Human capital and liberalization in Central Asia: comparative perspectives on development (1991 – 2020)

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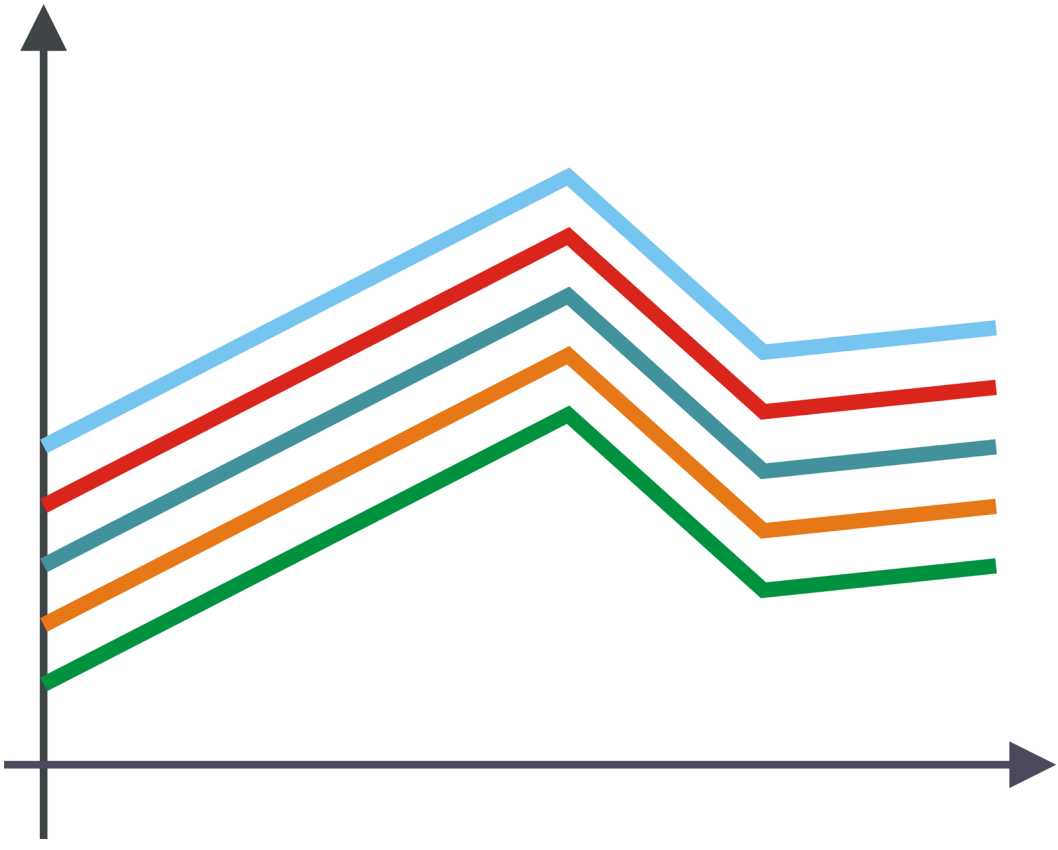

Berdymyrat Ovezmyradov
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Berdymyrat OVEZMYRADOV and Yolbars KEPBANOV

1 Introduction

Relevance of comparative studies in Central Asia

This research report includes four chapters on selected development topics in the Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. The overall purpose is to contribute insights on the role played by human capital and liberalization in important areas concerning sustainable development: science, foreign investment, renewables, and online presence. The report attempts to understand commonalities and differences in the studied areas across the countries and puts them in the perspective of development in the entire post-Soviet area. The comparative studies offer new ways of understanding Central Asia considering the distinct features of the countries in the region and how these changed over the period from 1991 to 2020. A discussion of findings and implications highlights how stakeholders in the region and beyond can influence positive developments in the studied areas. The report was written in a manner hopefully accessible to *non-specialists with brief explanations of the main terms in each studied topic.* Results will be of interest to policymakers, scholars, and students in the field of Central Asian studies.

There have been no recent studies providing a comparative analysis of Central Asian countries on their performance in renewable energy, investment climate, digitalization, and contribution to global science. Another factor adding to the timeliness of the studies presented in this report is the heightened concern about the sustainability of recent policies and prevailing practices in the region. After the pandemic outbreak in 2020, the already inadequate funding of crucial spheres of human capital could worsen, and it becomes necessary to rethink the role of science, investments, energy, and digitalization in social-economic development in Central Asian countries in view of the declining value of commodity exports.

The novelty of the studies included in this report is in investigating aspects of the aforementioned interconnected topics that, to the best of the authors' knowledge, have not been analyzed by previous research on Central Asian countries. Taken together, these studies highlight crucial but often indirect or hidden links to human capital and liberalization. The lack of certain skills among the academic staff from

the region could contribute to the low research performance, not least because of neglecting globally recognized scientific indicators. Political and social liberalization here is a precondition to attracting and retaining the talent needed to modernize the science sector. As for renewables in Central Asia, solar and wind power in the region could remain underdeveloped partly due to the underestimation of fossil fuel cost, which is a result of a lack of expertise. Furthermore, human capital is too often neglected as a precondition for the positive impact of foreign investment in the long term. However, economic liberalization is necessary to improve the investment climate. Fewer restrictions online would also encourage local talent to create national content. And the presence of the national language, culture, and knowledge online seems to be an underestimated factor in digitalization and nation branding. In all the studies, it is argued that excessive government control and a shortage of skilled staff can be identified as one of the main possible causes of slow progress. With the above considerations, it is reasonable to suggest that both liberalization and human capital could partly explain differences in transition economies.

A deeper understanding of the studied problems and the results of comparisons in the region would not be possible without the consideration of its Soviet background. Therefore, the studies in this report cover the Soviet period to some extent. International organizations were always crucial for providing access to the funds, facilities, and knowledge for the top areas of concern for development. Accordingly, the report dedicates sufficient space to the issues of foreign assistance and influence in the sections discussing implications. All presented studies contain a separate section discussing the implications of the main results.

Methods and limitations

Methodologically, the presented studies mainly rely on the analysis of data available from international organizations and, to a lesser extent, official government statistics. Throughout the report, visualizations and time series are frequently used. The strength of the analysis is derived from the scale and depth of the data on the countries accumulated by global and national bodies over the three decades of their independence. The data availability presents a clear advantage of producing quantified results and figures for objective comparisons between countries. Findings of analysis based on data from reputable sources are often deemed more reliable and convincing. This is particularly true in policymaking, when expert opinions might differ.

The weakness and limitations of the studies, however, come from the same reliance on quantitative methods and indicators: they cannot provide the same depth of analysis to explain many causes and motives that qualitative and other methodologies

offer. Inadequate statistics is another serious limitation. As the subsequent sections clearly show, detailed and accurate data on certain relevant indicators are often missing for most Central Asian countries from 1991 to 2019. Due to data availability and other limitations, statistical analysis is mostly conducted at basic levels without advanced methods such as difference tests and regression analysis. Therefore, no strong statements can be made about the statistical significance of the results. Each subsequent study ends with a discussion of major limitations and suggestions for future studies. In addition to strengths, an acknowledgment of the weaknesses of the chosen methods is also discussed in more detail at the beginning of each chapter. The repeated warning throughout the corresponding discussions of methods, implications, and future research is the need to exercise caution when interpreting and generalizing the results of data analysis. Consequently, another statement repeated throughout the report stresses the importance for Central Asian governments to fix issues involving inaccurate and missing statistics in order to develop in those respective areas.

Outline

The following four chapters present different studies that explore diverse aspects of liberalization and human capital development in the context of Central Asia. They can be summarized as follows.

The next chapter makes an attempt to compare the science sectors of Central Asian countries utilizing quantified indicators for analysis. Despite specific progress in international cooperation and academic mobility, the science sectors in Central Asian countries have shown lackluster performance relative to other post-Soviet countries. The countries that achieved higher levels of liberalization also lead the region in research indicators: Kazakhstan substantially improved productivity and Kyrgyzstan demonstrated higher output relative to population and economic size. Uzbekistan showed an overall declining research impact in the recent decade. Tajikistan and Turkmenistan need to improve low research indicators and create better conditions for making scientific progress as per modern standards. The study presents recommendations for policymakers on how the evaluation of research performance based on globally recognized indicators and transparent decision-making can help improve the positions of Central Asian science in international rankings. The analysis also suggests liberalization and internationalization could be necessary conditions for the improvements in scientific development and global position. Specifically, democratizing institutions and promoting globally recognized measures of research performance are important for the development of human capital in the science sector.

The third chapter aims at identifying the common causes, patterns, and effects of changing foreign investments across the countries of Central Asia. The experience of neighboring countries in Central Asia as a distinct region of the world attracting foreign investment is particularly relevant for each country in the area. Therefore, the comparative analysis of the Central Asian countries presented in this report for their first three decades after gaining independence is particularly relevant given the global shifts in 2020. Growth in direct foreign investment was fueled by extractive industries throughout Central Asia. This development has been highly volatile during the whole studied period. Foreign investments overall declined between 2009 and 2020. Substantial progress in liberalization, human capital, the rule of law, and democratization is needed for Central Asian countries to attract foreign investment beneficial for local populations in the long term.

The fourth chapter analyzes non-hydro renewables in Central Asia. The cost of renewable energy from wind and solar plunged in 2019 to the low levels that few policymakers had anticipated only several years before. Such technological developments have broad implications for all Central Asian economies. The share of wind and solar energy in the region remained negligible for a long time due to the abundant supply of cheap energy from fossil or hydro resources. Central Asian countries, to differing extents, remain dependent on the consumption, export, or transit of fossil fuel. While there was obvious progress in renewables elsewhere in the post-Soviet area, Central Asia, until recently, has not shown adequate levels of interest in developing wind and solar power. Such an approach could lead to a loss of opportunities in reducing electricity costs and addressing sustainability issues. Governments in the region can seize the opportunities for introducing a more sustainable energy mix during the major modernization and replacement of power generating capacity expected in the coming years. Foreign investors and specialists in installing renewables capacity can benefit from an investment in renewable energy in Central Asia. This approach is fully consistent with the provisions of the Paris Agreement on climate change. Its meaning is in the transition from fossil fuel-based technologies that have a harmful effect on the environment to science-based technologies focused on renewable sources with a minimal impact on the environment. This would enable a reduction of the risks and costs associated with the uneven distribution and depletion of resources. The degradation of the environment due to anthropogenic impact could be minimized, thereby increasing economic stability and creating conditions for investment and economic growth.

The final chapter makes an attempt to measure the online presence of Central Asian countries and their main languages with the aid of Wikimedia and Google, two publicly available internet resources massively used around the world. The number of pages and mentions on those immensely popular platforms can serve as approximate indicators of both the interest in the countries and the progress of digitalization. Such indicators might also reflect the global interest in the national

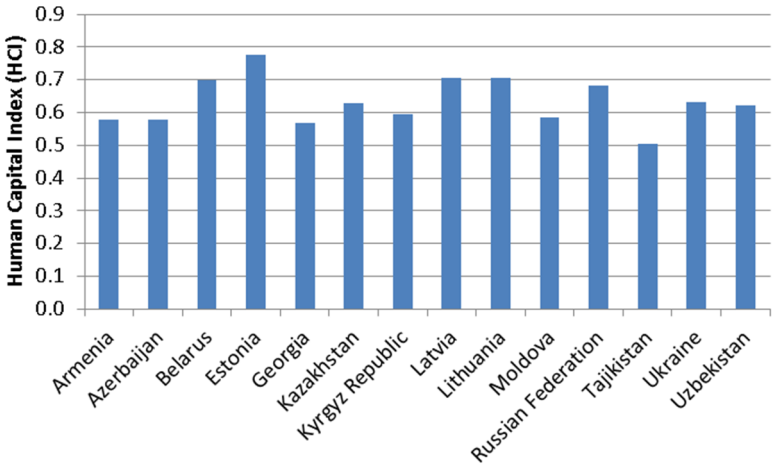
culture and language. Changes in the popularity of alternative names happened before, during, and after the Soviet era. Central Asian countries in general lagged behind comparable post-Soviet countries in creating online content.

Main implications

The central argument of this report is that firm long-term development in the key studied areas is hardly possible without adequate development of human capital, but in turn, the human capital itself needs higher levels of liberalization to be sufficiently developed. Before discussing liberalization and human capital in the subsequent chapters, it is important to provide clear definitions of both terms used in this report.

Liberalization can generally be defined as the loosening of excessive government control but is often applied in a narrower context of social, economic, and political matters (Brumberg 2005, Britannica 2021). The collapse of the Soviet Union and similar socialist states after 70 years clearly illustrated the dangers of excessive government control, though a poorly implemented policy of hastened economic liberalization could also be harmful to sustainable human development and growth in many developed countries (Gore 2000).

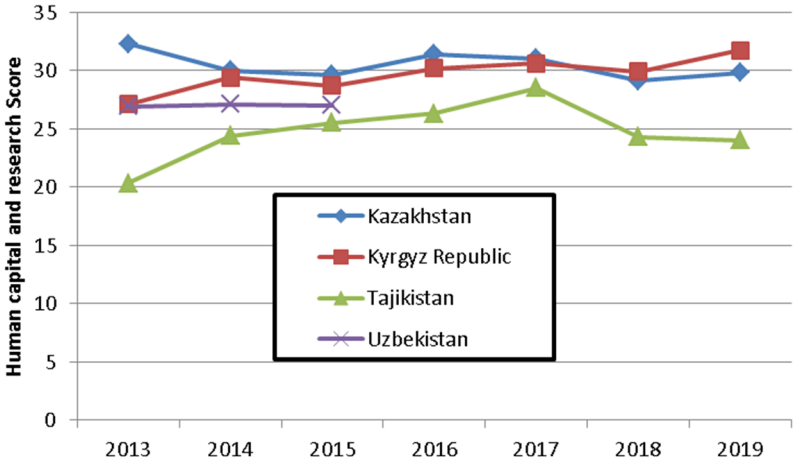
Alternatives exist for human capital methodologies. As a popular metric, the Human Capital Index (HCI) quantifies three components: survival from birth to school age, expected years of learning-adjusted school, and health (World Bank 2020). The definition of human capital by the World Economic Forum adopted in this report gives preference to capacity, development, deployment, and know-how (Samans 2017). This method emphasizes workforce, talent, and economics – human capital components that are directly relevant to topics covered in this report. Among the important indicators for this report are literacy, education, employment, staff training, employee qualifications, and economic structure. Figures 1.1 and 1.2 illustrate how indicators of human capital could differ according to methodology.



Note: no data available on Turkmenistan.

Fig. 1.1 Human Capital Index of post-Soviet countries in 2020 (World Bank 2020).

Among the post-Soviet countries, more liberalized states achieved the highest levels of human capital (Figure 1.1). When combining human capital and research in one indicator, Central Asian countries with higher levels of liberalization seemed to improve their development outcomes, with Kyrgyzstan leading the region in the most recent years (Figure 1.2).



Note: no data available on Turkmenistan.

Fig. 1.2 Change in human capital and research score of Central Asian countries according to the global innovation index (TCdata360 2021).

Unlike human development, there was no single acceptable index to measure the level of liberalization of the country. The focus of implications in the presented studies is on social and political liberalization, though economic liberalization is always taken into account. Allowing greater individual freedoms is believed in this report to be more beneficial for human capital in the long term than loosening control over the economy. Figures 1.3 to 1.6 show selected indicators believed by the authors of this report to express certain aspects of liberalization. Those figures are based on data available from the Worldwide Governance Indicators by the World Bank (2021). Those aggregate indicators are based on a large number of survey respondents and expert assessments worldwide. Each indicator ranges from approximately -2.5 (weak) to 2.5 (strong) governance. Regulatory quality reflects perceptions of the ability of the government to implement sound regulations that permit and promote private sector development. This regulatory indicator is obviously more related to economic liberalization. The voice and accountability indicator reflects perceptions of the extent of participation in selecting a government, as well as freedom of expression, freedom of association, and a free media. This indicator is related to socio-political liberalization. The rule of law reflects perceptions of the extent of confidence in and abiding by the rules of society, including the quality of contract enforcement, property rights, the police, and the courts. The rule of law is related to the topic because even the best policies towards liberalization will not be successful without consistent implementation and trust in regulations. Government effectiveness is related to political liberalization and includes perceptions of the degree of independence from political pressures, the quality of policy formulation and implementation. A set of arbitrarily chosen quantified indicators for comparison purposes is not able to capture every facet of liberalization. Though definitely not exhaustive and perfect, the estimates of the aforementioned indicators shown in the table and the figures below could serve as combined measures of important aspects of liberalization in the absence of a single index to evaluate the same in country comparisons.

Table 1.1 allows comparisons to be made between all post-Soviet countries in their recent liberalization levels. The countries can be divided into the following groups according to their achievements in good governance. First, the Baltic states (Latvia, Lithuania, and Estonia) are countries that made earlier and more sustained transitions to democracy. They also achieved the highest levels of good governance and liberalization in the post-Soviet area. The second group is comprised of countries with hybrid regimes that experienced an uneven path in achieving a state of democracies; this group includes countries with moderate to high levels of good governance and liberalization, such as Kyrgyzstan, Armenia, Georgia, Moldova, and Ukraine. The largest group comprised the remaining post-Soviet countries that are either authoritarian states or those that were once hybrid regimes. These countries achieved lower to moderate levels of good governance and liberalization. Unfortunately, the Central Asian countries did not rank high in most indicators of

governance and liberalization. Kazakhstan and Kyrgyzstan were still Central Asian leaders in this respect.

Table 1.1 Estimate of governance performance in post-Soviet countries as of 2019 according to the Worldwide Governance Indicators (World Bank 2021)

Country	Government Effectiveness	Regulatory Quality	Rule of Law	Voice and Accountability	Average for all indicators
Armenia	-0.06682	0.249515	-0.13128	0.050043	0.025366
Azerbaijan	-0.13918	-0.22664	-0.57727	-1.49179	-0.60872
Belarus	-0.18333	-0.54378	-0.79446	-1.4025	-0.73102
Estonia	1.174747	1.591124	1.281257	1.210472	1.3144
Georgia	0.829923	1.122067	0.309979	0.196047	0.614504
Kazakhstan	0.124713	0.137227	-0.43241	-1.21283	-0.34582
Kyrgyzstan	-0.68152	-0.34735	-0.8863	-0.45737	-0.59313
Latvia	1.105028	1.192686	1.013924	0.884952	1.049147
Lithuania	1.043381	1.157364	1.022871	1.024853	1.062117
Moldova	-0.3834	0.009787	-0.37303	-0.08994	-0.20915
Russian Federation	0.150365	-0.43162	-0.72369	-1.10008	-0.52626
Tajikistan	-1.04901	-1.01107	-1.22794	-1.82959	-1.2794
Turkmenistan	-1.15624	-1.9576	-1.41479	-2.13147	-1.66502
Ukraine	-0.29658	-0.25867	-0.69835	0.055238	-0.29959
Uzbekistan	-0.51465	-0.99329	-1.04818	-1.60551	-1.04041

The following figures reflect dynamics of change in the Worldwide Governance indicators of Central Asian countries between 1996 and 2019. According to Figures 1.3 to 1.6, Central Asia seemed to make slow and uneven progress in the selected indicators of liberalization. Kazakhstan improved regulatory quality recently, while other countries mostly stagnated in this respect (Figure 1.3). In voice and accountability, there were declines across the region, with the exception of Kyrgyzstan (Figure 1.4). In all Central Asian countries, there was a trend towards strengthening the rule of law since 2007, though it was neither substantial nor even for most countries; Kazakhstan was still leading with significant gains in the recent decade (Figure 1.5). Besides Kazakhstan, there was no clear tendency towards regional improvement in government effectiveness when considering the entire period (Figure 1.6). Overall, Kazakhstan and Kyrgyzstan seemed to achieve higher gains in liberalization.

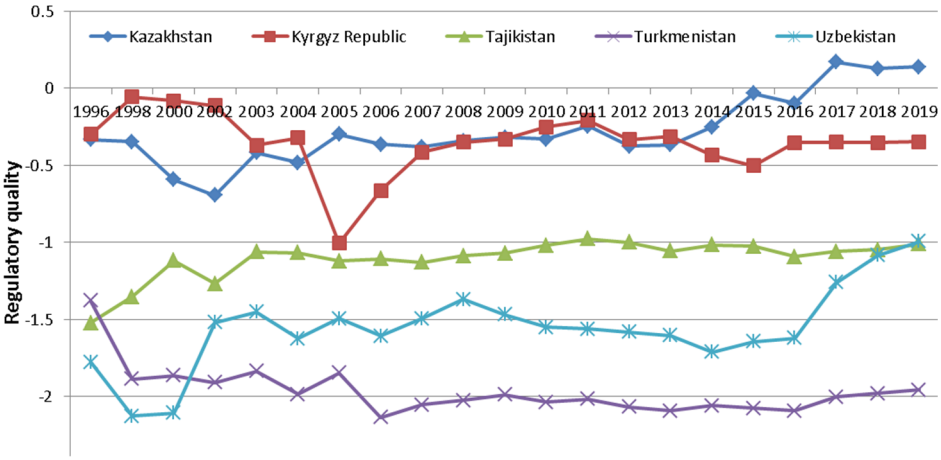


Fig. 1.3 Estimate of governance performance in regulatory quality according to the Worldwide Governance Indicators (World Bank 2021).

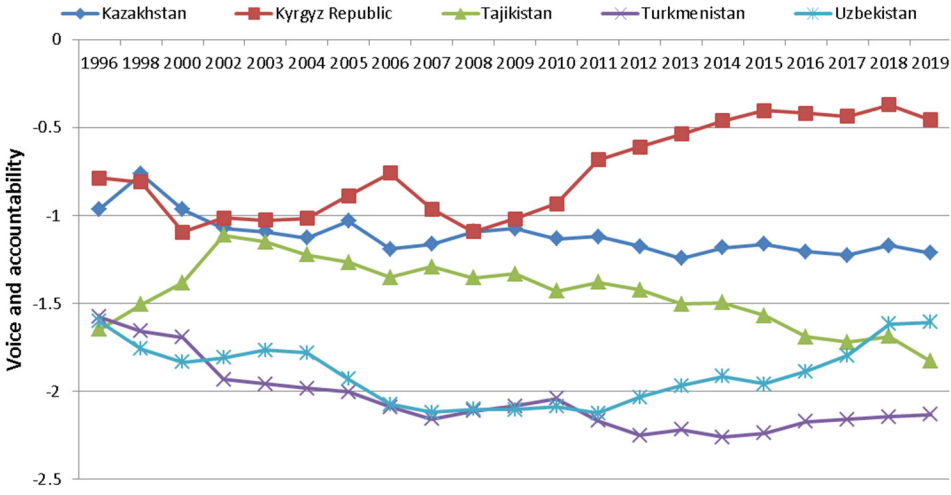


Fig. 1.4 Estimate of governance performance in voice and accountability according to the Worldwide Governance Indicators (World Bank 2021).

