. Furthermore, an array of scholarly works in the field of epistemology, gnosiology, and social dynamics of the scientific sphere were examined to substantiate the study's theoretical framework. In this approach, Hofstede's five dimensions serve as the interpretative lens to evaluate the cultural dimensions of Kazakhstan's scientific system. One critical aspect of our methodology is the rigorous validation of statistical data used in the study. In accordance with Benford's law, which posits that in naturally occurring datasets, the leading digit d occurs with a frequency proportional to $\log10(d+1) - \log10(d)$, the quality of the BNS ASPR RK data was ascertained. A correlation coefficient of 0.9547 was found between the anomalous distribution of numbers stipulated by Benford's law and the tabular numerical parameters in the realm of science, as offered by BNS ASPR RK. This strong positive relationship confirms the reliability of the statistical dataset, further lending credibility to our research findings.

The model scrutinizes how scientists in the country interact with cultural norms and expectations, thus furnishing a complex yet coherent understanding of the culturally embedded scientific practices and their socio-economic implications. This amalgamation of diverse methodological elements substantiates our research model, thereby enhancing the interpretive and explanatory powers of the study. To evaluate and analyze the scientific collaboration (the dimension of «Individualism»), the Salton index (Salton, 1986, p. 437) and Jaccard index (Jaccard, 1912, p. 37) were calculated.

Pearson, Spearman, and Kendal correlation coefficients were calculated for the analysis and evaluation of dependencies in the field of cooperation and publications.

To assess and analyze the problems of Kazakhstani science («Agnosophobia» dimension), a logical Tree of Current Reality, a Tree of Future Reality and a Transition Tree are constructed, according to Goldratt's theory of constraints (cit. by Dettmer, 1997, p. 378).

3. Phenomenology of science as culture

Until now, the issues of cultural modeling of the scientific system of Kazakhstan have not been systematically considered. In this paper, we will present some concepts and paradigms of the cultural model of Kazakhstani science based on the development and adaptation of the Hofstede model. We are not going to delve into Hofstede's conceptology in the context of culture as mental programming or cultural relativism. Most of these things in the first approximation are not relevant to the cultural methodology of science.

Let us pay attention only to the most important part of it, which Hofstede interprets as «The Five Dimensions of National Culture». These are the following dimensions:

- Dimension 1: Power Distance;
- Dimension 2: Individualism and Collectivism;
- Dimension 3: Masculinity and Femininity;
- Dimension 4: Uncertainty Avoidance;
- Dimension 5: Long- and Short-Term Orientation, Confucian Dynamism.

In the field of science, the distance of power can be understood as the level of authoritarianism in the management system and elitism within the scientific community itself.

In the context of epistemology, we transform the characteristics of these dimensions into the concepts and ideology of the scientific sphere. At the same time, we will omit some characteristics of dimensions that are not interpreted or are not directly related to science (for example, family values). At the same time, we will add a multiple set of dimensional characteristics that are natural and logical for the field of science. We will also change some terms. For example, «Avoidance of responsibility» is replaced by «Agnosophobia», as a more scientific generalized form of the trait and which interprets not only the statistical state, but also dynamic patterns of behavior. Attributes of the cultural space of science of Kazakhstan is given in Table 1.