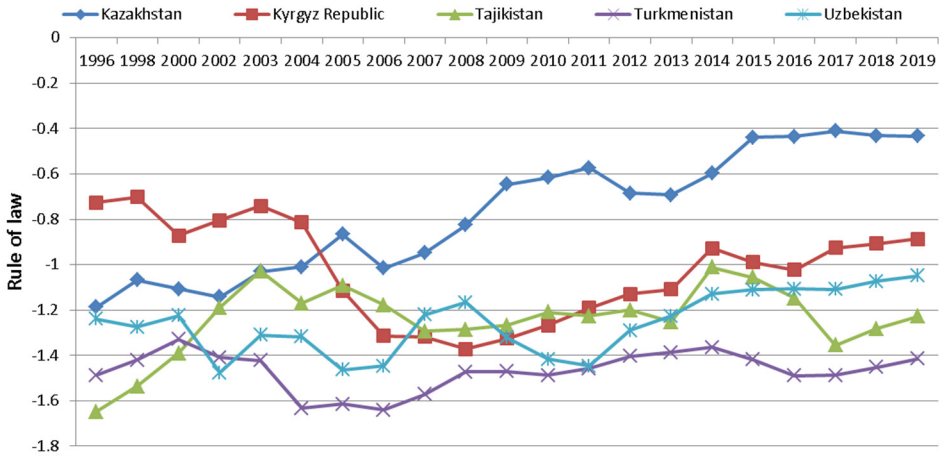


Fig. 1.5 Estimate of governance performance in rule of law according to the Worldwide Governance Indicators (World Bank 2021).

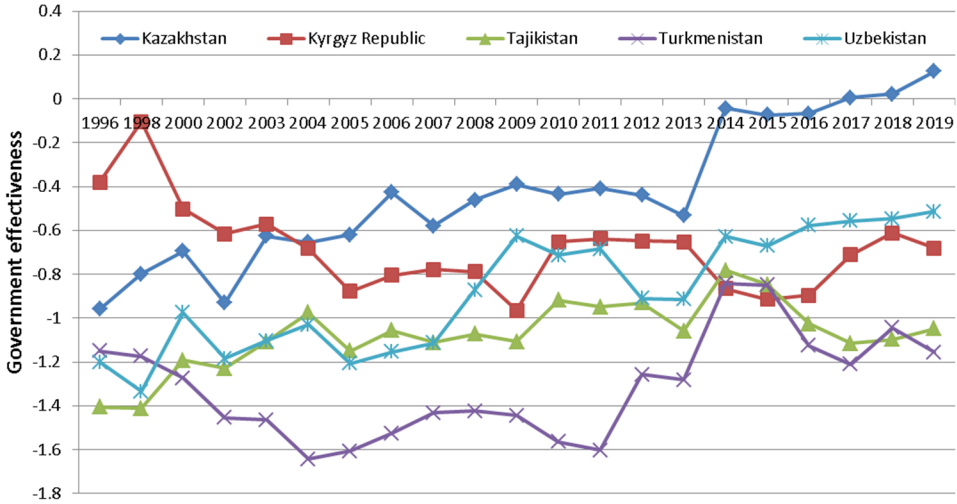


Fig. 1.6 Estimate of governance performance in government effectiveness according to the Worldwide Governance Indicators (World Bank 2021).

For almost three decades, newly independent countries have tried to develop policies and institutions to become more competitive in the increasingly global market. These processes are analyzed in this report through comparative studies of Central Asian and other post-Soviet countries. One or more of the 15 post-Soviet countries were included in certain comparisons to demonstrate their relative performance with respect to Central Asia. As illustrations, Ukraine, Armenia, Georgia, Moldova, and all the Baltic states achieved decent performance in the global rankings. Those

countries also demonstrated relatively more progress in liberalization and democratization. In relative terms, the liberal democracies often outperformed hybrid and authoritarian regimes. Even within Central Asia, more liberalized states seemed to perform better in many indicators.

With the aid of international partners, Central Asian governments could promote the necessary institutional reforms for the long-overdue liberalization of policies and institutions through expanding government privatization programs, reducing ideological influences, eliminating excessive control, enhancing transparent decision-making, objective performance evaluations, and providing more autonomy. Importantly for Central Asian states, political liberalization is not equal to democratization but can bring positive effects for both authoritarian government and society even in the absence of full-blown democracy, as so-called liberalized autocracies in the Middle East have demonstrated (Brumberg 2005). As Table 1.1 showed earlier, few authoritarian countries in the post-Soviet area seemed to achieve comparable or even slightly lower levels of governance and liberalization in certain indicators compared to hybrid regimes. The governments of most Central Asian countries seem unlikely to cede the control levels sufficient for serious democratization. It is nevertheless necessary to expand research on the political and economic liberalization required to bring the progress in sustainable development desired by the governments and populations in the region.

Beyond an understandable suspicion of autocrats, liberalization policies advocated by richer, developed countries and international organizations have often been criticized by many developing countries and scholars as a part of a broader market-reforms approach (known as the *Washington Consensus*) that could threaten equitable and sustainable growth (Gore 2000). Instead of unconditional and maximum liberalization, the implications discussed in this report argue that a bolder but at the same time measured decrease in government control throughout Central Asia is urgently needed to match or at least catch up to the development levels demonstrated by more successful economies in the post-Soviet area and within the Central Asian region itself. The arguments of finding unique "national" paths or needing extra time for adaption simply do not hold after three decades of independence when other states in the post-Soviet area that had comparable starting conditions achieved much higher progress after liberalization. Finally, the benefits of providing more freedom to the economy and society become even more obvious when considering the particularly powerful role of liberalization for nurturing and attracting human capital identified in this report as a crucial factor for the sustainable development of Central Asian countries.

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2 Comparative Analysis Between Central Asian Countries in Scientific Indicators

Introduction

Even though the starting conditions were similar to a certain extent at the moment of the Soviet Union's collapse, each Central Asian country later diverged with unique characteristics in the national science sector that reflected the paths of economic and political development specific to each transition economy. Nearly three decades of independence in this region has provided data on scientific development, which has not been adequately studied. This report aims at comparing research performance within Central Asian countries using quantified indicators. This topic is essential because it could provide valuable information on scientific development, a crucial transition to knowledge and the digital economy. Currently, there is a shortage of academic, technical, and non-academic literature on scientometric measurements in Central Asia. To the best of the authors' knowledge, the most recent report with greater inclusion of quantified indicators of research output was published around 2016 (UNESCO 2016). This study is a continuation of the authors' previous work on the internationalization of Central Asian research and higher education (Ovezmyradov and Kepbanov 2020).

This study addresses the following questions: (i) What are the most important developments in research productivity and impact in Central Asia? (ii) How does the research performance of the science sectors in Central Asian countries compare to other post-Soviet countries? A variety of quantified indicators was used to gain

insights, but the analysis of publications from databases provided by SCImago and Web of Science (WoS) form the basis of the study. The region mostly lagged behind post-Soviet comparator countries in significant indicators of development in research. Since the countries would have to reduce reliance on the export of natural and labor resources, this will be critical to developing human resources for future growth based on the knowledge economy. Meanwhile, a shortage of highly skilled personnel in science and other sectors is a severe obstacle for creating innovations and making scientifically based decisions in the region. Therefore, the objective evaluation and promotion of science could be essential for becoming more competitive in R&D.

The following sections cover scientific indicators before and after the collapse of the Soviet Union, international rankings, and developments in each Central Asian country. The chapter ends with a discussion of implications and conclusions for policymakers and foreign partners.

Scientometric method

Since the 1970s, the analysis of citations and databases has come to play a significant role in the measurement and evaluation of research performance in funding, hiring, and policymaking. In this chapter, terms such as document, paper, item, and article are used interchangeably to refer to the peer-reviewed types indexed in the global databases: academic articles, reviews, and conference proceedings. Comparative analyses between Central Asian countries in this study are based on scientometrics – quantitative methods of studying science. The brief description of the scientometric approach, its strengths, and weaknesses, is based on the review by Mingers and Leydesdorff (2015).

No perfect measures of research performance exist, but the global scientific community seems to agree on the two indicators: number of published documents and number of citations. These are accessible metrics, which are incorporated in the majority of indicators used in this study. Those main indicators affect countries' relative positions and their institutions in the global academic rankings, which are also included in the analysis. The number of publications, sometimes differentiated as being citable documents, is the traditional measure of research productivity. The total number of citations is the primary measure of research impact. If a paper has never been cited, it is not necessarily low-quality, but its content is almost certainly disconnected from the respective scientific field. A standard measure of article performance is citations per document, while for countries and publishers, it would correspond to average cites. The easy to interpret *h* index, another standard measure of the quality of the publication record, means the number of papers that received

at least *h* citations. This index is usually applied at the level of individual researchers but can also be calculated for separate institutions and countries. Indices such as the *h* index (including Google Scholar's *h5*), based on combinations of citations and number of publications, are more convenient for measuring both the volume and quality of scientific work in a single value. Percentile-based measures such as a certain top percentage of the papers with the highest citations are increasingly being adopted.

The limitations of the described methods have to be acknowledged before presenting and interpreting the results of the study analysis. Articles in STEM areas tend to have more authors than those in the social sciences and humanities; thus they generate more papers and citations per authors in STEM. The same applies to particular times, types, and places of publication, both between and within various disciplines. Therefore, citation-based indicators must sometimes be normalized depending on the scientific field or the publisher, though this seems relevant for country comparisons. Average citation values do not reflect the number of publications: 20 citations per document could mean only one paper or a hundred papers with 20 citations each. The mean value is generally problematic for statistics in the highly skewed distribution of citations in science. Composite indicators such as the *h* index put young scholars and highly cited researchers with few papers at a disadvantage. Science in developing countries has experienced the perverse effects of researchers, journals, and institutions chasing a higher number of publications and citations to the detriment of quality, as happened in China (Roach 2018). Despite their superiority in a descriptive study from the viewpoint of objective comparability and precision, quantified indicators are poorly suited to explain underlying reasons, hidden motives, and other factors where qualitative methods could be more effective. Since no accurate data was available on the sizes and variability of scientific indicators across all countries and years of comparisons, the statistical significance of the differences could not be determined in this study.

An alternative to quantified scientific indicators (scientometrics) would be a peer review – an evaluation of research output by experts. Such peer reviews have traditionally been highly valuable in academic publishing. Unfortunately, they are also known to be time-consuming and occasionally biased. Arguably, scientometrics is preferable to peer review as a low-cost and relatively accurate determination of country performance in Central Asia on which less expert knowledge and qualitative indicators are available. Intensive use of quantified indicators has other added benefits since it provides quantified results, which are harder to argue with and can be updated fast during the decision-making process.

Other measures complement the main scientometric indicators in the subsequent analysis. The relative measures used in this study include absolute measures divided by the total population or GDP of a studied country. It could be preferable to the total number of publications or citations in measuring relative success, as Central

Asian countries vary in size of population and economy. Sufficient attention is given to international cooperation, another important factor contributing to research performance, including academic mobility, participation in the Bologna Process, and other international activities. IF (Impact Factor, or journal-level two-year moving average) and science visualization (mapping) were excluded from the analysis due to the lack of data on certain Central Asian countries. Due to the limitations of the regional study, deeper analysis was not provided on the country level in the following indicators: science funding, number of researchers, number of institutions, percentage of highly cited documents and other measures of research excellence. Emerging indicators of social media such as downloads and views are outside the scope of this chapter.

The analysis combines a multitude of the following reputable databases of academic publications to ensure the validity and consistency of results: SCImago, Web of Science (WoS), and Google Scholar. The SCImago is a publicly available portal developed from the Scopus database (Elsevier B.V.) covering 27 thematic areas, 313 subject categories, 34 100 titles, 5 000 international publishers, and 239 countries worldwide as of 2021 (SJR – SCImago 2021). SCImago presents readily available research performance metrics for measuring international positions of academic institutions that could be absent from other global rankings such as those by Times Higher Education. The SJR (SCImago Journal Rank) indicator expresses the average number of weighted citations received in the selected year by the documents published in the three previous years. SIR (SCImago Institutions Rankings) is a classification of research-related institutions ranked by a composite indicator combining research performance, innovation outputs, and societal impact (online visibility). Importantly, SCImago data has been free and available at the levels of countries, academic journals, and institutions since 1996 (however, full access to the more detailed information available in Scopus is subscription-based). The WoS platform covered 1.9 billion cited references, 170 million records, and 34 600 journals as of 2021 (Clarivate 2021). Unlike the free portals, WoS is subscription-based but covers a greater timespan (since 1900) and multiple databases, including WOS, BIOSIS, CABI, FSTA, KJD, MEDLINE, RSCI, SCIELO, and ZOOREC. Google Scholar is generally regarded as a less reliable database but offers better coverage of research areas and outputs such as the social sciences and humanities and local and non-English publications, books, and online resources (Mingers and Leydesdorff 2015, Martin-Martin et al 2018). Google Scholar provides coverage of around 90% in most research subjects, while for WoS and Scopus, it is generally lower and differs between different fields (Mingers and Leydesdorff 2015). It should be noted here that even the leading academic databases might occasionally get contaminated by illegitimate content, or predatory or highjacked journals (Abalkina 2021).

Unfortunately, the inclusion of WoS and Scopus in most of the analyses in this study likely does not cover many local publications in the region. This happens because many institutions in Central Asia continue to accept articles in a limited number of national journals in fulfillment of requirements for obtaining advanced degrees and promoting researchers. Too often there is no requirement to publish in international journals indexed by the global research community. Despite limited coverage of regional publications, this research assumes that only two leading databases are sufficiently representative of the quality of Central Asian research. It can still be true that the peer-reviewed research indexed in the top databases captures globally commensurable forms of high-quality research dissemination (World Bank Group 2014).

Soviet background

To better understand the current state of science in Central Asian countries, it is worthwhile first to take a look at their Soviet past. The influences of communist ideology and the relative isolationism of socialist countries, mainly being closed to the researcher communities of developed countries (considered representatives of the rival "bourgeois"), were significant disadvantages for science in Soviet Union (Graham 1993). Famous Soviet scientists and even entire scientific fields experienced repressions at different points in time (Wrinch 1951, Graham 1993). The infamous campaign led by Trofim Lysenko in the mid-20th century against Soviet genetics was one of the most glaring examples. The centralized planning of higher education and science was not viable for developing post-Soviet science structures, and governmental initiatives that included more foreign influence were necessary to create a new and healthier basis for science (Dezhina and Graham 1999).

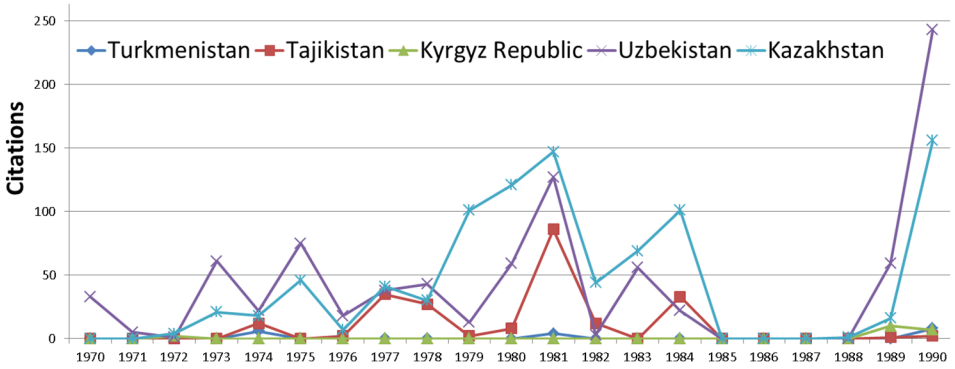
The shortcomings mentioned above, however, should not obscure the Soviet achievements in various research fields. The performance of the Soviet researchers was widely recognized in STEM and economics, with the number of Nobel Prize and Fields Medal winners unmatched by all post-Soviet states. Renowned aerospace projects and military technology also exemplified the remarkable performance in research and development. The popularization of science and gender balance in Soviet science was taken to levels that even the advanced Western countries struggled to achieve (Eveleth 2013). The majority of the research institutions in Central Asia were established during the Soviet period (UNESCO 2010; UNESCO 2016). Despite a limited translation to the English language, the total number of citations for the Soviet Union's publications was 818359, higher than in all post-Soviet states excluding the Russian Federation as of 2021 (see Table 1). Russian researchers historically assumed leading positions in the Soviet Union (Graham 1993). The experience and expertise of the top Soviet scientists contributed to the growth of

researchers and institutions in all parts of the Union, including Central Asia. The Soviet Union had the highest number of scientists and engineers in the world during the last decade of its existence (Graham 1993). Even decades after independence, holders of the Candidate of Science and other advanced Soviet degrees were widely recognized and made up a significant part of the researchers in Central Asia (UNESCO 2010, UNESCO 2016).

The positive aspects of belonging to the massive Soviet science sector could not be preserved, since the newly independent countries of Central Asia could not benefit from centralized transfers of funds, staff, and knowledge (Brunner and Tillet 2007). Adverse developments took place elsewhere in the post-Soviet area too. For instance, the collapse of the Soviet Union led to a crisis in financing and a brain drain affecting Russia's ability to maintain excellence in the natural sciences, engineering, and the popularity of scientific research (Dezhina and Graham 1999). What happened to Russian science soon after the collapse of the Soviet Union more or less applies to Central Asian countries as well. Meanwhile, the outdated Soviet legacy is still maintained in specific characteristics of the organization of the sciences in Central Asian countries that distinguish them from most developed countries and more Westernized post-Soviet countries (the Baltic states being relevant examples). Germany historically served as a model for the organization of Soviet science (Graham 1993). Some features of the model are still present in Central Asia: the central position of the national academies of sciences and specialized institutions in research as opposed to the greater role of universities in most developed countries (though Kazakhstan seems to have modernized in this respect, as Table 2.3 will show). University-level research with strong links to industry and business still seems underdeveloped. Science and higher education in Tajikistan and particularly Turkmenistan continues to rely on centralized government planning, with heavy dependence on the public sector and a lack of privatization even after the collapse of the Soviet Union, which does not help innovative growth (UNESCO 2010). Science sectors in Central Asia are probably still not free from ideological influences and limits on free speech imposed by the governments continuing the harmful Soviet tradition.

Figure 2.1 shows the limited data available in WoS on citations attributed to academic institutions in the Soviet republics of Central Asia from 1970 (the modern names of the former Soviet republics are shown). This database probably does not cover all publications and authors in the region due to the Soviet emphasis on local languages and the dominance of other Soviet republics as places of publication. The Soviet period, therefore, cannot be directly compared to the period of independent development. The data nonetheless allows conclusions to be drawn about relative research performance in the last decades of the Soviet Union. First, the Uzbek Republic seemed to have a leading position in most periods, closely followed by the Kazakh Republic, the country that later became a post-Soviet leader in Central Asian

science. Second, the Tajik Republic appeared to achieve higher performance for a short time in the late 1970s and early 1980s, but then declined to the lower positions comparable to Turkmenistan and Kyrgyzstan. Finally, the indexing of the regional publications in the global database soared in the last two years of the Soviet Union's existence, which coincided with the opening of the country. This growth again reinforces the idea that the research performance of Soviet (and Central Asian) science reflected in the global rankings would be even higher should the country be more open to the worldwide community beyond the socialist bloc. The exact conditions and other details surrounding Central Asian science during the Soviet and earlier periods are beyond the scope of this study, but they present an interesting direction for future study.



Note: citations are summed for all subsequent periods in the year of publication.

Fig. 2.1 The research impact of Central Asian republics in the Soviet Union (Clarivate 2021).

Regional performance

The interest of Central Asian governments in academic fields after the collapse of the Soviet Union has been motivated by expectations that technology can bring prosperity (Brunner and Tillett 2007). The governments promoted technology parks specializing in advanced research (UNESCO 2016). Reforms were implemented to modernize the science sector. Yet despite some progress in internationalization, scientific standards degraded in most post-Soviet countries (Brunner and Tillett 2007). There has been an urgent need for preserving already existing human capital in research because of worsening financing and brain drain (particularly in the 90s). Despite a shortage of recent papers on scientific developments in Central Asia, the available literature helps to identify the following issues pervading the science sector in all countries of the region: low R&D investment, loss of talent, ageing research workforce, corruption, inadequate scientific facilities, few new research institutions,

little industrial R&D, poor ICT infrastructure, few registered patents, and excessive reliance on higher education for the employment of R&D staff (ETICO 2004, Brunner and Tillett 2007, UNESCO 2010, UNESCO 2016). Researchers and institutions can be financed and promoted based on publications in local journals that are rarely indexed in the global databases. This study suggests that low research performance could partially be explained by another important cause: an outdated and untransparent system of promotion that lacks international standards.

A certain level of success in internationalization was among the developments in the science sector. The exact impact of internationalization and foreign aid on the number of publications and citations is hard to determine, but the performance probably would be lower without such support. Global academic mobility greatly expanded relative to the Soviet era (UNESCO 2020). Central Asian talent seemed to prefer pursuing advanced and continuing research abroad. The outbound mobility ratio among doctoral students from Central Asia between 2000 and 2013 was the highest globally (UNESCO Institute for Statistics 2015). Academic exchanges of researchers and professors undoubtedly intensified between Central Asia and many countries globally. Still, the lack of detailed data makes it difficult to make any statements comparing the respective performance. The Bologna process started in the 1990s in cooperation with European partners, making notable progress in the region with a mix of Soviet and modern Western academic structures of degrees. The majority of advanced degrees in the Central Asian countries correspond to the Soviet system of the Candidate of Science (roughly equivalent to the Ph.D.) and the Doctor of Science (a more advanced Soviet degree relative to the western Ph.D.). Soviet-style degrees are often unfamiliar to Western researchers, as are Western degrees to many Central Asian academic staff. Kazakhstan and Uzbekistan already switched to the Western degree structure, while other countries in the region preserved a combination of traditional and new degrees (UNESCO 2016). Mobility, recognition, and flexibility in obtaining advanced degrees are crucial for bringing new talent to the science sector.