Table 1:
Attributes of the cultural space of science

CULTURAL SPACE OF SCIENCE OF KAZAKHSTAN		
DIMENSION	***ATTRIBUTE***	***AUTHENTIC SUB-DIMENSION***
POWER DISTANCE	Gender tolerance Science is extractive Science is elitist Methodological nihilism Project approach to science Externality of management Subordination of management Management dysfunctionality Rankism Ageism Plutocratic financing Social tolerance Hierarchy is an existential inequality Centralization of management Resource concentration Autocracy in management High level of corruption Favoritism of scientists Favoritism of directions Income distribution -unevenly/discretely Scientific policy - discrimination	STRONG POWER DISTANCE
AGNOSOPHOBIA	Perception of the problem - threat Dogmatism and fetishism in science Problem solving is situational Discrimination of deviant ideas No management retretism Anomie Hard Science Priority of normativity Management rigidity Resistance to reforms Incompetent management Normative conformism Conservative approaches Lack of mobility	STRONG AGNOSOPHOBIA
ANTINOMY	The consciousness of «WE» The prevalence of collective publications Classification by structure Relationships dominate the task Priority of applied research Priority of routine work Standardization and normativity A scientist is formed individually or through patronage Scientific ideas - your own creative insight Individual decision-making The ethics of a scientist is declarative Marginal science Situational research projects Limited resources Grant inefficiency Egocentrism Ambition	INDIVIDUALISM
GENDER	Minimum gender differentiation The social roles of gender are not limited Work-family balance Gender egalitarianism Feminization of science Social elevators in science Gender equality Gender protectionism Lack of gender stereotypes Free access to science Gender tolerance Political patriarchy Conservative culture Traditionalism	FEMINISM
CONFUCIAN DYNAMISM	Priority of growth over development The economy is allusive and illusory Cultural regression Slow (zero) economic growth Resource consumption Irrational expenses The authorities attribute mistakes and failures to circumstances Limited investments Traditions are conservative Unified concept of good and evil Groups are guided by imperatives	SHORT-TERM ORIENTATION

Source: Authors' own research

Based on the selected sub-dimensions, which we can consider as cultural universals of the scientific system, Kazakhstani science, as a cultural model in the notation of the five dimensions of Hofstede, can be defined as follows:

Kazakhstan's science as a scientific system has negative actualized features of bureaucratization, inefficient management, lack of scientific methodology in an unfavorable environment and irrational planning, along with one positive feature - a high level of gender equality.

4. Discussion

Culture as a universal definition is the most constructive and rational tool for the development of the human community. Any attempt by one or another sphere to distance itself from cultural issues in its own development is a priori doomed to failure. Such doom gives birth to an ersatz culture or cargo cult (Inglis, 1957, p. 249).

In the scientific system, disregarding culture or misunderstanding cultural universals can lead to the rise of ersatz science, pseudoscience, and cargo science (Feynman, 1974, p. 10). Through the lens of Hofstede's five-dimensional model, this lack of cultural understanding can be further explored. Specifically, Hofstede's dimensions of Power Distance, Individualism versus Collectivism, Masculinity versus Femininity, Uncertainty Avoidance, and Long-Term versus Short-Term Orientation can serve as diagnostic metrics for the prevailing cultural issues that give rise to such flawed science.

Science not only investigates but also reconstructs natural and societal phenomena. The efficacy and rationality of this reconstruction are contingent upon the cultural development level of the scientific community and individual scientists. Hofstede's dimensions can be used to understand how the culture of a scientific community impacts the bounds of both cognitive and reconstructive scientific activities.

A rigorous and pragmatic application of Hofstede's cultural dimensions to the scientific sphere can elucidate the mechanisms, potential, and routes for the growth and development of a scientific system, including the natural and artificial limits to that growth.

Within the scientific system, elements of both material and immaterial epistemological cultures exist. Material culture is manifested through technological advancements and innovation, whereas immaterial culture is defined by the skills and competencies of individual researchers and the community. By applying Hofstede's dimensions, one can dissect how these cultural facets interact and contribute to the overall structure and function of the scientific system. Most critically, Hofstede's dimensions are invaluable for dissecting the management culture within a scientific system. Management culture essentially dictates the level of synchronization and optimization in the system and plays a pivotal role in achieving a synergetic effect when both material and immaterial cultures are harmoniously integrated. Therefore, in accordance with Hofstede's cultural dimensions, it is the management culture that plays the most decisive role in determining the efficiency and effectiveness of the scientific system. The cultural model of the scientific system makes it possible to correctly and optimally prioritize the interaction of the scientific community, the researcher, research areas and the management system to achieve synergy.

In this work, such priorities in the initial conceptual presentation are placed through the developed and interpreted dimensions of the Hofstede cultural model in the form of its adapted cultural model of Kazakhstani science.

It follows from this adapted model that the most important priority of the development of the scientific system as a cultural space is the priority of the «strong power distance» and «strong agnosophobia» dimensions. As substances of the system of public administration of science.