The experience and assistance of highly developed Western and Asian countries have been highly relevant for nurturing a new generation of scholars. Foreign organizations providing research-related funding included the U.S. Department of State, USAID, TEMPUS, ERASMUS, DAAD, GIZ, MEXT and JASSO, the British Council, and many others. Numerous foreign grants have been received by academic staff from Central Asian countries. The Innovative Biotechnologies Programme and Centre for Innovative Technologies focused on scientific cooperation with Russian researchers (UNESCO 2016). Leading researchers could benefit from American, European, Japanese, and other programs covering travel and living costs to attend the science institutions of top countries, which otherwise could be prohibitively expensive for scholars from the region. Data on the mobility of researchers is limited, but Kazakhstan and Turkmenistan may be the Central Asian

countries of origin with the highest number of scholars relative to their populations entering the U.S. for study and research (SEVP 2020). TEMPUS and Erasmus Mundus have been the prominent programs through which European agencies supported critical institutional changes in many aspects of science, higher, vocational, and secondary education (Cabe et al 2013). Initiatives such as IncoNet CA encouraged the participation of regional researchers in Horizon 2020 projects funded by the E.U. Importantly, TEMPUS supported the first university-wide Internet access networks and initiated the Bologna process. The Central Asian Research and Education Network (CAREN) project connected institutions in the region. International partners supported institutional changes too. For instance, European assistance in Central Asia supporting academic institutions has focused on structural contributions to the promotion of a market economy (Cabe 2013). Foreign organizations have tended to focus on providing support for higher education, while the science sector has seemingly received less attention in the region.

The results reflected in subsequent figures suggest research and development levels in the majority of Central Asian countries required improvement relative to other post-Soviet countries. Research performance has varied across the nations of Central Asia. Kazakhstan has made remarkable progress in most scientific indicators since 2010, while Kyrgyzstan was leading in weighted measures overall. WoS data in Figure 2.5 indicates the number of publications during the 1990s mostly decreased in all Central Asian countries, excluding Uzbekistan, in the immediate aftermath of the Soviet science sector's disintegration and the ensuing socio-economic crises. Following that was a prolonged period of stagnation or moderate growth in publications in all Central Asian countries except Kazakhstan, the only country that has substantially boosted research productivity since 2011. In terms of the total number of citations, Kazakhstan and Kyrgyzstan demonstrated more or less steady progress in increasing the number of citations after 2011. The corresponding performance measure had first increased up until 2008 and then declined for Uzbekistan afterwards. For Tajikistan and Turkmenistan, the number of publications and citations stagnated at lower levels across most periods (Figures 2.2 to 2.6). The declines in citations for all countries observed in Figures 2.2 and 2.3 since 2017 can be neglected in this analysis due to the likely effect of incomplete statistics and research impact for the newest publications during the most recent periods. The same effect could be seen in the number of publications reported by WoS (Figure 2.5). It should be noted that the aggregation methods used in the graphs reflecting citations were different for SCImago and WoS due to peculiarities of data export from the databases. Values shown in Figure 2.1 and 2.3 (WoS) are indicative of the more or less prolific years in terms of seminal papers. In contrast, Figure 2.2 reflects the dynamics of citations across the presented period better. Still, the general trends appear to be similar overall for both databases, which confirms the validity of the findings.

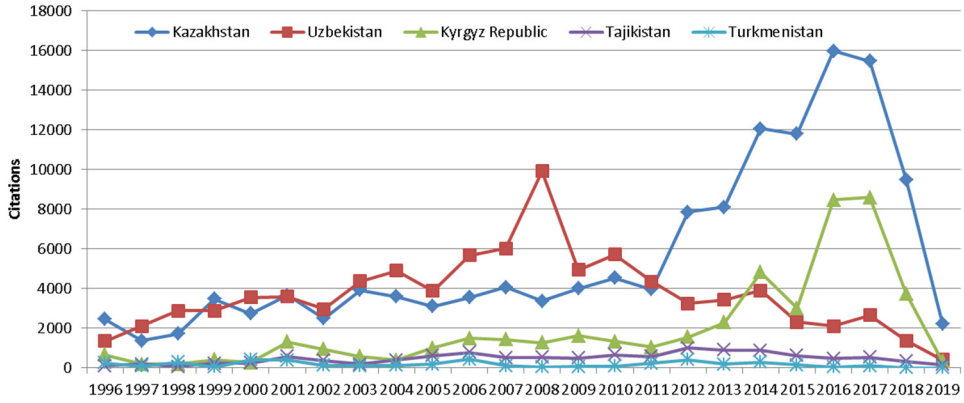
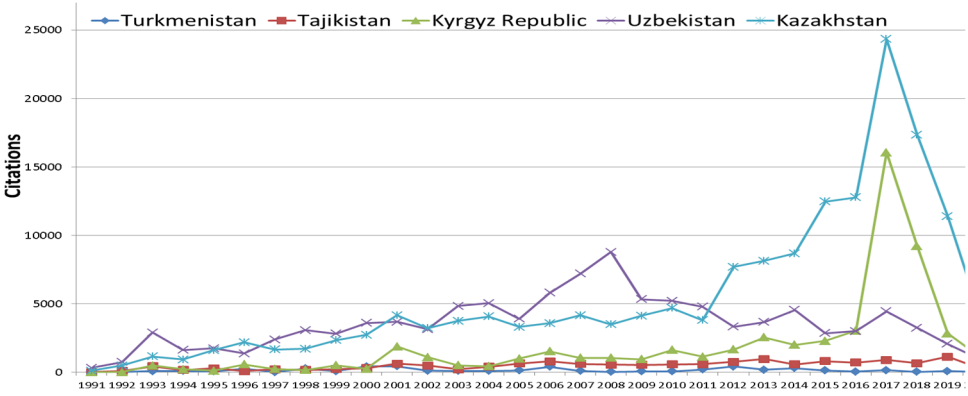


Fig. 2.2 The research impact of Central Asian countries according to SCImago (2021).



Note: citations are summed for all subsequent periods in the year of publication.

Fig. 2.3 The research impact of Central Asian countries according to WoS (Clarivate 2021).

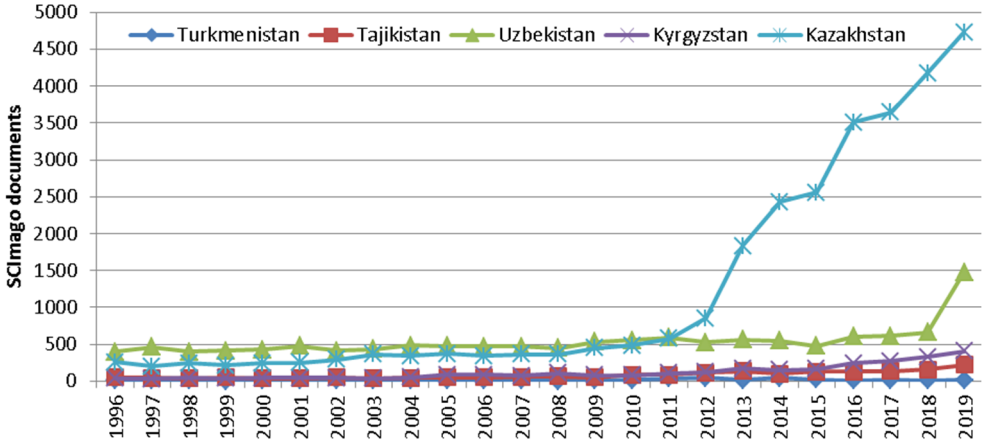


Fig. 2.4 The research productivity of Central Asian countries according to SCImago (2021).

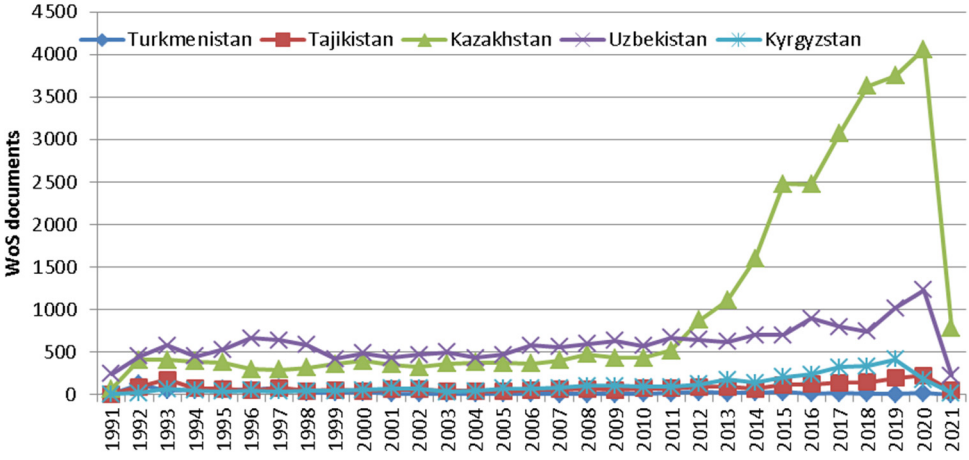


Fig. 2.5 The research productivity of Central Asian countries according to WoS (Clarivate 2020).

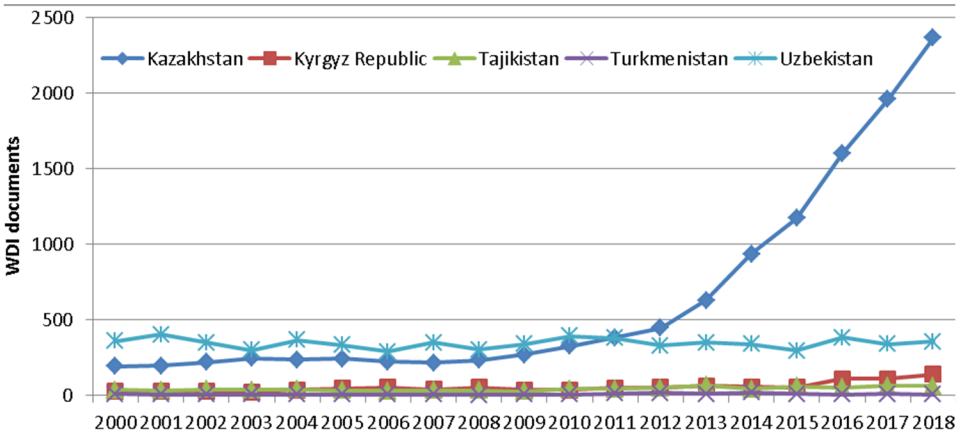


Fig. 2.6 The research productivity of Central Asian countries according to the World Development Indicators of the World Bank (2020).

As for areas of science specialization, Kazakhstan and Uzbekistan were more productive in physics and chemistry, Tajikistan in mathematics and chemistry, Kyrgyzstan in environmental and geosciences, and Turkmenistan in mathematics (Clarivate 2021). Figure 2.7 illustrates a positive trend in making regional research more accessible.

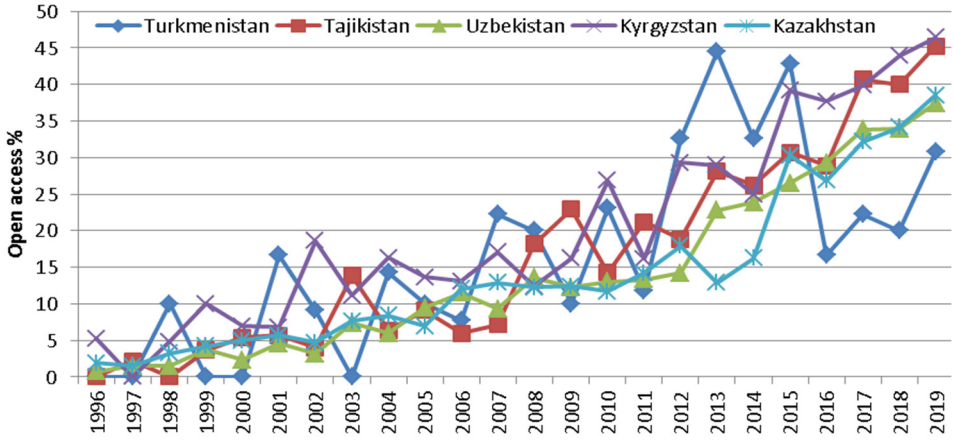


Fig. 2.7 The accessibility of research output of Central Asian countries (SCImago 2021).

Figure 2.8 indicates the favorable standing of Kyrgyzstan in self-citations. Kazakhstan's researchers cited themselves more often in the region, which could be among the unintended outcomes of citation-based performance evaluations. There was almost no information available online on questionable academic practices in

Central Asia. The limited number of Central Asian articles in the global retraction records is a symptom of low volume rather than high quality (Retraction Watch 2021). Retraction Watch data suggests the main reasons for retraction notices were fake peer review in Kazakhstan, withdrawal in Kyrgyzstan, and plagiarism in Uzbekistan and Tajikistan (no data was available on Turkmenistan). Non-authentic content made up a significant share of Scopus-indexed papers from Uzbekistan in 2021 (Abalkina 2021). The promotion of researchers based on publications indexed in global academic databases as advocated in this study will probably boost scientific indicators in the region, but it could also lead to cutting corners in the publication process. The example of China seems relevant here: the country managed to achieve spectacular growth in the number of publications globally by providing promotions and funding including highly unusual incentives such as rewards based on authoring papers in prestigious Western journals; unfortunately, such practices also led to the proliferation of fraudulent research and the highest number of retractions in the world (Roach 2018).

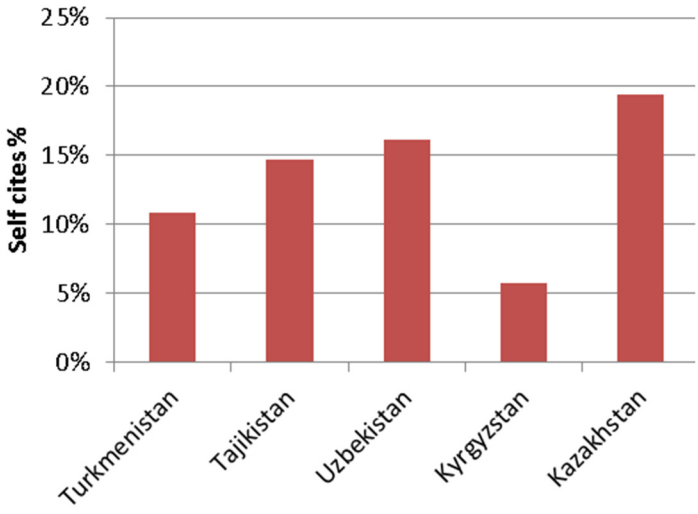
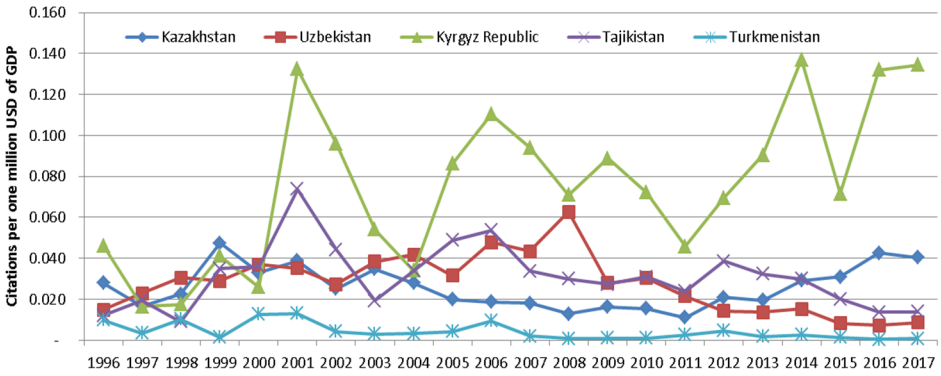


Fig. 2.8 The self-citation in Central Asian research (SJR – SCImago 2021).

Weighted research performance at the national level could refer to the capability of converting inputs such as wealth and human capital into research outputs. Such unconventional measures are helpful in the analysis of limited data on precise research inputs for specific regions (World Bank Group 2014). Figures 2.9 and 2.10 illustrate how Kyrgyzstan recently emerged as an undisputed leader among Central Asian economies in research output weighted by the respective country's population and GDP. Kazakhstan seemed to start improving performance in those weighted measures after 2011. Other countries (Turkmenistan in particular) did not show a

significant improvement overall from their lower positions during the analyzed period between 1996 and 2017. The discrepancy in results observed in Figure 2.10 between Uzbekistan and Kyrgyzstan suggests little correlation between population size and impact of research output. The various experiences of Central Asian countries illustrate that unsustainable economic growth primarily achieved on account of exports of natural resources does not necessarily lead to the advancement of national science without liberalization and accompanying institutional reforms.



Note: Output-side real GDP calculated at chained PPPs in 2011 US$ for comparability.

Fig. 2.9 The research impact of Central Asian countries relative to economy size (derived from SCImago (2021) and Penn World Table (2019)).

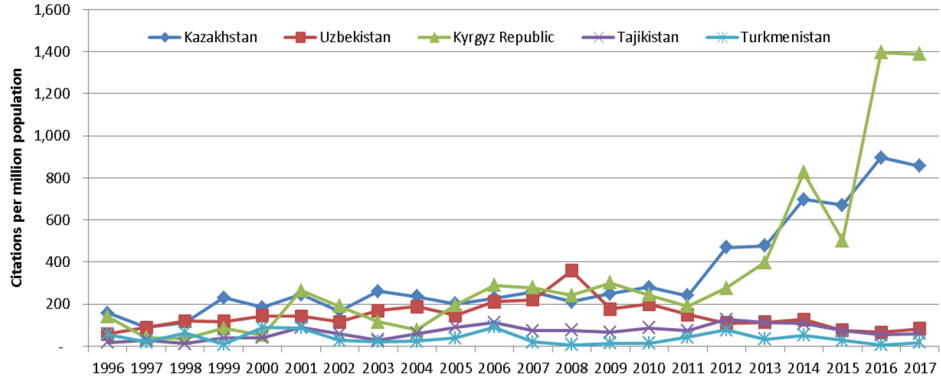


Fig. 2.10 The research impact of Central Asian countries relative to population size (derived from SCImago (2021) and Penn World Table (2019)).

Patents can be considered as a research indicator of innovation and links to industry. Perhaps unsurprisingly, Figure 2.11 shows Kazakhstan and Uzbekistan were leading the region in intellectual property, and trademarks in particular. Figure 2.12 reveals unfavorable dynamics for patents in the region, with significant declines suffered by Uzbekistan in the 1990s and by Kazakhstan in the 2010s. Kyrgyzstan showed better performance relative to Tajikistan despite a smaller population. Governments should consider the experience of the developed countries where advanced levels of democratization and privatization allow practical cooperation between universities and businesses.

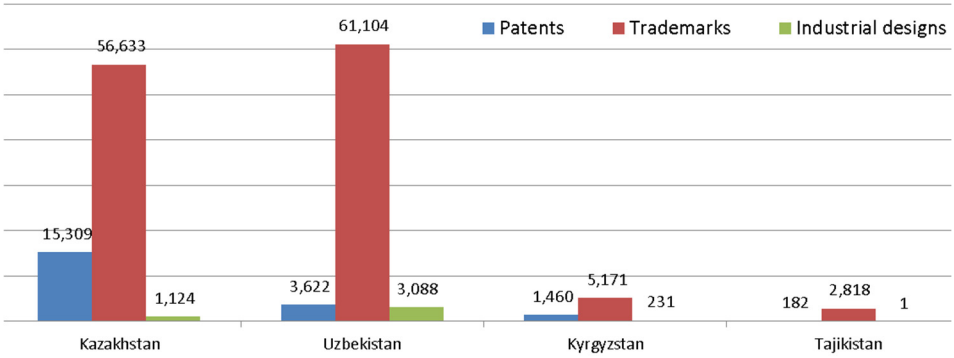


Fig. 2.11 IP filings (resident + abroad, including regional) and economy (Source: GII (2020); data not available for Turkmenistan).

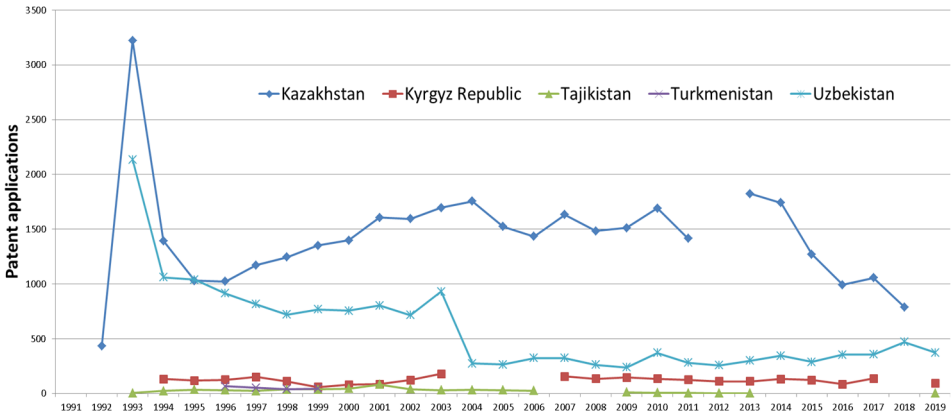


Fig. 2.12 Patent applications in Central Asian countries (World Bank 2021).

Figure 2.13 summarizes data on the frequency and selected statistics on citations. The highly skewed distribution with a zero median means many papers are never cited. This empirical result is not unique and can be found in many areas of science

(Mingers and Leydesdorff 2015). Non-parametric measures based on percentiles could be more appropriate here in a typical case of the "long tail" of papers receiving few or no citations. Figure 2.13 shows the citation values as thresholds to be included in the top 1% (99th percentile), 10%, and 25% of all papers. It should be emphasized here again that the analysis of data from WoS and SCImago does not include numerous local Central Asian journals that are not indexed in those global databases. The assumption is that the higher quality of publishers indexed by WoS and SCImago makes them more suitable for objective evaluation of research performance.

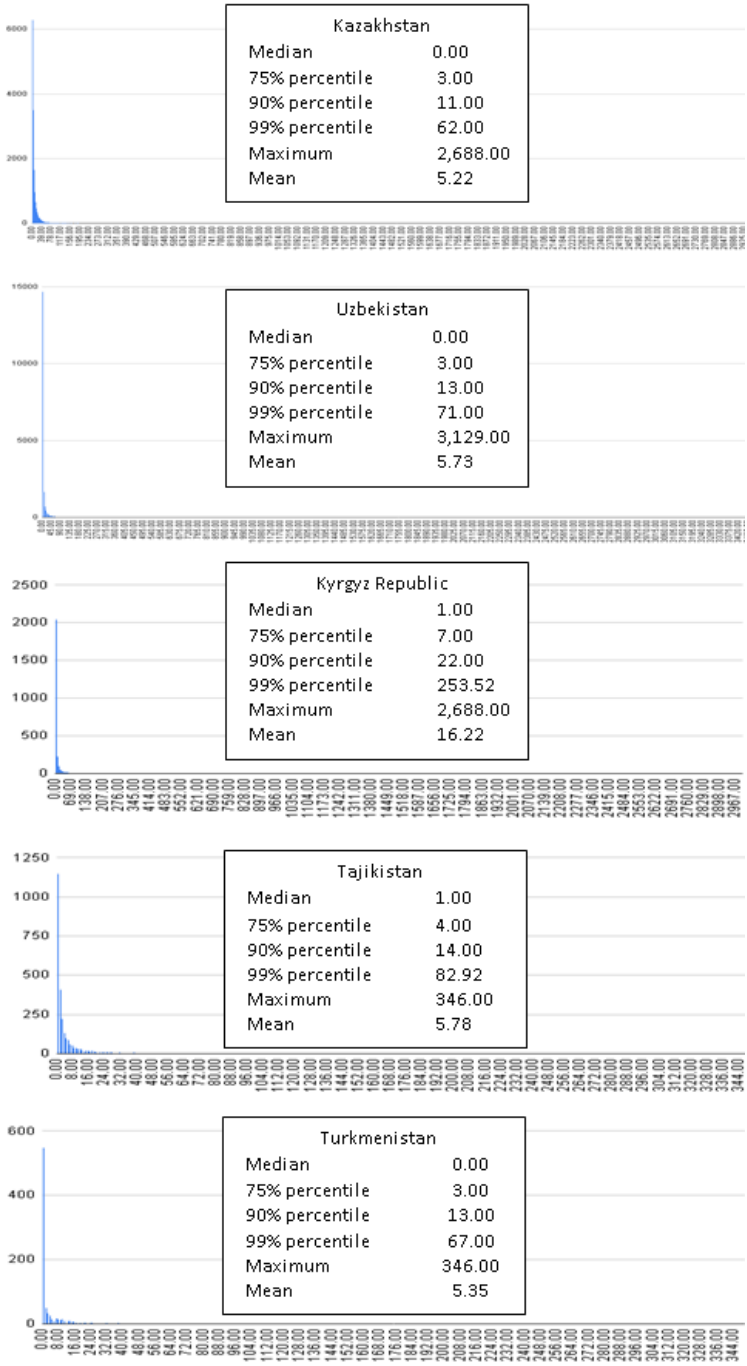


Fig. 2.13 Histograms and summary of statistics for the citation of papers published in Central Asian countries (Clarivate 2021)

International comparisons

This section concentrates on comparisons between Central Asian and other post-Soviet countries. The choice of the comparators is quite relevant given the shared historical and economic background. The countries are also exciting examples to compare due to the differences in achieved levels of liberalization, democratization, internationalization, and other characteristics. Inadequate development in national research standards inevitably harms the innovation and business climate of a country. Central Asian countries remained behind not only developed countries but also other post-Soviet countries in the comparison. Tables 2.1 and 2.2 show the striking differences, particularly compared to the more liberal states of the post-Soviet Caucasus (Georgia and Armenia) and Baltic (Lithuania, Latvia, and Estonia) that have demonstrated remarkable performance relative to their population size. Overall, the number of citations per publication from Central Asia was low. Kazakhstan still managed to become a leader in the region in the total output in this respect, while Kyrgyzstan demonstrated performance in the measure of citations per document – the highest in Central Asia and impressive among all comparators (this success is even more evident when weighted by the population).

To provide more accurate comparisons in terms of research quality and productivity, Table 2.1 presents the summary statistics for total publications, citations, *h* index, citations per document, global ranking, number of journals, and institutions according to SCImago. As a region, Central Asia lagged in scientific development behind other post-Soviet areas. Within the post-Soviet area, Russian science was understandably the leader in institutional ranks, journals, citations, and volume of research, followed by Ukraine. Both the Russian Federation and Ukraine experienced periods of drastic changes in democratization. Surprisingly, as the *h* index shows, Estonia could compete with the largest countries in terms of the size of its economy and population in post-Soviet area. This index is a popular metric for both the quantity and quality of research defined as the minimum *h* number of publications with *h* citations. Furthermore, Armenia, Georgia, and the Baltic states seemed to be leaders in research excellence with higher citations per paper. Estonia and Lithuania also impressed with the number of journals and institutions considering their population. Georgia, Armenia, and the Baltic states that switched to democracy relatively early all have favorable standings in citations per document compared to most post-Soviet countries with lower liberalization levels. It is admittedly impossible to control factors for starting levels of development and extra funding, as in the case of the Baltic states within the EU. One could also argue that the countries of the European parts of the Soviet Union already had higher infrastructure and human capital levels at the moment of its collapse. Nevertheless, liberalization and democratization both appear to contribute to the progress in education and research.

Table 2.1 Impact and productivity of research output in post-Soviet countries (sources: SCImago (2021), SCImago (2021)).

Country	Citable documents	Citations	*h* index	Citations per document	SCImago rank	Journals in SCImago 2019	SCImago institutions 2021
Russian Federation	1 173 571	9 135 422	580	8	12	557	315
Ukraine	202 674	1 419 614	277	7	42	65	58
Lithuania	54 076	610 038	220	11	61	60	10
Estonia	41 221	858 433	283	19	63	33	6
Belarus	40 392	401 105	184	10	67	10	7
Kazakhstan	28 105	135 074	107	5	74	5	11
Latvia	26 130	278 393	168	10	77	11	5
Georgia	19 303	331 828	184	16	85	7	5
Armenia	17 861	293 980	190	16	89	3	5
Azerbaijan	14 880	123 058	112	8	93	8	6
Uzbekistan	12 601	88 555	94	7	96	-	2
Moldova	8 039	102 896	117	12	103	9	2
Kyrgyzstan	2 624	46 957	79	17	137	-	-
Tajikistan	1 896	11 445	46	6	144	-	-
Turkmenistan	357	4 098	27	11	190	-	-

Note: For SCImago, all indicators outside the number of journals and institutions are given for the period between 1996-2019.

Tables 2.1 and 2.2 together suggest that most of Central Asia had room to improve relative to comparator countries. The number of institutions and journals included in the global rankings is a better measure of research performance than their total number in a country. Table 2.1 shows the limited number of Central Asian research institutions in 2021. It was still a significant increase relative to 2020 when SCImago included only seven institutions for Kazakhstan and only one for Uzbekistan. Not taking into account Kazakhstan, Central Asian countries had the lowest rankings relative to all other post-Soviet countries, excluding Moldova.

Table 2.2 presents more data for comparisons beyond SCImago. In terms of inclusion, WoS seemed to represent a broader range of documents than Scopus. Google Scholar items suggest Kyrgyzstan had significant online presence of publications, while Turkmenistan had relatively low presence relative to WoS and SCImago items. Though Google Scholar is valuable for analyzing bibliometric indicators as a more inclusive database, its limitations, such as lack of detail and a significant number of errors and duplications, should be kept in mind. Top results in Google Scholar included a limited number of publications originating from the domain country. The remaining results mainly included books from the Soviet era, foreign publications, local legal documents, and other publications unrelated

directly to national research output. Duplications were also found in WoS for papers from Kazakhstan and Uzbekistan, though in much lower numbers.

English proficiency was deliberately included in Table 2.2. Language remains another crucial skill for advancement in international research, and this is an area where the Central Asian researchers have probably been lagging since the Soviet period. Central Asia occupied the bottom positions of the EF English Proficiency Index (EF EPI 2020). The performance and proportion of test-takers in TOEFL, the most popular academic English test, does not seem impressive either (ETS 2021). Any future progress in research impact would require a greater mastery of the English language to access leading research and publish papers in international journals.

Table 2.2 Productivity and global share of research output in selected post-Soviet countries (Sources: SCImago (2021), EF EPI (2020), WoS (2021), Google (2021)).

Country	SCImago items	WoS items	Google Scholar items	SCImago documents world share	SCImago citations world share	EF English Proficiency Index 2020
Russian Federation	1 173 571	1 443 192	21 400 000	2.31%	1.13%	41
Ukraine	202 674	235 046	3 090 000	0.40%	0.18%	44
Lithuania	54 076	66 814	322 000	0.11%	0.08%	24
Estonia	41 221	51 659	39 000	0.08%	0.11%	25
Belarus	40 392	50 905	327 000	0.08%	0.05%	40
Kazakhstan	28 105	32 779	117 000	0.06%	0.02%	92
Latvia	26 130	36 514	101 000	0.05%	0.03%	29
Georgia	19 303	21 241	26 000	0.04%	0.04%	47
Armenia	17 861	22 114	101 000	0.04%	0.04%	51
Azerbaijan	14 880	17 614	14 200	0.03%	0.02%	86
Uzbekistan	12 601	18 774	30 600	0.02%	0.01%	88
Moldova	8 039	12 215	160 000	0.02%	0.01%	-
Kyrgyzstan	2 624	3 949	19 400	0.01%	0.01%	96
Tajikistan	1 896	2 653	5 300	0.00%	0.00%	100
Turkmenistan	357	851	112	0.00%	0.00%	-

Note: All indicators given for the date of the reference access or publication, except for SCImago referring to the period between 1996-2019.

None of the countries in Central Asia entered the global rankings, such as Times Higher Education and Shanghai indices, that include research performance. Similar conclusions can be made regarding journal rankings. Tables 2.3 and 2.4 include more information on the SCImago rankings of leading regional institutions and indexing (in Scopus or WoS) of publishers, correspondingly. They show the dominance of the public organizations in contrast to developed countries where private institutions play a significant role. There were no globally-ranked institutions

based in Kyrgyzstan, Tajikistan, or Turkmenistan – all countries with significantly larger populations than the Baltic states ranking much higher in SCImago.

Table 2.3 Top Central Asian research institutions, according to SCImago (2021).

Global rank	Institution	Country
712	Nazarbayev University	Kazakhstan
802	Al-Farabi Kazakh National University	Kazakhstan
808	Uzbekistan Academy of Sciences	Uzbekistan
817	Satbayev University	Kazakhstan
824	Saken Seifullin Kazakh Agrotechnical University	Kazakhstan
827	L. N. Gumilov Eurasian National University	Kazakhstan
833	National University of Uzbekistan	Uzbekistan
841	D. Serikbayev East Kazakhstan State Technical University	Kazakhstan
844	Karaganda State Technical University	Kazakhstan
849	Kazakh National Agrarian University	Kazakhstan
851	Kazakh National Pedagogical University	Kazakhstan
863	South Kazakhstan State University	Kazakhstan
873	Karaganda State University	Kazakhstan

Table 2.4 Academic journals published in Central Asia and included in WoS (2021) and SCImago (2021).

Title	WoS indexed	SCImago indexed	Publisher
Eurasian Mathematical Journal	Yes	Yes	Eurasian National University
Eurasian Journal of Mathematical and Computer Applications	Yes	Yes	L.N. Gumilyov Eurasian Natl Univ
News of the National Academy of Sciences of the Republic of Kazakhstan Series of Geology and Technical Sciences	No	Yes	National Academy of Sciences of the Republic of Kazakhstan
Eurasian Chemico-Technological Journal	Yes	Yes	Al-Farabi Kazakh State National University
Eurasian Physical Technical Journal	No	Yes	E.A. Buketov Karaganda State University Publishing House
Bulletin of the Karaganda University-Mathematics	Yes	No	Karaganda State Univ
Bulletin of the University of Karaganda-Chemistry	Yes	No	Karaganda State Univ
Doklady Akademii Nauk Respubliki Uzbekistan	Yes	No	Publ House
Doklady Natsionalnoi Akademii Nauk Respubliki Kazakhstan	Yes	No	Natsionalnoi Akad Nauk Respubliki Kazakstan
International Journal of Biology and Chemistry	Yes	No	Al-Farabi Kazakh Natl Univ
International Journal of Mathematics and Physics	Yes	No	Al-Farabi Kazakh Natl Univ
Izvestiya Natsionalnoi Akademii Nauk Respubliki Kazakhstan Seriya Biologicheskaya I Meditsinskaya	Yes	No	Natsionalnoi Akad Nauk Respubliki Kazakstan
Kompleksnoe Ispolzovanie Mineralnogo Syra	Yes	No	Inst Metallurgy & Ore Beneficiation
Uzbekiston Tibbiet Zhurnali	Yes	No	Abu Ali Ibn Sino Nomidagi Tibbiyot Nashriyoti
Uzbekskii Biologicheskii Zhurnal	Yes	No	Publ House

The share of Central Asia in the global research output in the number of documents (0.09%) and citations (0.04%) could imply that quantity dominates the quality in the region. Table 2.2 also reveals how the share of the Baltic states in global output exceeds the share of Central Asia despite having a population several times smaller. Figure 2.14 allows for cautious optimism with the increasing global share of Central Asia in publications and citations since 2011, though this progress could primarily be driven by one country – Kazakhstan. The fact that Central Asian countries mostly lagged behind other post-Soviet countries does not imply that the region could not compare favorably to other areas of the world. For instance, Central Asia's performance as an entire region already in the early 2000s seemingly was comparable or better compared to African countries in terms of international collaborations and, in particular, weighted performance measures (this preliminary comparison was based on the data provided by World Bank Group 2014).

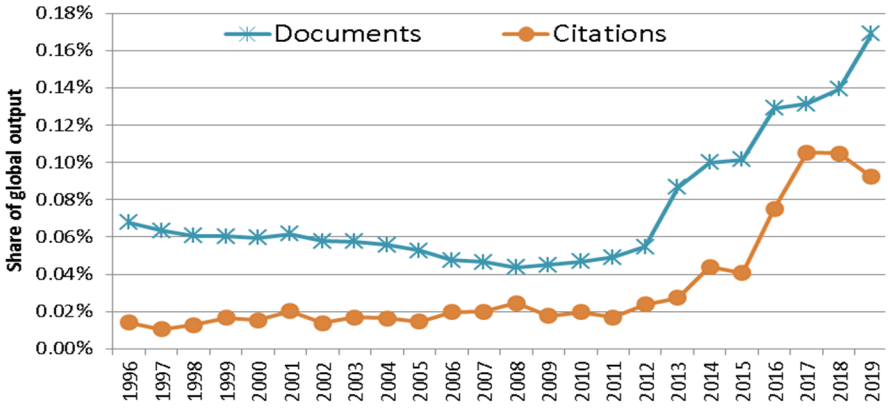


Fig. 2.14 Share of Central Asian countries in the global research output of citable documents (derived from SCImago 2021).

Figure 2.15 indicates trends in another interesting SCImago indicator – international cooperation in scientific publishing. Though the overall trend seems to be an increase in international collaboration in the region, the partnership in publications with foreign colleagues was volatile for the most prominent countries, Kazakhstan and Uzbekistan. The top partners in publishing in the area were from the U.S.A., Germany, Turkey, Russia, and other countries with a strong presence in Central Asia with businesses and offices of international assistance and cultural affairs (UNESCO 2016). Kyrgyzstan's researchers achieved progress in scientific collaboration and actively cooperated in publications with other Central Asian colleagues, unlike in the rest of the region (Clarivate 2021, UNESCO 2016). Meanwhile, Central Asian countries could take advantage of the vast potential for regional scientific cooperation as countries having close political, historical, and cultural ties (UNESCO 2010).

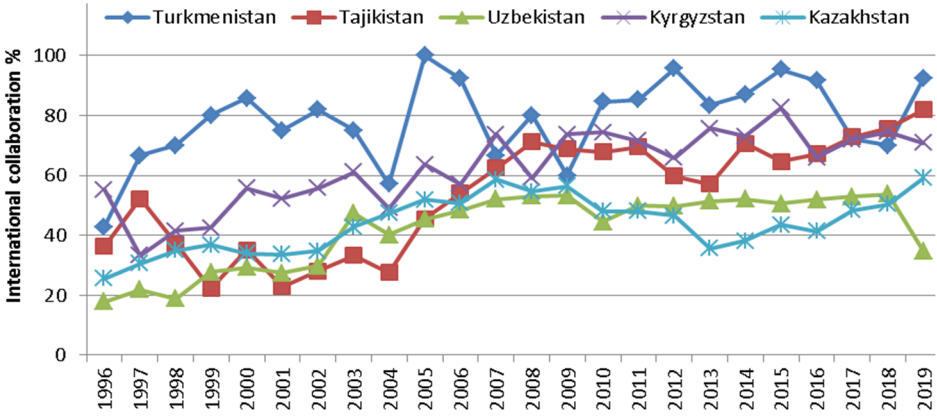


Fig. 2.15 International collaboration in the research output of Central Asia (Source: SCImago (2021)).

Country-level progress

This section provides more information on academic and socio-economic conditions in each Central Asian country that could explain the progress (or lack of thereof) in scientific indicators. The exact relationship between potential causes and effects is hard to establish within the limited scope of the data analysis presented earlier.

The scientific indicators in the presented analysis allowed Kazakhstan to be identified as a leading Central Asian country in terms of research. The biggest economy in the region presents interest for other Central Asian countries from its exemplary research performance. Because of the wider availability of data and corresponding analysis, Kazakhstan's experience could be valuable to other countries in the region. Kazakhstan's Ministry of Education required universities to build international partnerships, benchmarking indicators, and research cooperation while reducing academic fraud. The government encouraged foreign involvement in education from the beginning, and the number of international institutions and branches with foreign participation was notable. The breakthrough in the number of publications and citations that occurred during the 2010s showed the fruits of their long-term efforts. The country seems to have room for improvement in industrial research (patents) and output relative to GDP.

Uzbekistan had the highest number of researchers after Russia and Ukraine among post-Soviet countries and made efforts to develop its innovation infrastructure (UNESCO 2010). Still, Uzbekistan's economy lagged behind Kazakhstan and other comparator post-Soviet countries in innovation and research rankings (SCImago 2021; World Bank 2014). The number of citations showed a worryingly declining trend after 2008. The country also could not reverse the sharp decline in the number of patent applications during the 90s and 2000s. On the positive side, though, the government appears to have started improving its performance in the number of publications since 2018 after the preceding liberalization reforms. Recent socioeconomic developments in Uzbekistan allow a cautious expectation of accelerating positive changes in the science sector.

Kyrgyzstan actively worked with international organizations such as TEMPUS/TACIS, the Eurasia Foundation, and USAID to promote the European Credit Transfer System (ECTS) and internationalization. Foreign partners were among the founders of a significant proportion of the most prestigious Kyrgyz institutions. The country has attracted the highest number of international students relative to its population in Central Asia (UNESCO 2020). The long history of democratization and liberalization seemed to positively affect the impressive research performance in all of the country's research indicators relative to the size of its economy and population in the region. Further progress, however, would likely

depend on how the government can improve its political stability, transparency, and economy to bring more funding to the science sector.

Tajikistan's higher education system and research are notable for Russian influence in the academic sector (Huisman et al 2018). Kazakhstan and Kyrgyzstan have maintained an active scientific cooperation with Tajikistan. However, the country had made relatively limited progress in the Bologna process and the creation of private institutions (Huisman et al 2018). Lower levels of democratization and privatization inevitably affected the academic sector, including research and intellectual property in the country. The economy would have to implement institutional changes to achieve liberalization and economic growth to support the science sector in elevating the country's low positions in research indicators relative to the rapidly increasing population size.

Turkmenistan received relatively more attention in this section as an interesting case of a country that could not significantly boost its research performance despite a higher GDP per capita relative to most of the comparators in the region. The country showed the lowest performance in most of the scientific indicators analyzed in this study. Brain drain seems to be an issue since the 1990s, when many highly skilled citizens, including researchers, emigrated (UNESCO 2010). The country appeared to make certain progress during the brief period of liberalization after 2007, with the new government reopening the Academy of Sciences and other research institutions (UNESCO 2016). Further development seemingly stalled with economic difficulties leading to the announcement of spending cuts in the academic sector (AP News 2019). The defense of dissertations for advanced academic degrees seemed to be suspended recently. Scientific institutions in Turkmenistan are clearly in urgent need of institutional reforms and extra funding. Privatization is not likely to fundamentally solve the problems in the existing conditions since the issue of attracting funds and talent would remain. The positive development of the Academy of Science and respective scientific establishments after the implementation of self-financing could be uncertain. As the lack of information on scientific indicators and intellectual property suggests, the country needs to share more statistical information with higher data accuracy. As for research, it is essential to achieve more presence in international databases and online generally with institutional websites providing access to vital information for local and international users. The development of an effective merit-based system of promotion should become another priority. With falling hydrocarbon export revenues, the country has to face the challenge of fostering and retaining human resources for the planned transition to a knowledge economy based on innovations and digitalization. Overall, it seems crucial for the further development of science to implement bold reforms towards liberalization that provide more autonomy for academic institutions and expand rights in international cooperation.

Table 2.5 concludes this section by listing examples of top papers from each country in the region. The three papers that received the highest number of citations in each Central Asian country are reasonably representative of many high-impact publications: they are a result of international research in a larger team of scientists where researchers and host institutions from Central Asia are usually not the first among authors, and journals themselves are issued outside of the region. Interestingly, there are two common papers included for four countries in the ranking, reflecting a certain degree of regional cooperation in the highest-ranking publications. The highest-cited papers from Kazakhstan and Kyrgyzstan were published fairly recently, in 2017 or 2018. For other Central Asian countries, the majority of the top papers were published much earlier.

Table 2.5 The top three papers published in each Central Asian country included in the database of WoS (2021).