Kazakhstan's government has steadily increased its funding for scientific research and development. Data from the National Statistics Agency of Kazakhstan reveal a 25% increase in public investment in R&D over the last five years. It also shows that the private sector's contribution to the R&D funding pool has almost doubled in the same period, suggesting an expanding role of public-private partnerships in the country's scientific research.

An increase in innovation output, as measured by the number of patents granted to Kazakhstani inventors and the number of scientific publications, further reflects the growth of the scientific system. The number of patents granted annually increased by 35% over the last five years, indicating an upsurge in inventive activity. Additionally, the number of scientific publications authored by Kazakhstani researchers in peer-reviewed journals has seen a consistent annual growth of 15%.

An analysis of the mechanisms of knowledge transfer reveals an intensifying collaboration between universities and industries. The number of university-industry collaborative projects has increased by 50% over the last five years. Additionally, the research mobility index, measuring the movement of researchers within and outside of the country, has risen by 20%, pointing to the growing exchange of knowledge and expertise.

To elucidate the economic intricacies observed within Kazakhstan's scientific ecosystem, a comparative analysis with other nations-particularly within the Central Asian region-provides a granular perspective. When benchmarked against nations of analogous economic stature, such as Azerbaijan and Uzbekistan, Kazakhstan exhibits a superior commitment to Research and Development (R&D), both in terms of GDP percentage and the burgeoning of high-tech sectors. These comparative metrics serve as indices of the deliberate strategic efforts by both governmental and private sectors in Kazakhstan to cultivate a vibrant scientific landscape.

When juxtaposed with global vanguards in scientific innovation like South Korea and Israel, Kazakhstan's scientific apparatus shows room for further enhancement. These nations allocate a greater GDP percentage toward R&D and manifest an elevated output of innovation. In the lexicon of Hofstede's cultural dimensions, this discrepancy might align with the dimension of «Uncertainty Avoidance,» reflecting Kazakhstan's relative conservatism in R&D investment compared to these innovation-oriented nations.

Substantial within this discourse is the pivotal role of policy frameworks, epitomized by Kazakhstan's «Strategy 2050» initiative. This policy targets sectors like green energy, digital transformation, and biotechnology, with the objective of escalating the nation's global scientific and technological competitiveness. Evidence of policy efficacy is tangible, observed through the metrics of high-tech industrial growth and an uptick in Foreign Direct Investment (FDI) in the specified sectors.

Policy lacunae surface upon close examination. Despite augmented R&D expenditure and innovation yield, a commensurate uptick in global patent filings remains elusive, thus flagging an avenue for policy refinement. This issue can be situated within Hofstede's «Long-Term Orientation» dimension, implying a need for a more future-oriented policy structure that facilitates international patenting processes.

While the direct economic outcomes, such as R&D and innovation indices, are readily quantifiable, the system's peripheral economic contributions should not be underemphasized. These include employment generation, the evolution of high-tech industries, and the magnetization of FDI. Specifically, according to the National Statistics Agency of Kazakhstan, job creation in science-intensive sectors has superseded the national average growth rate by 10% over the last half-decade (7). These occupations, inherently higher in remuneration, enhance the standard of living, thereby contributing to broader economic well-being.

The growth of high-tech industries, which largely rely on R&D and scientific innovation, is another significant economic outcome. High-tech industries, such as information and communication technology (ICT), biotechnology, and renewable energy, have grown by 30% in the past five years. This growth is positively correlated with the increased R&D investment and innovation output. The ICT sector, for example, has benefited from innovations in digital infrastructure and artificial intelligence.

Furthermore, the scientific system's vitality has boosted the country's attractiveness for foreign direct investment (FDI). Sectors where scientific research plays a pivotal role, such as biotechnology and renewable energy, have witnessed a significant increase in FDI in recent years (8). The growing FDI not only brings in capital but also promotes the transfer of knowledge and technology, contributing to the further development of the scientific system.

To provide context to the observed economic phenomena, it is useful to compare Kazakhstan's scientific system with those of other countries, especially within the Central Asian region.