Country	Title and authors	Journal and year published	Citation count
Kazakhstan	2017 ESC/EACTS Guidelines for the management of valvular heart disease The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). *Baumgartner, Helmut; Falk, Volkmar; Bax, Jeroen J.; et al.*	European Heart Journal 2017	2 688
	Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Ezzati, Majid; Bentham, James; Di Cesare, Mariachiara; et al.*	Lancet 2017	2 017
	Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Naghavi, Mohsen; Abajobir, Amanuel Alemu; Abbafati, Cristiana; et al.*	Lancet 2017	1 920
Uzbekistan	The CMS experiment at the CERN LHC. *Chatrchyan, S.; Hmayakyan, G.; Khachatryan, V.; et al.*	Journal of Instrumentation 2008	3 129
	Multi-messenger Observations of a Binary Neutron Star Merger. *Abbott, B. P.; Abbott, R.; Abbott, T. D.; et al.*	Astrophysical Journal Letters 2017	1 505
	Carbon structures with three-dimensional periodicity at optical wavelengths. *Zakhidov, AA; Baughman, RH; Iqbal, Z; et al.*	Science 1998	1 034
Kyrgyzstan	2017 ESC/EACTS Guidelines for the management of valvular heart disease The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). *Baumgartner, Helmut; Falk, Volkmar; Bax, Jeroen J.; et al.*	European Heart Journal 2017	2 688
	Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Vos, Theo; Abajobir, Amanuel Alemu; Abbafati, Cristiana; et al.*	Lancet 2017	2 138
	Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *James, Spencer L. G.; Abate, Degu; Abate, Kalkidan Hessen; et al.*	Lancet 2018	2 027
Tajikistan	The Eurasian Heartland: A continental perspective on Y-chromosome diversity. *Wells, RS; Yuldasheva, N; Ruzibakiev, R; et al.*	Proceedings of The National Academy of Sciences of the United States of America 2001	346
	Changes in daily temperature and precipitation extremes in central and south Asia. *Tank, A. M. G. Klein; Peterson, T. C.; Quadir, D. A.; et al.*	Journal of Geophysical Research-Atmospheres 2006	305
	Assembly of the Pamirs: Age and origin of magmatic belts from the southern Tien Shan to the southern Pamirs and their relation to Tibet. *Schwab, M; Ratschbacher, L; Siebel, W; et al.*	Tectonics 2004	224
Turkmenistan	The Eurasian Heartland: A continental perspective on Y-chromosome diversity. *Wells, RS; Yuldasheva, N; Ruzibakiev, R; et al.*	Proceedings of The National Academy of Sciences of the United States of America 2001	346
	Changes in daily temperature and precipitation extremes in central and south Asia. *Tank, A. M. G. Klein; Peterson, T. C.; Quadir, D. A.; et al.*	Journal of Geophysical Research-Atmospheres 2006	305
	Anomalously high entropy change in FeRh alloy. *Annaorazov, MP; Nikitin, SA; Tyurin, AL; et al.*	Journal of Applied Physics 1996	233

Implications for policymakers and international partners

The earlier analysis in this chapter suggests the progress in growing the productivity and impact of scientific publishing has been slow or stalled in all Central Asian countries except for Kazakhstan since 2011. Poor representation and participation in globally recognized measures and rankings in many areas indicates that scientific potential in development remains unrealized. This section discusses the implications with potential reasons and possible solutions to the problem of research performance in the region.

All Central Asian countries were already experiencing economic problems due to price slumps in natural export resources. The pandemic could exacerbate the negative impact on human capital development in the region. Central Asia should eliminate institutional and legal limitations that hamper the further development of science: the unusually high degree of government control over critical aspects of teaching, ideological reluctance to adequately privatizing institutions in practice, lack of autonomy, and inconsistencies between programs designs and regulations (Brunner and Tillet 2007).

National governments in Central Asia have helpful examples to learn from within the region, including Kyrgyzstan's performance in weighted measures and Kazakhstan's regional leadership in global academic rankings. Liberalization, privatization, and the opening of the research sector to international cooperation mean giving up a certain degree of control that the officials (in particular, government of Turkmenistan and, to a lesser extent, Tajikistan) could be unwilling to allow. For such countries, the performance of Kazakhstan could serve as a suitable example of retaining political control over the academic sector while enormously benefiting from even moderate levels of liberalization. In the legal dimension, the decentralization of the systems with more significant funds and freedoms given to institutions could become the starting point of liberalization. Institutions seem to need more autonomy. The performance of post-Soviet liberal states presents the success story of liberalization leading to substantial academic development, innovations, English proficiency, internationalization, and global recognition.

Quality assurance in science remains a significant challenge to be addressed by public and private agencies in cooperation in the region. The objective assessment of researchers and institutions is crucial for any development in this regard. Administrators cannot improve things that cannot be measured. Transparency-related issues in decision-making on the allocation of funding or staff could further complicate the challenges. The region should shift towards the broader introduction of globally accepted measures and standardized testing to assess and encourage the

performance of local researchers in publishing, English proficiency, and STEM skills. The promotion of researchers should be based on their publications in globally recognized journals indexed by SCOPUS and Web of Science rather than local publications that are rarely translated into English or indexed in internationally recognized systems. Grants to individual researchers could be provided based on quantitative indicators due to the same reasons. Decisions on funding and the expansion of academic institutions should be tied to their progress in global rankings. Where such rankings do not provide sufficient information, policymakers could collaborate with international organizations to develop regional systems of academic ranking. For instance, QS University Rankings by Location provides information on several countries, including Kazakhstan (QS University Rankings 2021). This would serve as an institutional "quality check" and encourage internationalization with broader recognition and greater impact of the national scientific output.

Affordable institutional versions of more objective, standardized tests such TOEFL can play a crucial role in assessing future and current researchers' language skills more effectively than the prevailing subjective evaluation methods used by educational systems. Governments could promote English proficiency scores in standardized testing by subsidizing and developing more affordable variants of globally recognized tests. Academic mobility is another central area where language skills can be developed.

Finally, the governments of all countries in the region should improve data availability and depth on scientific indicators at all levels. The transfer to a more objective system should be supported with advanced data collection systems, including big data and machine learning.

Despite their importance as a starting point, the effectiveness of the specific measures within the science sector is ultimately limited by the national governments' economic and political progress in achieving the prosperity and freedoms necessary for funding and retaining scientific talent. Arguably, the greater freedoms and fewer restrictions enjoyed by counterparts in the science sectors of more liberalized economies of the post-Soviet area allowed a highly productive flow of ideas enabling growth. It is necessary to focus on the consistent implementation of the best international practices in research. Foreign partners should continue their important work in cooperation with government institutions to bring about institutional changes in Central Asia in accordance with the best practices. This development includes further liberalization and democratization in the region.

Conclusions

The results of analysis of scientific indicators in this report can be summarized as follows. Research standards in Central Asia visibly deteriorated after the collapse of the Soviet Union, leading to sub-par performance relative to other post-Soviet counterparts in research impact. Kazakhstan, with its increasing number of publications, appears to be ahead of the other countries in the region. Given the relative size of its population and economy, Kyrgyzstan has successfully internationalized research, boosting the impact of its academic publishing. Uzbekistan had steadily improved its research output before 2008 but showed declining performance afterwards. Tajikistan and Turkmenistan seemed to stagnate, remaining in their low-ranking positions in research output. Certain positive developments took place in developing formal academic structures in all Central Asian countries, including international mobility and the recognition of foreign degrees within the Bologna process. A lack of progress in liberalization, English proficiency, innovations, international cooperation, and industrial research could contribute to low research performance. Many research institutions in the Central Asian countries still predominantly practice inadequate, biased, and obsolete systems to evaluate academic performance. Instead of the ineffective systems of promotion and financing that exist on national levels, governments in Central Asia could evaluate and finance academic institutions according to more objective international rankings. Policymakers should consider the relevance of international cooperation in research with developed countries.

More research is required to understand the reasons behind low research performance and take corrective actions in Central Asia. In particular, comprehensive data analysis and theoretical support are necessary to develop effective policies for the objective evaluation of research performance and internationalization at the levels of local institutions. Setting up information systems to collect information and using local knowledge for validation should guide multidisciplinary research on scientific indicators. Surveys and interviews with researchers should be an essential part of future work to complement data-driven decision making with qualitative research findings.

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3 Inflows of Foreign Direct Investments in Central Asia

Developments in foreign investments and greenfield projects

The long-term consequences of the new industrial revolution, economic nationalism, a global push for supply chain resilience, and sustainability all bring challenges for attracting foreign direct investment (FDI) in developing and transition countries, which plan to industrialize and upgrade along the global value chains (UNCTAD 2020). The COVID-19 pandemic has caused a further reduction in the already declining FDI flows to fossil export-oriented countries that are dependent on commodity-linked investments. These factors apply to Central Asian countries in particular. This chapter aims to present an analysis of the recent state of FDI in Central Asia and present implications for policymaking to reverse the negative trends in attracting foreign investment. The available literature allows the current problem of attracting FDI to Central Asia to be formulated: declining FDI in most of the countries in the region over the recent decade at a time when such investments are urgently needed to overcome the negative consequences of decreasing revenues from commodities and the pandemic outbreak.

The first decade after the collapse of the Soviet Union saw more foreign businesses entering Central Asia following the expansion of market reforms and possibilities for foreigners to travel to the region. Central Asian countries have also received investments from international financial institutions (IFI) since their independence. After attracting considerable FDI in the hydrocarbon and manufacturing sectors during the first two decades of their independence, foreign investments in most Central Asian countries stagnated or declined in the period from 2010 to 2018, as

the following figures reveal. This chapter addresses the following questions: (i) What were the main FDI trends in Central Asian countries after gaining independence? (ii) Which measures can be taken by policymakers in Central Asia to attract more FDI? The practical outcomes of work on such a topic could be of interest to decisionmakers, foreign businesses, partner countries, and international development agencies. There are almost no recent studies in the existing literature dedicated to attracting foreign investments in Central Asia as a distinct region in the post-Soviet area. This chapter attempts to cover the causes of changes in FDI in an up-to-date analysis that takes the most important recent developments into account. The timeliness for conducting such analysis became evident in 2020, when disruptions in global markets caused by the pandemic outbreak necessitated reducing the heavy dependence on oil and gas exports as never before. Comparisons with post-Soviet countries in general and neighboring Central Asian countries in particular are relevant for this analysis, since the area had more or less comparable starting conditions and historical background. The comparisons within Central Asia are particularly warranted to put the region in the perspective of comparator economies for theoretical insights. Furthermore, the region's governments tracked the best practices of neighbors in various areas and, in some cases, tried to introduce them at home. For instance, the official policies related to FDI in such advanced areas as technoparks, digitalization, and renewable energy were seemingly influenced by and pursued in accordance with related policies in post-Soviet countries.

The analysis in this chapter is mainly based on information provided by UNCTAD (2021) and the U.S. Department of State (2020), which are perhaps the most reputable sources on the investment climate. UNCTAD (2021) provides detailed FDI statistics on countries summarized in the Global Investment Reports. In those reports, Central Asian countries are included in Transition Economies (countries of South-East Europe and the CIS) and Landlocked Developing Countries. Data from UNCTAD (2021) forms the basis of analyses comparing FDI flows and stocks in the countries. The U.S. Department of State (2020) provided the most comprehensive statements publicly available to date outlining the recent investment conditions on the ground in Central Asia.

Obviously, it is challenging to cover all facets of foreign investment in a single report. In this chapter, FDI outflows are not considered, which is perhaps not surprising given the relatively low outward investments from the region. FDI is specified as a financial account transaction in which a company's share or equivalent in a subsidiary exceeds ten percent. Greenfield projects are FDI by a company to build a new operational facility in a foreign country. This report narrows its scope of analysis to FDI inflows. Furthermore, the main focus of this chapter is on greenfield investments rather than acquiring existing firms (cross-border merger and acquisition or M&A). In addition to greenfield and M&A, studies further distinguish the following types of foreign investment as not directly belonging to

FDI, but which could still overlap in some instances: foreign portfolio investments (FPI), official development assistance (ODA), commercial loans, expansion of existing investments, joint venture with a host country entity, and establishment of a local subsidiary. Both greenfield and M&A investments are essential modes of FDI, but greenfield projects are beneficial in illustrating concrete examples of new establishments in Central Asia. Thus, the value and number of greenfield projects in each country are essential alternative measures of attracting foreign investments outside of the absolute values of total FDI flows. It should be kept in mind that not all announced greenfield investments materialize, as shown by the mass cancellations caused by disruptions related to COVID-19 (UNCTAD 2020).

As much as possible, the focus of the methods and deliverables is on the technical aspects and quantifiable measures of the studied topic with the limited inclusion of certain legal and political factors. This report considers the value of investments weighted by the population size of the respective country as representing an accurate measure of the relative performance in attracting FDI within the region that complements traditional measures, including percentage of GDP or gross fixed capital formation. Such unconventional units of measurement for the investment climate in each Central Asian country are introduced in the next section on FDI background with FDI inflow per capita and in the recent FDI trends with the estimates of greenfield FDI projects per capita. Unless stated otherwise, all of the financial indicators in this chapter expressed in national currencies are converted to U.S. Dollars using the official exchange rate for the convenience of comparability and interpretation. However, it has to be noted that data reflected in the official statistics could be subject to high inaccuracy, and therefore the resulting analysis could be distorted in certain country cases. For instance, the currency exchange rate in Uzbekistan and Turkmenistan significantly differed from the unofficial (black) market rate at different periods (U.S. Department of State 2020). As such, the figures showing flows denominated initially in the national currencies and other officially available data in this report should be interpreted with reasonable caution.

The following sections discuss FDI trends, causes of changes in FDI, foreign partners, legal and other factors affecting foreign investments. The chapter ends with implications and recommendations for stakeholders related to attracting foreign investments.

The background of FDI in 30 years of independence

Before 1991, the Soviet republics were a part of the centrally planned Soviet economy receiving state investments and subsidies in all spheres and branches of the public sector. The private sector, let alone foreign investment, was virtually non-

existent. The Soviet legacy cannot be ignored even after three decades of independence. Interestingly, the U.S. government considers the treaty with the Union of Soviet Socialist Republics on matters of taxation (1976) to continue to be in effect with Tajikistan, Turkmenistan, Uzbekistan, and Kyrgyzstan, even though some officials in the governments of those countries have argued against it (U.S. Department of State 2020). The U.S. still has no bilateral investment treaty with many former Soviet Republics covered by the 1973 income tax treaty with the Commonwealth of Independent States (CIS). Like other post-Soviet countries, the disintegration of economic structures in the newly independent countries (also known as transition economies) right after the collapse of the U.S.S.R. caused financial hardships during the 1990s. Despite gradual privatization opening new investment opportunities, state-owned enterprises (SOE) continued to dominate industrial production in most Central Asian states. Relatively cheap and abundant electricity, workforces, and natural resources managed to attract the considerable interest of foreign businesses in the region (OECD 2019). Still, with the exception of Kazakhstan, countries in Central Asia were generally less successful in attracting FDI than most other post-Soviet countries (Kenisarin and Andrews-Speed 2008). Importantly for conclusions of this chapter, Central Asia overall made less progress in the indicators of the rule of law, human capital, transparency, and democracy, as evidenced by the global rankings in these respective areas compared to other republics of the former Soviet Union.

The governments of countries in Central Asia have long expressed interest in attracting more foreign companies and bringing more western technology. Improved political stability since the late 1990s has helped to restore growth and attract FDI, and by the mid-1990s, FDI already exceeded ODA. Total capital flows as a share of GDP in Central Asian countries reached higher-than-average levels for developing countries worldwide soon after independence (Bayulgen 2005). As the World Bank and UNCTAD data in Figures 3.1 and 3.2 illustrate, independent Central Asian states achieved some progress in attracting foreign investments with the general trend towards increasing FDI both in absolute value and as a share of GDP in the first two decades following the collapse of the U.S.S.R. However, the growth in investments has gradually declined in resource-rich Kazakhstan and Turkmenistan since 2010, while in Kyrgyzstan and Tajikistan, it remained highly volatile without a clear trend. Such figures are not unique to the region – FDI mostly decreased globally and in all the comparator countries over the most recent decade before the COVID-19 outbreak except for a positive and more stable trend for Uzbekistan since 2015.

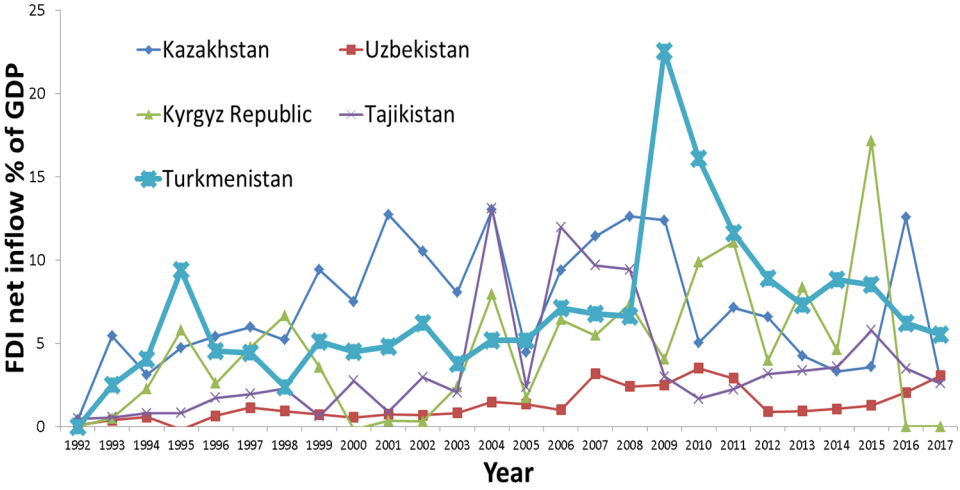

Fig. 3.1 FDI in Central Asia as a proportion of GDP (The World Bank 2020).

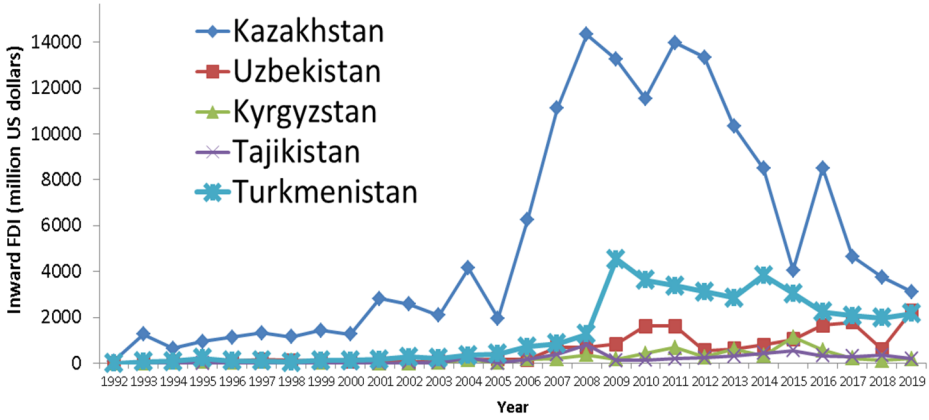

Fig. 3.2 FDI inflows in Central Asia *(UNCTAD 2021).*

As has already been stated, foreign investments from Central Asian countries are not the focus of this chapter. Figure 3.3 shows that FDI outflows have been negligible relative to inflows in all the studied countries except for Kazakhstan. For example, FDI flows from Central Asian countries were visible in Russia, but their value and profitability were much lower than in the other newly independent states (Ledyaeva et al 2014). Moreover, the top 100 non-financial multinational enterprises (MNE) by foreign assets from developing and transition economies include none of the Central Asian countries as of 2018 (UNCTAD 2021). MNEs are drivers of investments and technology transfer globally. Meanwhile, the share of global FDI in Central Asia in 2019 was nearly one third what it had been in 2009 (Figure 3.4).

This trend could suggest a worldwide shift of FDI to rapidly developing countries that demonstrate less dependence on commodity exports and more stable growth, such as China, which managed to capture an increasing share of global and Asian investments.

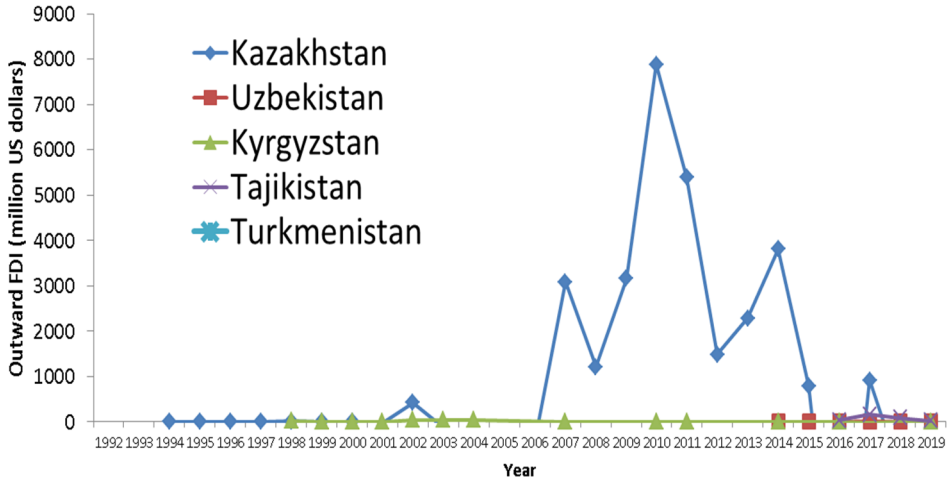

Fig. 3.3 FDI outflows from Central Asia *(UNCTAD 2021)*.

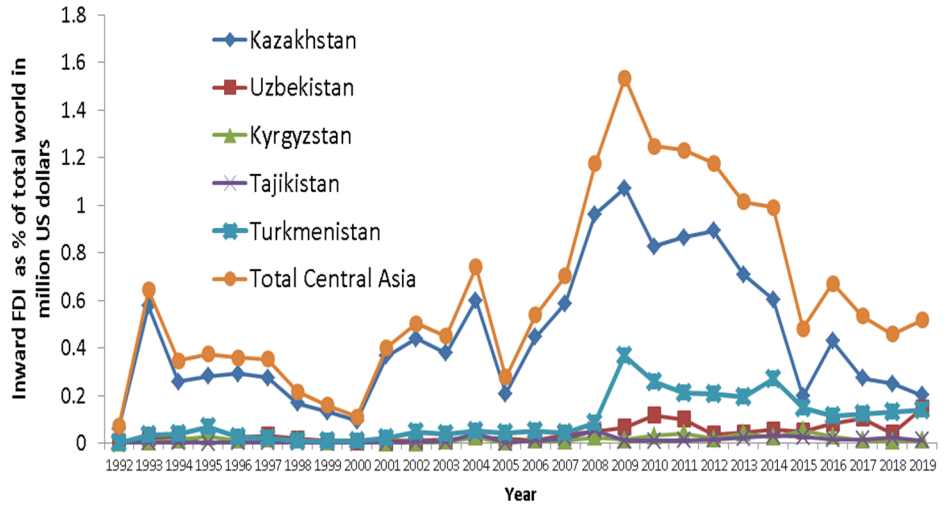

Fig. 3.4 FDI inflows in Central Asia as a proportion of the entire world *(UNCTAD 2021)*.

Any discussion of FDI would not be complete without per capita values. Trends in per capita FDI inflows look similar in this respect to the absolute values when comparing Figures 3.2 and 3.5. The same cannot be said about greenfield

investments in Figure 3.6, which suggests the prevalence of such investments is lower in Turkmenistan and higher in Uzbekistan in contrast to the general pattern in FDI inflows per capita presented in Figure 3.5. Kyrgyzstan managed to receive higher-than-average FDI per capita overall compared to other Central Asian countries with fewer hydrocarbon resources. Turkmenistan and Kazakhstan exhibited very similar patterns of FDI per capita, peaking around 2010 and then sharply declining in the recent decade to be closer to the level of the other three countries.

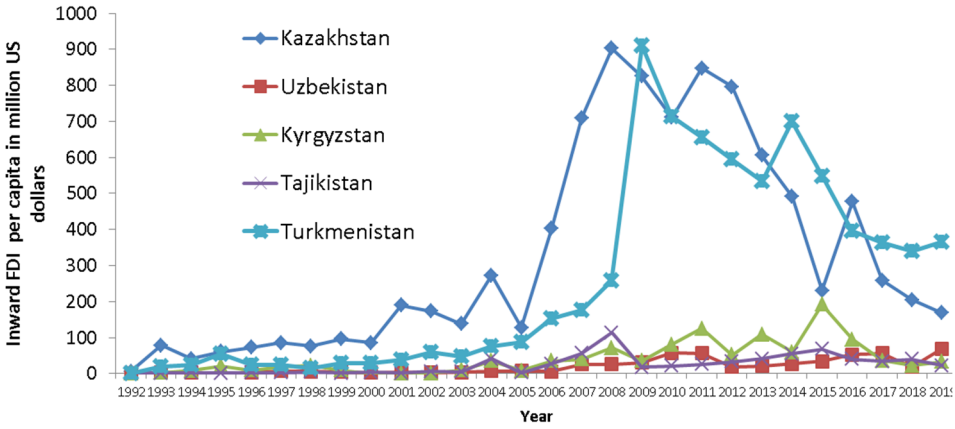

Fig. 3.5 FDI inflows per capita in Central Asia *(UNCTAD 2021)*.

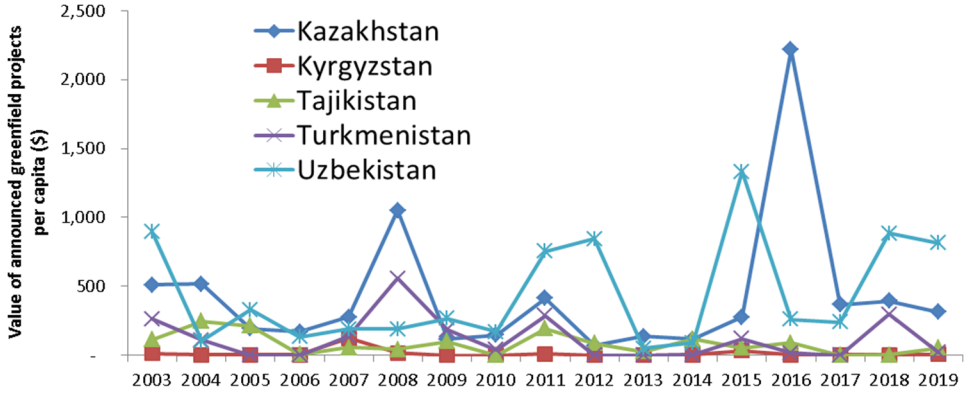

Fig. 3.6 Greenfield investments per capita in Central Asia *(UNCTAD 2021)*.

In Central Asia, one specific industry in each country dwarfs all others in attracting investment. Figure 3.7 shows fossil fuel as a sector attracting roughly half of greenfield FDI in Kazakhstan, Turkmenistan, and Uzbekistan. The dependence of Kyrgyzstan on a single sector for attracting FDI is even higher: metals capture about 80 percent of foreign investment. Tajikistan seems to be more diversified in

attracting FDI in different industries, with metals attracting almost 30 percent. Kazakhstan and Turkmenistan, both heavily relying on high hydrocarbon revenues, stand out in as the Central Asian countries attracting the largest FDI in three decades of independence.

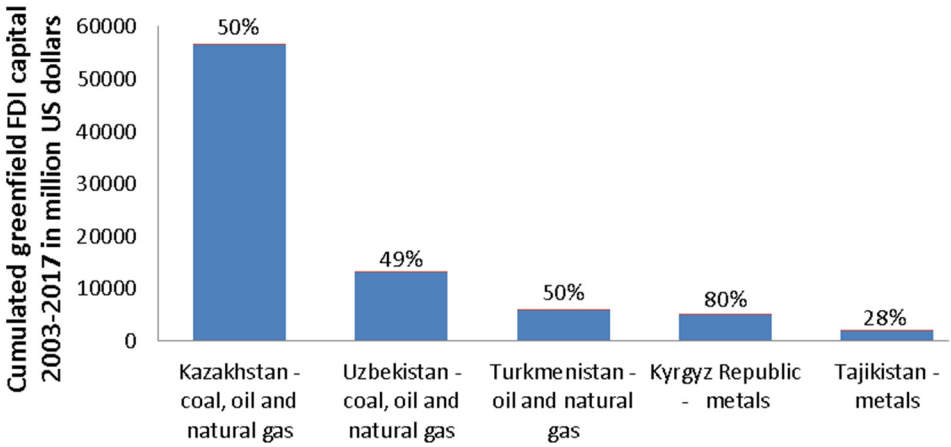

Fig. 3.7 Industries that received the most significant cumulated greenfield FDI capital as a value and share of the total between 2003 and 2017 in each Central Asian country (OECD 2019).

The stock of direct foreign investment is the cumulative value of all investments in a country made directly by residents of other countries. Though the total of FDI inflows and FDI stock are different measures of investment activity, there seem to be discrepancies in estimates between Figure 3.8 and Table 3.1 if converted to a common denominator (this is only a conjecture as the total of FDI inflows for a fixed time period and FDI stock for different time frameworks are not the same measures). Moreover, there are significant differences in the estimates of FDI between the total and stock for Uzbekistan and Tajikistan as reported by UNCTAD. This points to the study limitations that differences in data availability and methodological used by separate sources cannot avoid. Those discrepancies are once again reminiscent of the critical fact that precise statistics are not available, even though previous and subsequent figures presented in this chapter are the best estimates available from reputable sources. The following section provides more detail on each country.

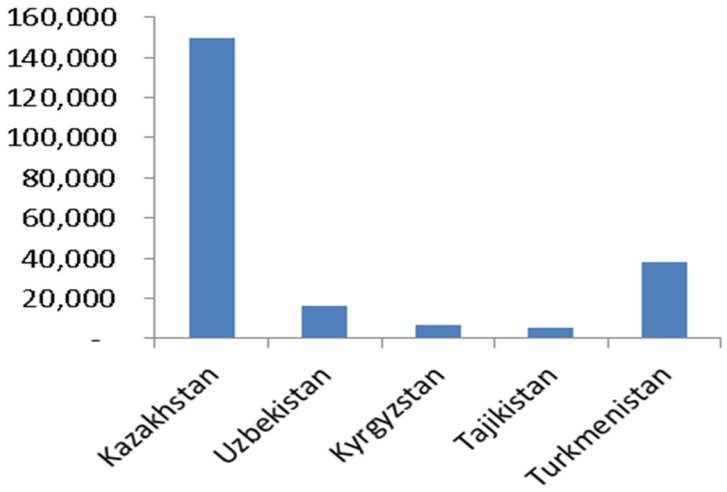

Fig. 3.8 Total FDI inflows in million U.S. Dollars in Central Asia between 1991 and 2019 *(UNCTAD 2021)*.

Table 3.1 Stock of direct foreign investment in Central Asian countries as of the end of the period indicated (The World Factbook 2020).

Country	FDI stock ($)	Global rank	Year of estimate	FDI stock per capita ($)	Population (million)
Kazakhstan	156,200,000,000	36	2017	8,580	18.2
Kyrgyzstan	5,860,000,000	105	2017	969	6.0
Tajikistan	2,272,000,000	117	2013	278	8.2
Turkmenistan	3,061,000,000	114	2013	570	5.4
Uzbekistan	No data available from the source				

Recent FDI trends in Central Asian countries

Central Asia managed to be an area of concentrated FDI among developing countries globally in 2019: Uzbekistan, Kazakhstan, and Turkmenistan were among the top five recipients of FDI in the category of landlocked developing countries (UNCTAD 2020). Looking from the perspective of greenfield investments, Kazakhstan and Uzbekistan recently dwarfed all other countries in the region (Figure 3.9); therefore, it seems natural that the most recent UNCTAD reports would focus on data from the largest countries in Central Asia between 2017 and 2019. Furthermore, there was substantial growth in announced greenfield projects in Turkmenistan, Tajikistan, and Uzbekistan, while the relative change in Kazakhstan and Kyrgyzstan

was more modest. However, the recent trends are not entirely indicative of the overall direction, as the unstable growth in FDI over the past three decades in Central Asia demonstrated. Overall, actual FDI inflows in the transition economies heavily dependent on oil and gas extraction and processing have declined for two consecutive years (UNCTAD 2019). Countries such as Kazakhstan and Turkmenistan can attract large projects in some periods, but they are exposed to investment and price cycles (UNCTAD 2019). The lack of new projects and divestments from existing projects was responsible for the FDI downturn in such countries, such as Germany's RWE closing down their operations related to natural gas in Turkmenistan. Significant divestments in Kazakhstan caused a drop of 18 percent of FDI (down to $3.8 billion) in 2018 and 17 percent (down to $3.1 billion) in 2019.

Central Asian countries received different credit ratings ranging from "investment grade" in Kazakhstan to "non-investment grade" in Uzbekistan to "highly speculative" in Tajikistan (OECD 2019). In the country assessment of the risk of a business defaulting by Coface (2020), Kazakhstan and Uzbekistan had Fairly High, while Tajikistan, Turkmenistan, and Kyrgyzstan all had Very High ratings of risk. Central Asian countries did not rank very high in the global rankings of transparency and democracy. Extractive industries had an outsized effect on investments and economic growth in all of the Central Asian countries. The overreliance on natural resources does not seem sustainable in the long term. Table 3.2 indicates how Kazakhstan and Uzbekistan, the biggest economies in the region, seemed to provide better conditions for the quick setup of a business even when compared within the larger area of Central Asia and Eastern Europe. In most other recent investment climate indicators related to taxation, Central Asian countries did not seem to differ enormously (as Table 3.2 shows). The remainder of this section outlines the reports by UNCTAD (2019, 2020, 2021) and other work on each Central Asian country. These reports reveal how inbound FDI mostly declined or remained unchanged in the last decade before 2020 amid the sluggish progress in reforms and conditions accompanying the attraction of investments within each Central Asian country except for Uzbekistan. The government of the respective countries should take broader measures to improve the investment climate and attract significant FDI outside the minerals, oil, and gas industries. With almost all countries of the region maintaining authoritarian political regimes, more liberalization seems to be a must for further progress.

Kyrgyzstan was the first post-Soviet country in the CIS to initiate broad reforms to encourage foreign investments and recently ranked between Switzerland and Norway on the FDI Restrictiveness Index (OECD 2019). These measures were not sufficient to attract substantial investment at the beginning: 85 percent of FDI in Central Asia during the first decade of independence still went to resource-rich Uzbekistan, Kazakhstan, and Turkmenistan; Kyrgyzstan received less than ten percent, while conflict-affected Tajikistan received the rest (Vitalis 2020). However,

the strategy seemed to bring the desired effect in the end: Kyrgyzstan achieved higher-than-average performance among comparable economies (especially relative to the countries that are less reliant on hydrocarbon resources – Uzbekistan and Tajikistan) in FDI as a percentage of GDP and FDI stock per capita in the region in the recent decade, though the growth remained highly volatile (Figure 3.1, Figure 3.5, Table 3.1). Businesses enjoyed relatively cheap electricity from abundant hydroelectric power (OECD 2019). Mining, finance, and petroleum product manufacturing attracted the most FDI, but flows to other activities remained weak (Santander 2021, U.S. Department of State 2020). The anti-corruption plan promulgated in 2012 seemed to improve the business climate in the country (Santander 2021). Kyrgyzstan pioneered the adoption of integrated national financing frameworks supported by the U.N. (UNCTAD 2020). The main sectors attracting FDI were metals, making up 79.5 percent (more than ten times larger than the next largest sector), and building and construction materials, making up 7.1 percent (OECD 2019). The country has preferential access to markets in Kazakhstan and Russia within the Eurasian Economic Union (OECD 2019). The prominent investors in 2017 were from China (49%), Russia (16%), Kazakhstan (8%), the United Kingdom (5%), Germany (5%), Canada, Turkey, Japan, and the Netherlands (OECD 2019, U.S. Department of State 2020, Santander 2021). Kyrgyzstan introduced the investment treaties pertinent in Lee John Beck v. Kyrgyzstan, a case involving the authority's termination of the investor's land-lease agreements (UNCTAD 2019). There were disputes with a Canadian firm over the control of the gold mine, and China pulled out of a $280 million project of a logistics center in a free-trade zone in 2020 following anti-Beijing protests (Santander 2021, U.S. Department of State 2020). Overreliance on the mining industry and Chinese investments present future risks in sustainable FDI flows. The limited capacity to effectively implement regulations and the poor-quality infrastructure continue to reduce competitiveness and impede the potential for attracting more FDI (OECD 2019). One issue for foreign investment opposing the benefits of democratization was political instability occurring at different periods of the change in governments during the country's independence. This lack of stability could have affected the negative trends in attracting FDI since 2015. Remaining the most democratized economy in the region, Kyrgyzstan should further strengthen its liberal institutions, good governance, and the rule of law to provide a stable environment for foreign investors.

Kazakhstan's economy is the largest in Central Asia. It has been heavily dependent on hydrocarbon resources. The country has benefited from a growing economy, a skilled workforce, a banking system with a large surplus of foreign exchange, a location at the crossroads of Europe and Asia, and Chinese investments through the Belt and Road Initiative (Santander 2021, U.S. Department of State 2020). It is no wonder that the country managed to attract over 70% of the FDI flowing in Central Asia (OECD 2019). The largest sectors attracting FDI were fossil resources (coal,

oil, and natural gas), making up 49.5 percent, and metals, making up 14.6 percent (OECD 2019). The biggest of the nine landlocked CIS countries, Kazakhstan was the third-largest recipient of FDI among transition economies in 2018 and 2019, but the investments seemed to be in decline. Publicly announced divestments included the departure of Telia (Sweden) and Turkcell (Turkey) from the telecommunications sector (UNCTAD 2019). Still, an increase was observed in large projects by MNEs. Greenfield projects of foreign investors announced in Kazakhstan were among the largest within the group of landlocked countries. These included textile mills (Chinese Cathay Industrial Biotech estimated at $2 500 000 in 2018), petroleum refineries (R Way Solution from Singapore estimated at $940 000 in 2018), and basic chemicals (Chinese North Huajin Chemical Industries estimated at $600 000 in 2019). French Total made investments in oil and gas production, and French Alstom invested in transport. The largest project started in 2019 was a carbide plant of a Chinese chemical company. Metals mining, manufacturing, wholesale and retail trade were the other areas attracting FDI. The U.S., China, and the Russian Federation have long been among the most significant FDI source countries (UNCTAD 2020). In 2018, the Netherlands was the biggest investor contributing to Kazakhstan's FDI (29%), followed by the U.S. (18%), Switzerland (14%), the Russian Federation (6%), and China (5%) (OECD 2019). Kazakhstan has been among the largest economies in transition to introduce special economic zones (SEZ) that encourage investments. Cross-border Economic Zones under joint ownership by neighboring countries involved deeper integration. The Horgos/Khorgos became a hub for trade, entertainment, duty-free commerce, shopping, and intercultural exchange. Travelers from China, Central Asia, Europe, the Russian Federation, and Turkey have been able to stay for 30 days visa-free to meet, communicate, and trade since its opening in 2012. Kazakhstan pays attention to the Sustainable Development Goals with a list of priority activities for the implementation of investments that includes the collection, treatment, and distribution of water and the collection, treatment, and disposal of waste (UNCTAD 2020). The country remained among the more liberalized economies in Central Asia and the CIS in many aspects. Still, considerable problems with FDI attraction remained, including the excessive dependence on commodity prices and the economic conditions of partners (mainly Russia) and interventionist and protectionist policies (Santander 2021, U.S. Department of State 2020). Further liberalization is needed in the country's legal framework, as well as progress in corruption, infrastructure, privatization, state monopolies, environment, human rights, labor relations, and intellectual property protection (OECD 2019, U.S. Department of State 2020). While relatively high compared to Central Asian counterparts, these areas remain below the best international standards.

Uzbekistan received surprisingly low FDI as a percentage of GDP in the first decades of independence, considering it had the largest and fastest-growing population in Central Asia. The situation started to change with the new government, becoming

one of the most notable transition economies in 2020 that saw FDI inflows increase prompted by the liberalization of the country in recent years (UNCTAD 2020). Uzbekistan enjoys comfortable levels of debt and foreign exchange reserves, a strategic location between China and Europe (the "New Silk Road"), the largest domestic market in Central Asia in terms of the population at 32 million, and an ambitious public investment program (Santander 2021, U.S. Department of State 2020). Legislative changes since 2017 have included the elimination of punitive inspections of businesses and the requirements to convert hard currency export earnings at the official exchange rate. FDI flows to Uzbekistan grew four-fold to over $400 million in 2018, as the country gradually opened up to foreign investment. The main sources of FDI in 2017 were Russia (55.6%), China (15%), Japan (6.6%), the Netherlands (4.3%), and the Islamic Development Bank (4.2%) (OECD 2019). Russian MNEs started investing relatively recently in hydrocarbon industries with large projects in oil and gas by Lukoil. More investors in 2018 included MNEs from China, India, the Republic of Korea, and Turkey. Petroleum refineries by Kawasaki Heavy Industries of Japan announced in 2018 are estimated at $940 000 (UNCTAD 2019). More FDI came to agribusiness and renewable energy, which more than tripled in 2019 to $2.3 billion, with the equity investment and reinvested earnings together expanded by 231 percent to $2.1 billion. Intracompany loans turned from negative to positive. The country promoted industrialization in its 21 newly established free economic zones. Textiles and apparel projects were started by Chinese, German, Indian, Korean, Thai, and Turkish companies. Two Turkish investments in fossil fuel electric power made by Cengiz Enerji San ($996 000) and Yildirim Holding ($996 000) were the second and third largest in the group of landlocked countries in 2019. Furthermore, Orano Mining (France) invested in uranium exploration and development, while the chemical sector attracted Chinese, Russian, Singaporean, British, and U.S. investors. Political stability seems to be another factor adding to the recent benefits brought by liberalization. Numerous joint ventures commonly benefitted from foreign investments, but there were reports of complications in currency exchange or earnings withdrawal (OECD 2019). The most significant problems of FDI persisted, including low economic diversification, dependence on commodity prices, underdeveloped banking, and state interventionism (Santander 2021, U.S. Department of State 2020). While considerable progress has been made recently in these respective areas, the state still maintains a strong presence and regulations have discriminatory effects on foreign investors in energy, telecommunications, airlines, mining, and textiles (OECD 2019). Further progress in attracting FDI will also depend on diversifying inflows with the slowdown of investments in the energy industry (UNCTAD 2020).

Tajikistan attracted relatively low to moderate inflows of FDI compared to its neighbors in the region. The internal conflict during the early 1990s likely had a severe impact in the first decade after gaining independence. Growth in FDI inflow did not seem strong as of 2019, though the number and value of greenfield projects

increased sharply in the same period, as evident from Figures 3.9 and 3.10 (UNCTAD 2021). The aluminum, renewables, fossil fuels, construction, cotton, and energy sectors attracted foreign investment from the most prominent sources in terms of share in the total FDI between 2007 and 2015, including China (22%), Russia (21%), Kazakhstan (8%), the United Kingdom (7%), the United States (6%), and the Philippines (5%) (OECD 2019). China gradually replaced Russia as the largest investor as part of its Belt and Road Initiative, funding thermal power, hydropower, and road infrastructure, including a project between Dushanbe and Uzbekistan (U.S. Department of State 2020). Tajikistan was ranked relatively low in the Doing Business rankings, though it made progress by advancing 20 spots and had a relatively well-developed regulatory framework as of 2020 (OECD 2019). Poor productivity, cumbersome procedures for obtaining permits, stringent labor regulations, limited access to credit, the poor resolution of the insolvency cases, an uncertain business environment, poor infrastructure, inadequate training, the lack of an independent judiciary, and widespread corruption all limit the attraction of more FDI to the country (Santander 2021, U.S. Department of State 2020). Large-scale investments involved considerable debt distress considered unsustainable by some global institutional investors (OECD 2019).

Turkmenistan attracted considerable FDI in the decades after gaining independence. By 2009, its FDI reached almost a quarter of the GDP – a record among Central Asian countries (UNCTAD 2021). The FDI numbers looked less impressive in the greenfield and stock per capita values, as shown in Figure 3.6 and Table 3.1. Overall, hydrocarbons and petrochemicals in the country's public sector attracted the most foreign interest and investment – about half of all greenfield FDI (OECD 2019). Other significant sectors receiving FDI were transportation with 24 percent, metals with 10 percent, chemicals with 5 percent, and textiles with 5 percent (OECD 2019). However, growth has slowed since 2010, and companies have been increasingly leaving the market recently due to issues with the exchange rate and payment of bills (Santander 2021, UNCTAD 2021, U.S. Department of State 2020). Though the country has not published detailed information on recent FDI, international analysts estimated that Turkmenistan's largest foreign investors in 2012 were China (39%), followed by Russia (16%), the Persian Gulf countries (12%), Turkey (9 %), and Canada (8%) (OECD 2019). China provided $4.1 billion in loans to build the second-largest gas field in the world (Santander 2021). Turkmenistan has regularly amended its laws to meet international standards. Political stability has been the most positive aspect of business in Turkmenistan outside of the lucrative budgets allocated to grand projects financed by hydrocarbon revenues (U.S. Department of State 2020). Low crime rates have also been a positive security aspect, while ongoing and future privatization presents new opportunities. Foreign companies were able to secure contracts with the government for construction materials, agricultural machinery, oil and gas extraction equipment, medical devices, food processing equipment, and other kinds of exports on a large

scale. Major foreign companies such as General Electric established business in the country as industrial equipment suppliers, but their local operations were primarily limited to sales of machinery to the government (U.S. Department of State). Turkmenistan's business environment is among the most difficult in the region due to its regulatory framework and business practices (OECD 2019). There were reports of issues with the rule of law, opaque regulations, transparency, and expropriation risks (U.S. Department of State). Strengthening legal protections for assets, contract awards without the need for connections to those in power, and an independent judiciary are necessary. The control of foreign exchange flows complicates payments (Santander 2021). Developments in the financial sector, including the market exchange rate and conversion, would improve the investment climate. The country was not included in Doing Business data and overall suffers from inadequate ICT infrastructure (Santander 2021). There is also a lack of detailed and accurate information for decisionmakers, to the extent that foreign sources are often more reliable and readily available. An effectively functioning one-stop shop to facilitate the registration of businesses and an investment promotion agency is desirable (OECD 2019).