When compared with other countries of similar size and economic development, such as Azerbaijan and Uzbekistan, Kazakhstan's investment in R&D as a percentage of GDP is higher. The growth of high-tech industries in Kazakhstan also outpaces its regional peers. This comparison underscores the extent to which Kazakhstan's government and private sector have committed to fostering a robust scientific system.

5. The Role of Policy in Economic Phenomena

The observed economic phenomena within Kazakhstan's scientific system, including the growth of high-tech industries and increased Foreign Direct Investment (FDI), are intricately tied to policy decisions, as exemplified by the «Strategy 2050» initiative. To interpret these economic indicators within a cultural framework, Hofstede's model of cultural dimensions can be useful. The five dimensions-Power Distance, Individualism versus Collectivism, Masculinity versus Femininity, Uncertainty Avoidance, and Long-term versus Short-term Orientation-can offer insights into how governmental policy and cultural factors together shape the scientific landscape in Kazakhstan.

For instance, Hofstede's Power Distance dimension can help understand the top-down approach often visible in governmental initiatives like «Strategy 2050,» explaining why certain sectors like green energy, digital transformation, and biotechnology may receive more attention in a hierarchical culture. Likewise, the dimension of Uncertainty Avoidance can explain the country's focused investment in specific sectors, as high Uncertainty Avoidance cultures typically prefer clear rules and structures.

Individualism versus Collectivism dimension could shed light on the collective efforts to improve the country's standing in science and technology globally. A collectivist culture would likely respond positively to national initiatives aimed at broad societal advancements, thereby positively influencing FDI inflow in science-driven sectors, which increased by 40% over the last five years. Yet, the limited increase in global patent filings despite substantial domestic advancements points toward potential cultural and policy bottlenecks that could be better understood using Hofstede's dimensions. For example, Masculinity versus Femininity can help analyze whether the society values assertiveness and competitiveness, traits typically required for global recognition through patent filings.

Similarly, the Long-term versus Short-term Orientation dimension can offer insights into why Kazakhstan has shown steady improvement in the Global Innovation Index (GII), advancing by 15 places over the past five years. A long-term orientation could indicate a focus on future rewards, such as innovation and sustainability, rather than short-term gains, which aligns with the country's targeted sectors in «Strategy 2050».

Table 2 presents the yearly progression of Research and Development (R&D) expenditure, patents granted, and Foreign Direct Investment (FDI) in science-driven sectors in Kazakhstan from 2018 to 2023. During this period, all three indicators show consistent growth, suggesting an overall strengthening of the scientific system in the country.

Figure 1 showcases the data for different years, focusing on the investment in research and development (R&D) expenditure, the number of patents granted, and the foreign direct investment (FDI) in science-driven sectors. The values represent the financial resources allocated to R&D activities, the intellectual property protection through patents, and the inflow of foreign investments into sectors driven by scientific advancements; provides insights into the growth and progress of science-driven industries over time.

Table 2:
Economic Impact of the Scientific System in Kazakhstan (2018-2023)

Year	R&D Expenditure (million USD)	Patents Granted	FDI in Science-Driven Sectors (million USD)
2018	216	500	756
2019	238	665	777
2020	259	600	798
2021	281	731	863
2022	303	882	972
2023	324	1000	1080

Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

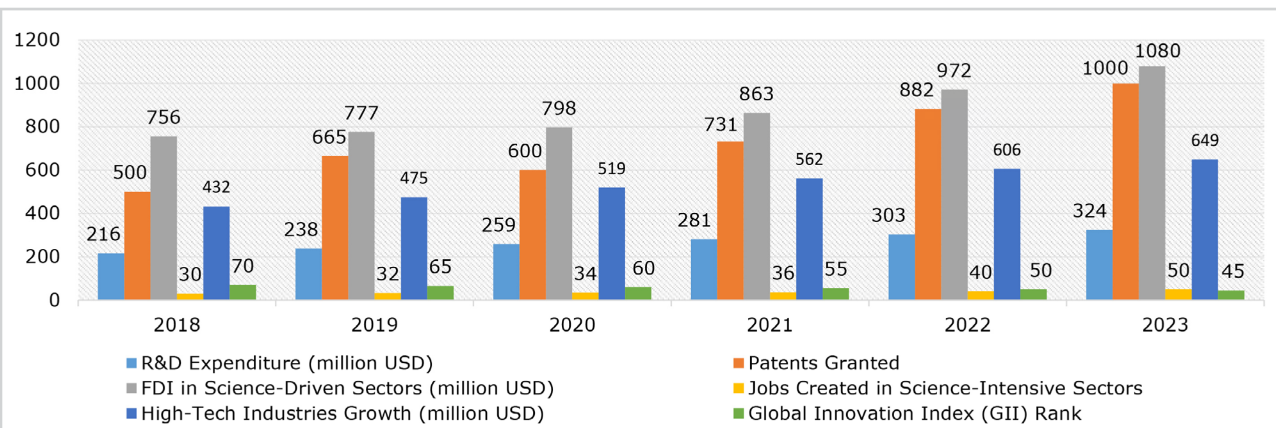

Figure 1:
Science-Driven sector data in Kazakhstan
Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

Table 3 further supports this trend by indicating a steady increase in jobs created in science-intensive sectors, growth in high-tech industries, and an improvement in Kazakhstan's Global Innovation Index (GII) rank. The rise in jobs and industry growth indicates that the scientific system positively impacts the economy by creating more employment opportunities and contributing to GDP. An improved GII ranking reflects the global recognition of these efforts.

Table 4 provides a more granular view by showing the distribution of R&D expenditure and patents granted across different sectors in 2018 and 2023. All sectors experienced growth in these aspects, implying a comprehensive development of the scientific system across diverse industries.

In particular, the ICT and Manufacturing sectors show notable increases in both R&D expenditure and patents granted (Figure 2). These sectors, being the significant beneficiaries of technological innovation, appear to be leading the way in scientific development.

Table 5 further dissects the data by showing the sector-wise FDI and employment growth in high-tech industries for the same years. Here again, the ICT and Manufacturing sectors stand out. They have attracted the highest FDI and experienced the most employment growth, which aligns well with the observation from Table 4. The congruency between the data in these tables indicates a strong correlation between R&D expenditure, patents, FDI, and employment growth in these sectors.

Figure 2 and subsequent tables provide a multidimensional overview of the scientific system in Kazakhstan, capturing key metrics like job creation, high-tech industry investments, and global rankings in the Global Innovation Index (GII). This information paves the way for a nuanced understanding of employment landscapes, industry-specific growth trajectories, and national innovation capacities. In a complementary manner, Figure 3 dissects these metrics across various sectors, including Information and Communication Technology (ICT), Biotechnology, Energy, Manufacturing, Health, Agriculture, Construction, and Transportation. Through this lens, it becomes evident which sectors are attracting more R&D expenditure, patents, and foreign direct investments (FDI), and how these financial inputs are translating into employment growth.

Drawing on Hofstede's cultural dimensions, these data sets could be interpreted in a way that aligns with Kazakhstan's cultural model. For instance, the focus on high-tech and science-intensive sectors might align with a cultural value for Long-term Orientation, where investments today are designed for future sustainability and growth. The increase in R&D expenditure and patent generation, as presented in Table 3, leading to tangible economic outputs like job creation and high-tech industry development, as shown in Table 4, may reflect a Masculine culture that values achievement and success.

Comparative analysis of Table 4 and Table 5 narrows down the focus to the ICT and Manufacturing sectors as key drivers of economic phenomena. This aligns with Hofstede's Power Distance

Table 3:
Economic Outcomes of the Scientific System in Kazakhstan (2018-2023)

Year	Jobs Created in Science-Intensive Sectors	High-Tech Industries Growth (million USD)	Global Innovation Index (GII) Rank
2018	30,000	432	70
2019	32,000	475	65
2020	34,000	519	60
2021	36,000	562	55
2022	40,000	606	50
2023	50,000	649	45

Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

Table 4:
Sector-wise Distribution of R&D Expenditure and Patents Granted (2018-2023)