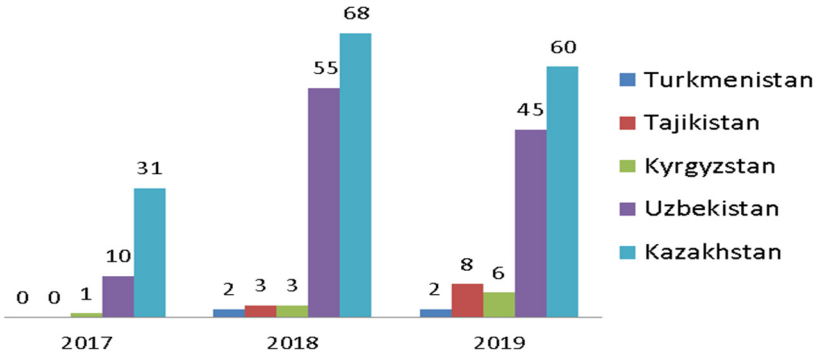

Fig. 3.9 The number of recent greenfield investments in Central Asia (UNCTAD 2021).

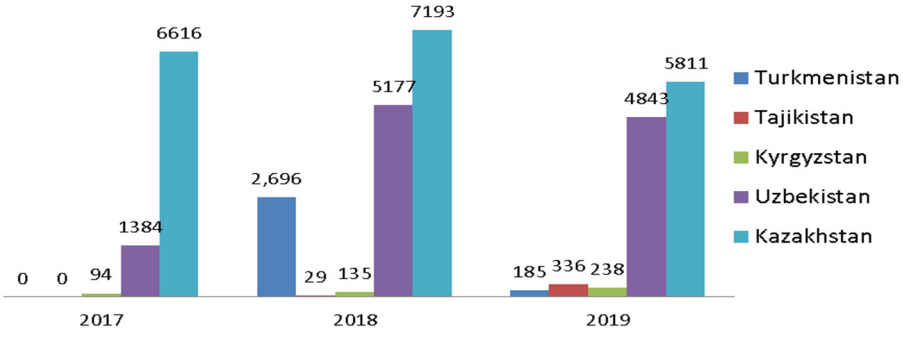

Fig. 3.10 Value of recent greenfield investments in Central Asia (UNCTAD 2021).

Table 3.2 Comparisons in selected conditions of the recent investment climate within Central Asia and Eastern Europe.

	Turkmenistan	Tajikistan	Kyrgyzstan	Uzbekistan	Kazakhstan	Data sources
Index of Transaction Transparency		8	7			Doing Business (2020)
Index of Manager's Responsibility		6	5			
Index of Shareholders' Power		6	8			
Value Added Tax (VAT)	15%	18%	12%	15%	12%	Santander (2021)
Company Tax	8%	23%	10%	15%	20%	
Withholding Taxes* – Dividends	15%	12%	10%	10%		
Withholding Taxes* – Interests	15%	12%	10%	10%		
Withholding Taxes* – Royalties	15%	15%	10%	20%		
Number of Payments of Taxes per Year		6	51	10	7	Doing Business (2020)
Time Taken for Administrative Formalities (hours)		224	225	181	182	
Total Share of Taxes (% of profit)		67.3	29	32.1	29.4	
Setting Up a Company – Procedures (number)		4	4	3	5	
Setting Up a Company – Time (days)		11	10	4	5	

* Including those per double taxation treaties

Data for comparison: estimates for all of Eastern Europe & Central Asia			
Index of Transaction Transparency*	7	Number of Payments of Taxes per Year	17.6
Index of Manager's Responsibility**	5	Time Taken for Administrative Formalities (hours)	238
Index of Shareholders' Power***	6	Total Share of Taxes (% of profit)	34
Setting Up a Company – Time (days)	10	Setting Up a Company – Procedures (number)	5

It is worthwhile to briefly mention the relevant responses to COVID-19 here. The majority of developed countries introduced stricter FDI screening in critical industrial sectors to protect against undesirable foreign influences. Central Asian countries cannot afford to provide the same support for struggling businesses as rich countries. There is a delicate balance between urgently needed investments for post-

pandemic recovery and the long-term need to protect areas of strategic importance from excessive control or takeover by foreign entities. Thus, the protection of critical sectors and weakened companies is another concern for governments in the region trying to attract foreign investors. Legislation plays a vital role in this and other aspects of foreign investment, as discussed in the next section.

Legal and institutional basis

This section covers certain legal aspects of investments in Central Asia. The following types of legal instruments and investor protections exist in national laws protecting investors' rights, security, and property; bilateral investment treaties between home and host governments; host-country adherence to multilateral treaties protecting intellectual property; host-country adherence to multilateral treaties governing human rights and worker protections; adherence of business partners in the host country to voluntary corporate codes of conduct on human/worker rights, environmental protection, and others. (Economist Intelligence Unit 2014). The rule of law and efficient bureaucracy are conditions that make high-quality investments from abroad possible. Legal and institutional reforms are necessary, but existing investment-related legislation should be consistently implemented or enforced in Central Asia. Central Asian countries have developed bodies and legislation in charge of foreign investments that differ in structure and approach (OECD 2019). The following are some of examples.

In Tajikistan, there is the Committee on Investment and State Property Management responsible for investment policies, TajInvest, in charge of promotion, while the Ministry of Economic Development and Trade is in charge of the free economic zones, and the Consultative Council on Improvement of Investment Climate promoting related reforms.

In Uzbekistan, the Foreign Investment Agency is responsible for information and legal support to foreign investors, one-stop servicing of investors, an investment map with information on the profile of each province, and various policies for attracting foreign investments within the Development Strategy for 2017-21.

Kyrgyzstan has legislation based on global best practices on tax administration, permits, technical regulations, and inspections.

Kazakhstan introduced a new public-private partnership law, improved concession legislation, enhanced the protection of foreign investments, provided effective dispute resolution mechanisms, removed foreign equity restrictions in transport and telecommunications, simplified licensing, and setting up a business.

In Turkmenistan, extensive regulations of the investment included the following legislation: "On Investment Activities in Turkmenistan" (1992), "On Foreign Concessions" (1993), "On Foreign Investments" (2008), "On Hydrocarbon Resources" (2008), "On Currency Regulation and Currency Control in Foreign Economic Relations" (2011), "On Foreign Economic Activity in Turkmenistan" (2014), "On International Commercial Arbitration" (2014), and "On Free Economic Zones" (2017). The country provided legal guarantees for participation in multilateral international agreements on the promotion and mutual protection of investments. Turkmenistan joined the International Center for Settlement of Investment Disputes. The country is a party to bilateral investment treaties with Great Britain, Germany, India, Italy, Canada, China, Russia, Turkey, and others. Concerning the avoidance of double taxation of income and property, there were over 37 bilateral international treaty agreements (Ministry of Finance and Economy of Turkmenistan 2020). In order to protect the national economy from economic, financial, legal, sectoral, regional, and natural risks, the Agency for the Protection of the Economy from Risks was created in 2013 under the Ministry of Economy and Development.

The post-pandemic period could accelerate efforts to reform investment agreements to ensure regulation in the public interest while maintaining adequate investment protection (UNCTAD 2020). Bilateral investment treaties (BITs) and treaties with investment provisions (TIPs) are instrumental in special economic zones and investment dispute settlement. Transition economies have been adopting the regimes of such zones since the 1990s. The UNCTAD Investment Policy Hub (2021) indicated the number of investment treaties in Central Asian countries could correlate with population size (Table *3.3*). It should be noted that countries' development and growth levels in the global ranking did not necessarily mean a higher number of agreements.

Table 3.3 Investment treaties in Central Asia (UNCTAD Investment Policy Hub 2021).

Rank*	Country	Total BITs	Total TIPs
41	Uzbekistan	50 (45 in force)	5 (4 in force)
43	Kazakhstan	47 (43 in force)	11 (10 in force)
70	Tajikistan	35 (24 in force)	7 (6 in force)
72	Kyrgyzstan	34 (24 in force)	9 (8 in force)
92	Turkmenistan	26 (19 in force)	7 (5 in force)

*Global rank based on International Investment Agreements by the economy.

Major countries and global investors as sources of FDI

The country-specific information presented in the relevant reports outlines China, the Russian Federation, and countries of Western Europe as significant origins of investments in Central Asia (OECD 2019, UNCTAD 2021). In this section, the scope and quality of investments from selected countries and areas are briefly discussed, though admittedly, other countries are not included here that are of significant importance for FDI in the region.

With the size of its economy, ***China*** is often the foremost option in the economic development of geographically isolated Central Asian countries. Uzbekistan and particularly Turkmenistan have become increasingly reliant on China as the major importer of their gas and the source of investment in extractive sectors since 2010. This dependence became particularly evident in 2020 after China sharply reduced its gas imports from both countries, citing the coronavirus-induced emergency (Hess 2020). Interestingly, China increased gas imports in the same period from Kazakhstan, a country with diversified exports that is less dependent on the Chinese market. Central Asian countries exporting commodities and already borrowing heavily from Chinese banks should carefully consider the cost of any future joint projects. China has a history of refusing to pay the agreed price upon completing a pipeline once the balance of power shifts from supplier to buyer (The Economist 2020). In addition, less stringent requirements on transparency, environment, and social responsibility make Chinese organizations even more attractive for governments of certain developing countries. However, the seemingly straightforward upfront conditions of getting investments in projects other investors would not consider can come at a cost later. China presents a powerful economic partner capable of driving low prices for its purchases, borrowing at interest rates often higher than other international lenders, and negotiating other favorable conditions for Chinese companies and lenders. In negotiations with cash-strapped developing countries, outcomes sometimes could be detrimental to the partner economies in the long term. In particular, large-scale projects financed at high market rates and other unfavorable conditions for developing countries present the risk of a debt trap. One conspicuous example is Sri Lanka handing over its port and surrounding land to a Chinese company for an almost century-long lease. This case could serve as a warning about dealing with partners willing to fund and build projects that ignore adverse feasibility reports due to their own government's political and strategic considerations (Abi-Habib 2018). Realizing the inefficiency of previous agreements with Chinese companies, the new government in Malaysia recently tried to cancel a controversial project but had to renegotiate instead to avoid $5 billion in termination fees (Mitchell and Woodhouse 2019). There is an ample body of evidence in the aforementioned examples and in other regions spanning from Asia to Africa that projects could suffer from poor cost-benefit analysis (The Economist

2020). A considerable number of projects in debtor countries under the Chinese Belt and Road Initiative already face the risk of default. However, some of the projects in the initiative could still bring benefits to local populations, and many projects are yet to demonstrate results. Chinese operations in Turkmenistan were mainly limited to the oil and gas sector. Considerable opportunities remain in Chinese FDI in technological industries such as renewables. The government could effectively attract FDI in more expansive areas if balanced and mutually beneficial terms can be negotiated with partners from China.

The Russian Federation historically had considerable economic ties, political influence, and soft power in Central Asia. The Russian language is the preferred means of communication between officials and business representatives of post-Soviet states, more commonly spoken than English or any Turkic language. Russian companies have invested in operations in Central Asia since independence, and they will likely continue to be attractive business partners in the foreseeable future.

The E.U. countries had cultural and economic connections with the post-Soviet region strengthened over the years of independence. Numerous projects have been funded and implemented through the participation of European organizations. European countries and companies traditionally enjoy great soft power among the Central Asian population that highly values the quality and transparency levels achieved by E.U. businesses. All Central Asian governments have seemed highly interested in attracting more investments from the E.U. Non-hydro renewables are just one very relevant example where European partners are particularly capable of and willing to invest in greenfield projects. In this area, Central Asia was lagging behind other regions but recently strived to catch up. E.U. partners will continue to strengthen their focus on investing in the green economy and Sustainable Development Goals, which matches the best interests of Central Asian populations facing the impact of environmental changes and outdated infrastructure. Yet the very strengths of European investors that earned them a positive image could present challenges in dealing with partners from the post-Soviet area. Issues with infrastructure, complex regulations, an underdeveloped private sector, corruption, occasional problems with the currency exchange rate, and human resources all hamper the wider involvement of E.U. business that typically have stringent requirements towards transparency, the environment, and ease of doing business in foreign countries. These high standards are often in contrast to Russian and Chinese investors for whom it is relatively more comfortable to afford to be less scrupulous in negotiating agreements in such conditions. In particular, Chinese investors appear to have the advantage in negotiations with governments to implement large-scale projects without paying extra attention to the socio-economic and human impact on the local population in the long run. A viable option to combine the strengths of European businesses to enter the local markets and counter competition from state-backed companies in Central Asia could be forming joint ventures (JV) or other

forms of cooperation. As a relevant example from the construction equipment area, Zeppelin International AG maintained a strong regional presence in Russia and Central Asia (Zeppelin 2020). This European-based company selling American Caterpillar machinery benefited from the synergies created by a well-integrated network of Russian-speaking specialists to offer high-value services to public and private customers in the local markets. There are other examples of flexible Western companies in post-Soviet countries adapting to the local business culture while maintaining acceptable ethics and social responsibility standards. However, even companies from developed countries with the highest rankings of transparency could sometimes be prone to questionable practices, as scandals involving Daimler AG and Telia in Central Asia have illustrated (U.S. Department of Justice 2010, Schoultz and Flyghed 2016). Maintaining high standards of social responsibility in Central Asia while being flexible in adapting to peculiar manners of doing business in the region should remain a priority for foreign companies.

Actual benefits and best practices

In a world where increasingly competitive economies try to attract limited foreign investments, studying the best practices from other regions and countries is necessary for any government. Developments in Central Asia should be considered in the context of global trends in FDI. With the official aid from industrialized countries remaining far below and occasionally declining further from the target of 0.7 percent of GNP, the growing share of FDI rather than ODA has become effective in boosting the economic growth of developing countries (Vitalis 2020). Donor countries were mainly investing in a small number of recipients and generally showed declining interest in less developed countries for both ODA and FDI (Vitalis 2020). Global investment flows could increasingly shift from Central Asia to regions that are more competitive and less dependent on commodity exports, including countries such as China and India, the recipients of the lion's share of intra-Asian FDI over the past two decades. In natural-resource-based projects in Central Asia, prospects are likely to be further revised downward after 2020. Demand for commodity and fossil resources weaken; the prices of the main exports remain depressed; the prospects look even worse considering the potential of the price wars between major oil producers and cheaper renewables (UNCTAD 2020). The previous section of this chapter on recent FDI trends already outlined these and other issues and strengths that each country can address or exploit. Governments of countries in Central Asia should continue to work on all aspects known to create the conditions and image that is attractive for much-needed foreign investment in all sectors.

A question could arise for policymakers who want to base their decisions on scientific evidence in the first place: what are conditions that attract FDI to the national

economy beneficial for development in the long term? Theoretical and empirical evidence supports the widespread view that greenfield and M&A investments could have a positive homogenous effect on growth. Still, the effect is not strong, and the enhancement of the human capital of host countries is an essential condition to get the maximum benefits. The relevant results can be summarized as follows: A foreign direct investment made by organizations or individuals in foreign business operations or assets can substantially enhance the levels of technology transfer and socio-economic growth in developing countries (Vitalis 2002). FDI can thus be desirable for the technological development of the host country compared to other types of investment. FDI can promote growth by contributing to capital formation, incorporating new technologies, and promoting knowledge transfer from more developed nations. On the other hand, a purchase of securities – foreign portfolio investment (FPI) – might be more effective than foreign aid (ODA) in promoting institutional reforms from public sources and FDI from private ones (Bayulgen 2005). However, the positive spillovers from any foreign investment may not arise in less-developed nations because domestic firms with backward technologies and low-skilled labor may not learn from MNE since the technology and knowledge gap is too broad (Moid 2018). Foreign investment could even lead to negative impacts if investments into a less-developed country are primarily in the form of resource-seeking FDI when investors obtain scarce resources that are less available in the home market and, at the same time, a workforce and technology are not sufficient to benefit from FDI. The actual benefit that foreign investment brought to local populations in developing countries with authoritarian governments is still a subject of debate, as the next section discusses in more detail (Bayulgen 2005).

Though the exact impact of each aspect on the investment climate in each Central Asian country is not clear, the publicly available surveys in other countries allow a broad range of factors, motives, and incentives affecting FDI to be identified. Businesses can have various commercial reasons for FDI: access to new markets through local production or service provision, replacing importation; access to locally sourced natural resources; reduction of operating costs through cross-border integration of production or provision of services; or access to knowledge-based assets of the investment location, e.g., local innovation and R&D (Economist Intelligence Unit 2014). Factors that might deter companies from investing abroad can include political or social instability, the lack of transparency in regulatory or legal rule-making processes, arbitrary or discriminatory treatment by the host country government, the lack of recognition of contract or intellectual property rights, the lack of independent and impartial courts in the host country, the risk of physical security of in-country personnel, the risk of expropriation of investment without adequate compensation, poor human rights conditions in the host country, the non-democratic character of the host country government, the lack of trust in the judiciary, widespread corruption, the monopolization of markets and state capture by oligarchs, cumbersome and frequently changing legislation, oppressive

law enforcement agencies, complicated tax administration, an unstable financial system and currency, regional conflicts, restrictive capital and foreign exchange controls, and large-scale labor migration (Economist Intelligence Unit 2014, Dragon Capital 2020). The conditions necessary for FDI decision-making include the ease of doing business, a stable political environment, the strong rule of law, the low cost of doing business, reliable infrastructure and other utilities, low levels of corruption (public and private), a stable macroeconomic environment, regulatory or tax incentives for investors, access to natural resources or raw materials, access to skilled labor and other key staff, access to national or regional markets, access to innovation or R&D in the host country, and access to capital markets and finance (Economist Intelligence Unit 2014).

As for the rule of law, steps for a country to take to improve the situation can include greater independence of the judiciary; greater independence of the police and security forces; better-trained judiciary, police and security forces and the legal profession; improved transparency in legal and administrative rule-making; stronger laws for the enforcement of investor rights, including intellectual property rights and laws guarding against expropriation; adoption of bilateral investment protection treaties; adherence to international agreements and standards on human rights; controlling corruption; increased political and social stability; adoption of democratic systems of government; and adherence of local business partners to internationally recognized corporate codes of conduct (Economist Intelligence Unit 2014).

The following steps by authorities could have a positive impact on investment decisions: a demonstration of practical anti-corruption efforts, a re-launch of the judiciary, visible steps to separate politics and business interests and reduce the influence of oligarchs, the appointment of credible reformers to top positions, improvements to infrastructure and logistics, rapid agreement with the global institutional investors on loan tranches and regular disbursements later on, government support and financial incentives for new direct investors, agreement with regional organizations to expand market access, reforms in law enforcement bodies, and transparent large-scale privatization (Dragon Capital 2020). The following steps, on the contrary, could harm investment decisions: a change in geopolitical direction from west to east, increased tax pressure on businesses, a shift away from democratic values, giving direct or hidden privileges to selected firms, loose fiscal and monetary policies increasing risks to macro stability, a failure to reach an agreement with the global institutional investors on the next loan tranche, default on government debt, removal of credible reformers from their current positions, the re-imposition of capital controls, and protectionist measures in foreign trade (Dragon Capital 2020).

Services provided to potential investors could include business events or conferences promoting priority sectors abroad or within the country; investment-related shows

promoting priority sectors; comprehensive briefings with company representatives during first-time site visits and at follow-up visits; guidance on government structure and regulatory and nonregulatory aspects for business start-up, including entry and establishment procedures, through advice and introductions; support during first-time site visits with itinerary and agenda suggestions, planning, and meeting confirmation; location-specific investment guides in the form of printed or downloadable resources from the website; information updates concerning priority sectors and activities; outreach to investors to gather information on potential or actual grievances related to government conduct; tailored responses to specific questions asked by particular investors; facilitation and coordination of participation in initiatives and events that provide networking opportunities in the local ecosystem; periodic visits and meetings to monitor the status of the investment projects and explore new investment opportunities; comprehensive support through interventions on project management for business expansion or reinvestment; invitations to relevant activities and events to promote linkages and matchmaking opportunities between investors and suppliers; and introductions to other foreign companies, domestic companies, potential suppliers, and institutions (World Bank Group 2020).

Most recently, the pandemic-related restrictions and lockdowns have likely influenced the investment plans of any business globally. Measures that could be implemented to counter the impact of COVID-19 on investors include working from home using digital platforms; providing laptops to employees for a continuous provision of services to investors; providing subsidies to establish internet or increase bandwidth to their homes; strengthening transparency and communication on COVID-19 by updating investors on impact; updating investors on country measures or responses; bolstering direct assistance; tracking the portfolio effect on investors; contacting the highest risk firms or all established firms; solving individual investor issues; boosting advocacy services; submitting or mediating requests for investors to access public financial support, debt assistance, trade finance, or tax relief; systematically gathering information about issues investors are facing; advocating the government for emergency policy responses or reforms; following up until reforms or solutions are provided; supporting companies in repurposing lines; assisting investors on restructuring their projects to return the operations back to scale; promoting repurposing, which could even lead to expansions or diversification in segments that could benefit from the crisis; and supporting the diversification of investor activity (World Bank Group 2020). The global pandemic has accelerated the processes of automation-driven reshoring, localization, shortening of supply chains, and increasing protectionism and trade costs in the global value chains, making it increasingly challenging for Central Asian economies to attract more foreign investments, which would be highly beneficial for the development of local industries (UNCTAD 2020).

Implications for stakeholders

None of the considerations or recommendations presented so far are new, and they are not exclusively related to FDI. If implemented consistently, the broader liberalization of all aspects of life in Central Asia is likely to bring much-needed improvements in the social, economic, and educational conditions of the population, and might have a positive impact on the image of the countries abroad. All of these are likely to boost the interest and actions of investors in the long term. However, the extent of the much-needed measures taken by the governments in the region would ultimately depend on their willingness to surrender tight control over various areas of their respective economies and societies. As the trend in the long-term decline in hydrocarbon and other export revenues continues, the countries should increasingly adopt the best management practices standard for most neighboring regions. These best practices should be used instead of the particular policies the government could afford to rely on in the past, when prices of oil and gas and other major commodities from Central Asia were high. Those unique ways of running the economy and doing business, also known as "the national path," differed sharply for many years not only from other post-Soviet countries but also from most neighbors in Eurasia. The need to understand "the local ways" and adopt a gradual, low-risk approach was frequently used as an excuse for resistance to the further liberalization of economies. The rule of law and democratization accompanying liberalization efforts could be perceived as a threat to political stability and control. Given the high uncertainties and opaque decision-making at the top levels of power in the governments of the region, it is difficult to judge whether and how much the economies of Central Asia would succeed in giving up excessive government control to gain the obvious benefits of liberalization in higher economic growth and investments. The potential benefits could convince the ruling elites to take bolder steps towards bringing the "local specifics" closer to the best international standards of transparency and the rule of law. Political stability up to a specific point has its apparent benefits for attracting investment, but not at the expense of stifling growth in other areas of the development potential of the economy. Ruling elites need to realize that an excessive focus on stability is likely to destabilize the economic and social situation in the long run, thus threatening the cherished control they might be benefiting from. International organizations could play an essential role in persuading governments to implement necessary reforms, which is discussed later in this section.