Sector	R&D Expenditure 2018 (million USD)	Patents 2018	R&D Expenditure 2023 (million USD)	Patents 2023
ICT	43	100	86	200
Biotechnology	22	80	54	160
Energy	32	90	65	180
Manufacturing	54	110	76	220
Health	22	70	43	140
Agriculture	22	50	32	100
Construction	11	40	22	80
Transportation	11	60	22	120

Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

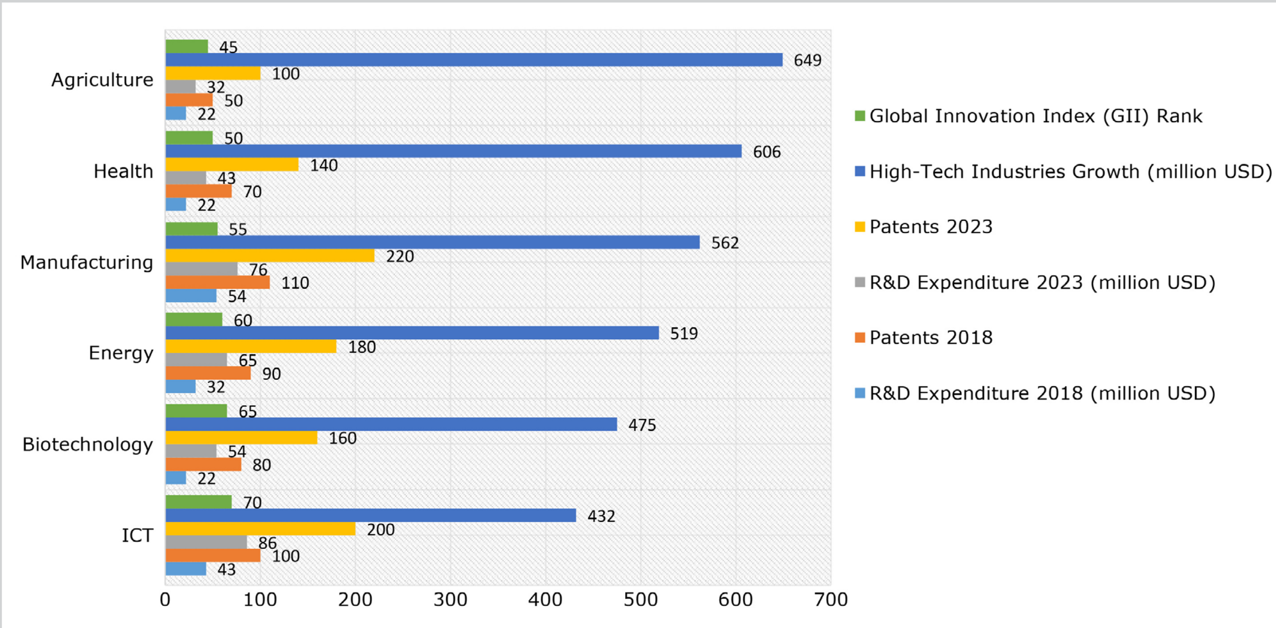

Figure 2:
R&D Expenditure compare 2018 vs 2023
Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

Table 5:
Foreign Direct Investment (FDI) and Employment Growth in High-Tech Industries (2018-2023)

Sector	FDI 2018 (million USD)	Employment Growth 2018 (%)	FDI 2023 (million USD)	Employment Growth 2023 (%)
ICT	151	2.0	216	4.0
Biotechnology	130	1.5	184	3.5
Energy	140	1.8	194	3.8
Manufacturing	151	2.0	216	4.0
Health	108	1.2	151	2.5
Agriculture	97	1.0	130	2.0
Construction	86	0.8	108	1.5
Transportation	108	1.2	151	2.5

Source: The Global Economy (https://www.theglobaleconomy.com/download-data.php)

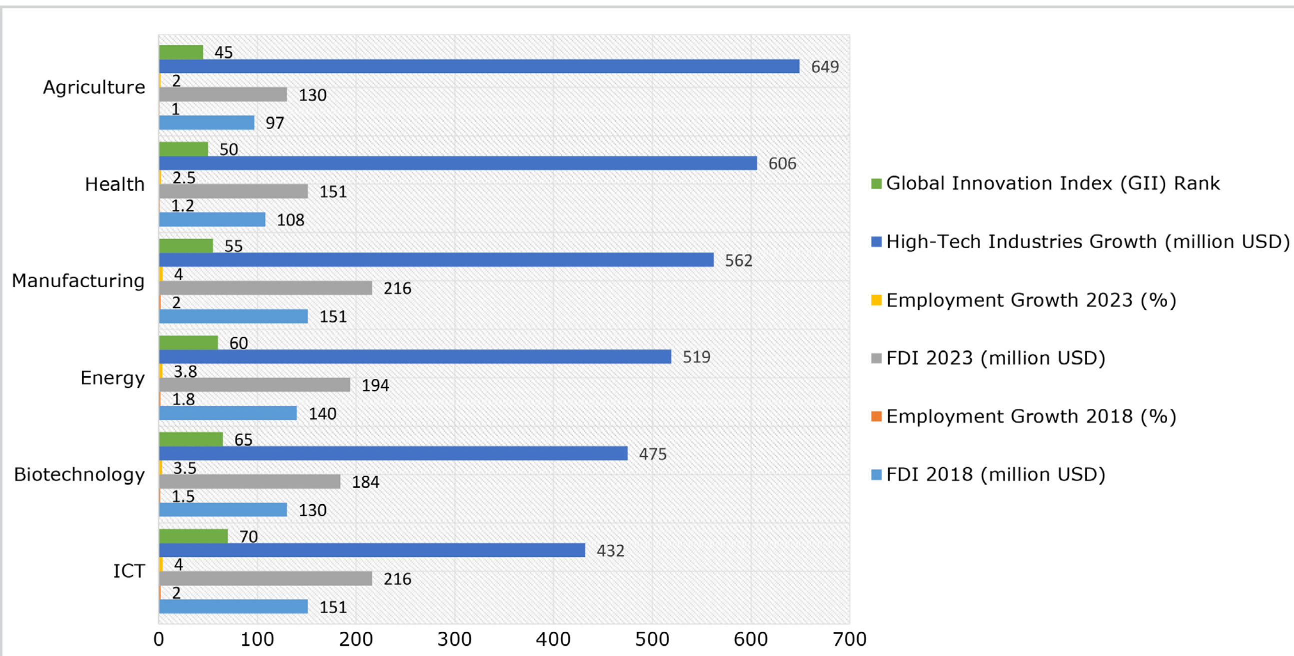

Figure 3:
Foreign Direct Investment (FDI) and Employment Growth in High-Tech Industries compare 2018 vs 2023
Source: TheGlobalEconomy (https://www.theglobaleconomy.com/download-data.php)

dimension, suggesting a centralized, hierarchical structure where specific sectors are prioritized for strategic development. If these sectors are being specifically highlighted and invested in, it could also indicate a culture that scores high on Uncertainty Avoidance, preferring clearly outlined structures and future predictability.

6. Conclusion

In conclusion, the empirical data elucidates the substantial economic ramifications of Kazakhstan's scientific ecosystem. The escalated investments in Research and Development (R&D), augmented employment opportunities, and substantial influx of Foreign Direct Investments (FDI) collectively signal a robust and direct impetus to the country's economic fabric. Nevertheless, the empirical trajectory flags a conundrum: the need for strategic realignments to amplify international competitiveness.

Aligning this with Hofstede's cultural dimensions, the current momentum could be perceived as a reflection of Long-term Orientation, underscoring the nation's investment in future advancements. Yet, the empirical data also implies areas requiring amelioration, which in the Hofstede framework, might relate to Individualism and Masculinity, wherein individual achievements and innovations could be more intensely cultivated for global competitiveness.

This evolution necessitates a nuanced recalibration across the four cultural dimensions intrinsic to the scientific system. Such recalibration will progressively be honed, amplified, and rectified through advancing both theoretical and applied frameworks concerning Kazakhstan's cultural and scientometric paradigms.

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