As was already mentioned, adequate human capital is a necessary condition for FDI inflow to positively impact growth in the long run (Moid 2018). Central Asia certainly has room for improvement in the R&D and education sectors (Ovezmyradov and Kepbanov 2020). It should be noted here that progress in the closely interrelated issues of low investments and inadequate human capital go hand

in hand with the lack of liberalization in the respective countries, leading to brain drain and preventing the attraction of the best talent. The lack of a qualified workforce and low R&D performance threaten the governments' plans and policies aimed at advancing the positions of Central Asian countries in the global value chains. In addition to human capital, the reforms related to FDI should focus on issues that are known to affect investment decisions, such as corporate governance (corruption, transparency), social and economic stability, transparent and reliable administrative processes, fair taxation and competition policies, and socio-economic issues including human rights and security (World Bank 1997). Earlier studies in post-Soviet countries also determined good governance, economic freedom, and perceptions of corruption to be crucial for improving FDI and avoiding stagnation (Kenisarin and Andrews-Speed 2008). Furthermore, as the example of Argentina in the 1990s illustrated, successfully opening a country to FDI and attracting enormous foreign investments alone cannot maintain long-term growth without addressing the structural weaknesses of the economy. Even countries taking the necessary measures to attract FDI can have to wait for a very long time until those reforms bring the desired investments, as the aforementioned example of Kyrgyzstan illustrated. The path to improving the investment climate could take a long time, but failure to take timely measures while staying complacent with high FDI and revenues in extractive industries will lead to an inevitable loss of competitiveness in the fast-changing world.

Good governance, transparency, the green economy, and sustainable debt in Central Asia remain significant issues in negotiating the terms of investments from certain countries. The importance of FDI from developed countries and institutional investors with high standards of social responsibility was previously highlighted. Western states have long considered the prospect that economic and trade engagement (of which FDI is an important part) could stimulate necessary political reforms in developing countries, and rightly so. Critics argued that Central Asia depended heavily on external capital flows that could finance and empower authoritarian governments but provided little financial strength to local businesses (Bayulgen 2005). Central Asian countries rich in natural resources benefiting from booming hydrocarbon revenues did not have to rely as much on efforts to improve institutions (Billmeier and Massa 2007). The earlier Western support of the democratic and economic transition, in the form of TACIS and similar programs, was mostly devoted to technical measures to be taken by Central Asian partners for the facilitation of economic exchange, while there was less discussion of the political and institutional objectives (MacFarlane 2002). Compared to other states of Central Europe and the CIS, the E.U. encountered larger difficulties in the movement of the Central Asian states on the rule of law, rights, democratization, and the integration of the regional economies beyond the energy sector (MacFarlane 2002). In fact, the differences among Central Asian countries in terms of capital flows could explain why some of them moved towards more authoritarian rule while others remained in

hard authoritarianism (Bayulgen 2005). Global investors could indeed offer more incentives for reforms aimed at market and political liberalization. In the past, more authoritarian states could afford to ignore or even deride the efforts of international partners to promote liberalization when foreign aid and loans tied to necessary political reforms were negligible relative to private investments in extractive industries (Bayulgen 2005). Furthermore, even in countries with a high share of ODA in Central Asia, progress in liberalization could differ, as Tajikistan and Kyrgyzstan demonstrated. The experience of the IMF in Central Asia is highly illustrative of the fundamental changes that occur when international partners successfully persuade national elites into a shared way of thinking about the economy and the limits of the state's role. Elites could take into account the future material benefits of cooperating with the IMF to receive external financing, but considerable political investment in institutional change and policy learning play important roles in shaping political outcomes (Broome 2010). These effects could explain the earlier differences in foreign involvement: a substantive change in a regime's policy orientation in the case of IMF-friendly policy in Kyrgyzstan, less durable change in Kazakhstan when the government encountered domestic resistance towards top-down changes, and the government quickly abandoning recommended policies in Uzbekistan. Importantly, 2020 appears to be the right time for the Western partners of Central Asia to renew their efforts in support of institutional change as most countries in the region seek ways to move away from an unsustainable reliance on exports.

FDI by no means can be considered the most important type of investment to promote political reforms. The conditions of FDI and especially ODA are rarely tied to the implementation of necessary changes in private and public sectors. In fact, MNEs could even prefer to work with an authoritarian leader in the region for "one-stop shopping" in getting a major investment deal rather than negotiating with strong institutions that rigorously enforce high standards (Bayulgen 2005). FPI (for instance, in the form of government bonds) and commercial loans (for example, IMF loans) allow more pressure for political reforms in the transition to democracy and the market economy. Foreign capital thus can promote pluralism by augmenting the resources available to local businesses and shifting to the rule of law, which reduces the costs of doing business and favors liberalization in alternative sources of power in society to challenge and curb authoritarian or despotic tendencies (Bayulgen 2005). Donor and recipient countries could increase funds that support important areas of investment decisions for the development of synergies between FDI, FPI, loans, and ODA. This should include more consistent efforts to develop institutions and policies. Some donor countries and institutions such as the World Bank could focus on the mechanism of output-based aid, where agreements are established between government agencies and the private sector to deliver specific services. Central Asia should become more open to reforming its institutions and expanding privatization in order to benefit from combined loans, FDI, FPI, and ODA inflows.

The shifting priorities of the E.U. and the new American administration after the global pandemic outbreak present new opportunities for supporting environmental protection, renewables, institutional reforms, and other initiatives among partners in the region that will benefit wider populations rather than narrow groups. Strengthening institutions and human capital are key areas where developed countries have assisted in Central Asia. "Promotion of the Rule of Law in Central Asia" (commissioned by German Federal Ministry for Economic Cooperation and Development) and "Central Asian Law: Legal Cultures and Business Environments in Central Asia" are examples of such projects supported by the E.U. that are relevant for efforts to improve the investment climate in the region. International partners should continue the redistribution of investments away from less sustainable sectors such as fossil energy to those contributing to sustainable development goals. This is particularly relevant for rural and vulnerable populations, as private investments in the agricultural sector might be low due to the limited potential for irrigation and productivity in landlocked and arid locations (Woertz 2008). Finally, stakeholders should support intra-regional investments between the countries of Central Asia, which have considerable potential and opportunities that remain to be realized as the regional cooperation grows.

Conclusion

As a distinct area attracting direct foreign investments on the world map, Central Asia achieved certain progress in attracting foreign direct investments globally in the first three decades after gaining independence. In drawing the attention of investors, the governments of the respective countries in Central Asia have been implementing the necessary reforms, but the recent trend of decreasing global and regional FDI indicates that policies should be reconsidered and extra measures implemented. Concern remains about whether the investments from major countries of origin would actually contribute to sustainable development in the long term because of the lack of a skilled workforce and the low priority of socio-political objectives for sustainable development. Another related concern is foreign investment concentrated in extractive industries, with the countries becoming overly dependent on a single origin with unfavorable financing terms. Advancement in liberalization and a stable environment seems to be a key element of making the countries more attractive for foreign partners even without considerable hydrocarbon resources, as the example of Kazakhstan and, more recently, Uzbekistan demonstrated. The region lacks the necessary level of human capital development, one of the most important conditions for upgrading the position of the countries in global value chains and the overall positive impact of foreign investments in the long term. Legal reforms and technological upgrades alone would not suffice. Consequently, concrete

progress in fostering closely interrelated aspects of democratization, the rule of law, and human capital are areas of improvement to both attract and maximize the benefits of FDI for local populations in the long term. However, the future progress of each country in the region is highly uncertain and could ultimately depend on the willingness to surrender excessive government control over various aspects of Central Asian economies.

The results and implications presented in this chapter have clear limitations. Accurate and up-to-date data on national-level FDI flows are the main concerns of the analysis this report is based upon. Discrepancies were found in the values reported by different sources. Future work should focus on combining comprehensive data analysis with investigations of the root causes of negative changes in the investment climate. Also, a deeper analysis of the most recent state of foreign investments in Central Asia from the perspective of global value chains is necessary, considering the global changes caused by the pandemic outbreak.

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4 Non-hydro Renewable Energy in Central Asia

Regional energy trends

The past decade has brought spectacular technological developments in renewable energy on the global scale that few policymakers expected: the cost of wind and solar power sharply decreased to levels comparable to the cheapest fossil fuels (coal, oil, and gas), while the cost of mature renewables such as hydro, biomass, and geothermal did not change much. The fact that the share of renewables will increase to the detriment of fossils is a boon for the environment and the quality of economic development on a global scale. At the same time, gas and oil exports cannot be relied on anymore as steady drivers of future growth in the economies of many countries in view of the green transition.

Central Asian countries that rely on hydrocarbon (Kazakhstan, Uzbekistan, and Turkmenistan) and hydropower (Tajikistan and Kyrgyzstan) resources for electricity generation have long realized the threats presented by changes in the commodity markets. They should also be aware of the opportunities coming from renewables in the near future after the slowdown in global demand as a result of the COVID-19 pandemic. If existing policies continue, the negative economic impact could be two-fold: a decreasing value of exports and transit coupled with an increasing electricity cost for local consumers due to excessive reliance on fossil and hydropower in the national energy mix. The region was still far behind many parts of the world in terms of its preparedness for the ongoing green energy revolution. The main focus of local policymakers has always been on using cheap and abundant fossil and hydro energy with decades of experience and mature technology. Improved air quality, lower emissions, resilience, and security of electricity supply, as well as the overall better ecology as extra benefits of renewables, were probably never prioritized. The timing seems right to substantially enhance the share of non-hydro renewables. Central Asia thus could turn the possible threats posed by renewables to their dependence on

fossil and hydro resources into opportunities for economic and environmental development after the period of uncertainty brought by the pandemic outbreak.

This chapter aims at addressing the following questions: (i) What is the potential of the Central Asian area for the generation of non-hydro renewable electricity? (ii) What are the achievements of Central Asian states in terms of renewable energy capacity and policies? (iii) How can the governments of Central Asia benefit from foreign investments in renewables? (iv) Which threats are presented by non-hydro renewables to Central Asian economies that are dependent on fossil and hydropower resources? These questions are relevant in view of the underdeveloped renewables sector in these countries that requires foreign expertise and funds to fully benefit from the rapidly growing technologies. Extant literature on the recent status of renewables includes relatively little information on Central Asia as a distinct region. The results presented in subsequent sections are mostly based on the analysis of data from relevant industry reports. Comparative analysis of Central Asian countries in this report is limited to the implications of renewables for electricity and fossil exports. Though the share of renewables in the alternative transportation and heating and cooling sectors is increasing globally, the research scope of further discussion concentrating on electricity generation and consumption is justified in the case of Central Asia, a region where electric vehicles, solar thermal, and similar applications of renewable energy are not likely to play any significant role in the near future.

In the subsequent sections, the following topics are discussed: the general state of renewable energy as of 2020, Central Asia's potential for renewables, investment opportunities and threats, corresponding legislation, implications, and conclusions.

The current global state of renewable technology

There is plenty of theoretical and empirical literature available on the subject of renewables covering all their aspects from technology to the environmental and socio-economic impact. This report is mostly based on hard data provided by two influential organizations assessing the world energy market and renewables: the International Renewable Energy Agency (IRENA) and REN21. The experience of countries that are at more advanced stages of non-hydro renewable deployment is valuable for Central Asia, as there is currently limited information on specific projects in the region due to the low share of wind and solar. A brief introduction to the state of renewable technology is worth presenting at the beginning before proceeding to economic aspects. Currently, underdeveloped forms of renewables such as ocean and marine (technologies that include wave and tidal but exclude offshore wind) are not considered in this report, although they have the potential to become significant in the distant future.

Probably everyone knows that common renewables include mature technology such as hydropower, bioenergy, and geothermal one the one side, and rapidly developing technology such as wind and solar on the other. Fewer non-specialists know that widespread solar technology includes two distinct technologies: concentrating solar power (CSP) and photovoltaic (PV). PV is cheaper than CSP, though it has a lower capacity factor and storage. Here, the capacity factor is the relative measure of utilization of rated (maximum) capacity for electricity generation. Importantly, CSP and PV are often considered in combination where PV brings benefits of distribution while CSP ensures the accumulation of energy for a stable supply in periods when irradiation is low. PV is further classified into utility-scale solar PV for larger projects and residential and commercial sector rooftop solar PV for smaller or distributed systems. In addition, onshore and offshore wind technologies are distinguished based on whether turbines are located in seas or on land. Utility-scale PV requires larger initial investments. Rooftop PV energy could cost more than utility-scale PV but provides wider distribution and encourages the participation of individual households. Finally, solar thermal heating and cooling for industrial processing and residential systems constitute significant capacity globally, but it is not considered in detail in this report because of the focus on electricity.

Offshore wind farms can be built only in coastal areas and are understandably more expensive to build (high installed cost) and operate, but they provide higher efficiency (capacity factor) and stable supply due to stronger winds offshore. Offshore wind represents about one-tenth of total wind capacity in the world, mostly concentrated in the coastal areas of Western Europe and Asia. Offshore wind, while of interest for coastal areas of Kazakhstan and Turkmenistan in the distant future, is not considered in subsequent sections of this report as the relevant countries currently lack infrastructure, expertise, and other resources to economically develop this type of renewables.

Bioenergy and geothermal are more diverse in the types of technology used. They have high capacity factors but require special natural resources that are challenging to explore (geothermal) or deliver within the proximity of a power plant (biofuel). Gas from landfill and renewable municipal waste is already a mature technology that addresses both ecological and energy concerns.

Understandably, ocean and geothermal power are excluded from deep analysis in this report for the Central Asian region where natural and other resources in this renewable seem negligible. Furthermore, hydropower and bioenergy as mature forms of renewables with smaller changes in technology and costs are considered mostly from the perspective of complementing and replacing wind and solar power when appropriate. Hence the main focus would be on rapidly growing wind and especially solar technology (often collectively referred to as VRE – variable renewable electricity).

It is important to understand that fossil and renewable technologies often complement one another rather than compete (CSP and PV are a good example). Virtually no country envisions a total of exclusion fossil from the energy mix soon due to cost and stability considerations. The economic life of most projects in wind, solar, and geothermal renewables is 25 years – lower than for hydropower (30 years) but higher than for biofuel (20 years) (IRENA 2020). Thus decisions made on power plants are long-term and hard to adjust once implementation starts: a relevant factor for Central Asia where modernization of fossil and hydropower plants is underway.

Financing renewable projects and shift in energy outlook

Improving technologies, economies of scale, competitive supply chains, and developer experience led to renewable power becoming the lowest-cost option for new capacity in almost all parts of the world (IRENA 2020). As of 2019, renewables accounted for over 70% of all new capacity additions. Between 2010 and 2019, the cost (LCOE) of utility-scale PV fell 82%, CSP fell 47%, onshore wind 39%, and offshore wind 29% (IRENA 2020). The cost for the mature technologies of bioenergy, geothermal, and hydropower has not changed considerably relative to solar and wind. Traditionally important hydropower remained highly competitive, though: most capacity commissioned in 2019 had power costs lower than the cheapest new fossil fuel-fired projects.

The common modern methodology for the estimation of renewable costs usually involves the average lifetime levelized cost of electricity generation or LCOE. The LCOE calculation formula includes the sum of all major costs (investment expenditures, fuel expenditures, operations, and maintenance expenditures in any year of the renewable project) divided by the sum of electricity generation and discounted by the discount rate (cost of financing); all those parameters are taken over the life of the system. This method reveals the crucial role that financing terms play in decisions regarding investments in renewables. The weighted average cost of capital (real) for renewable projects is assumed to be 7.5% within the Organisation for Economic Cooperation and Development (OECD) and China, countries with low borrowing costs and low risks (meaning relatively stable regulatory and economic policies). The same cost is already assumed to be 10% for the rest of the world (IRENA 2020). This fact alone demonstrates how high initial costs, regional risks, and the lack of competitiveness discourage renewable developments in areas such as Central Asia. Interestingly, soft costs including not only finance but also permits, project rights, compliance with incentive applications, and environmental and other regulations constitute a considerable share of the costs of renewables such as PV (IRENA 2020). Official Development Assistance, foreign investments, and the private sector therefore should be combined with appropriate governmental

funding, legislation, and other policies. The important role of legislation and investments is discussed later in detail.

The experience of the leading and largest countries in financing renewables is interesting to consider first. China is the major importer of fossil fuel for post-Soviet countries, and leads the world in installed coal, wind, and solar capacity, as well as nuclear power. If renewables trends continue, over 60% of China's electricity will come from non-fossil sources by 2030 at 11% lower cost, but the share of gas as a relatively clean fossil fuel in the total energy capacity should remain stable within the 7 to 11% range (He et al. 2020). China's pledge to cut its net carbon emissions to zero by 2060 would further reduce the use of fossil fuels in electricity and transportation while offsetting remaining emissions through carbon capture or planting forests (Normile 2020). The E.U. aims to achieve net-zero greenhouse gas emissions already by 2050 as an objective of the European Green Deal (European Commission 2020). Japan, the U.K., and other developed countries have put similar targets by 2050; the U.S. is a notable exception, where currently only parts of the country such as California have made such targets, but this could change soon under the new administration after 2020 (Darby and Gerretsen 2019). India, a potential future importer of energy resources from Central Asia, recently achieved the lowest renewable costs in the entire world (IRENA 2020). The performance of renewables is all the more impressive considering the huge subsidies fossils still receive disproportionally relative to wind and sun capacity in all the major countries. The entry of an increasing number of businesses to the renewables market in the 2010s, when high demand initially drove considerable profit margins, recently contributed to more competitive prices for related equipment and services in international markets, where suppliers actively try to enter new markets with untapped potential such as Central Asia. The difference in observed capacity factors for PV, depending on location, globally motivates the move of installed new solar capacity to sunny locations, which again favors Central Asia (IRENA 2020).

The funding remains an issue for many developing countries in expanding all types of renewables outside decentralized PV. The formerly centralized economies of Central Asia still tend to favor grand projects showing sizable investments and scale. To illustrate large-scale renewable capacity costs, the following projects in comparator countries are worth mentioning. The largest renewable asset finance in 2019 was a $3.9 billion deal to construct a 700MW solar thermal (tower and parabolic CSP) plant in the U.A.E. (IRENA 2020). The largest deal to finance renewable projects among the post-Soviet countries in 2019 was a 750MW onshore wind facility in Ukraine at $1 billion (IRENA 2020). Baku A waste-to-energy plant in Azerbaijan inaugurated in 2012 presents an interesting example of bioenergy in the former Soviet republic (IRENA 2020). The plant had an estimated cost of EUR 346 million, 20 years of operation, and 500 000 tons of annual capacity of municipal waste per year (IRENA 2019). Such biopower plants bring the combined benefit of

energy and heat supply as well as processing solid household waste. Overall, large plants can deliver higher efficiency and stability in power supply, but the financing terms involving foreign investments can be considered risks, as will be discussed later.

Though information on specific Central Asian countries is scarce in the extant literature, relevant information on comparator countries and regions is valuable for purposes of comparisons. For instance, regional information on Central Asian renewables costs is often included in the IRENA report as part of the Other Asia category, which includes Asian countries minus China and India. Obviously, it is problematic to draw accurate conclusions on Turkmenistan, Tajikistan, Uzbekistan, Kazakhstan, and Kyrgyzstan when they are included in a diverse geographical area encompassing such different countries as Afghanistan, Bangladesh, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Viet Nam, South, and North Korea. Nevertheless, regional data on areas such as post-Soviet and Other Asia are useful for evaluating what can be achieved by states with comparable resources. The unfavorable renewable dynamic trend in Other Asia revealed by IRENA 2020 with costs falling less sharply and rapidly than in other regions could be partially explained by late entry, just like in the case of the Central Asian part of the area. Eurasia is another exemplary area where post-Soviet Ukraine, depending on hydrocarbon imports, achieved remarkable scale and low cost of utility-scale PV. Even energy-rich countries such as Russia and the Gulf states actively invest in renewables in the realization that hydrocarbon dependence cannot last long (Ajadi et al 2020; IRENA 2020). Many Arab countries rich in hydrocarbon but with historically low to negligible renewable energy use now set ambitious targets to develop renewables, with the U.A.E. leading the Middle East in recent renewable development (REN21 Secretariat 2020). Certain countries, including those in Central Asia, could be already missing renewable opportunities due to various reasons, and they should be more active in catching up.

Potential of non-hydro renewables in Central Asia

As Figures 4.1 and 4.2 illustrate, Central Asia has on average a higher potential for the generation of electricity from both onshore wind and sun as compared to the rest of Eurasia. The northwestern parts of Central Asia, encompassing Kazakhstan, Uzbekistan, and Turkmenistan, in particular seem to have a larger potential for wind (Figure 4.2). The larger part of Central Asia has a high number of sunny hours, with close to 300 sunny days annually, meaning a decent potential for a stable, uninterrupted supply of solar power (de Jong et al 2017). This is particularly relevant for Uzbekistan, Tajikistan, and Kyrgyzstan – countries prone to seasonal or weather-related fluctuations in energy supply (EIU 2017). The potential of the region for PV capacity looks higher than other renewable technology due to lower installation costs

and complexities compared to CSP and wind. Overall, wind and PV in Kazakhstan, PV and biogas in Uzbekistan, small hydropower in Kyrgyzstan, small hydropower and PV in Tajikistan, and PV in Turkmenistan have higher prospects (Nabiyeva 2018).

Floating solar (FPV) installations tethered to the bottom of a reservoir or canal seem especially promising for Central Asia, with its extensive network of irrigational channels and dams. Not only does floating photovoltaic technology require fewer resources of land and cooling energy, it importantly helps improve water quality (by algae control) and saves water in a region with scarce water resources (Daley 2019). Manufacturers of floating solar plants claim they can save 80% of the evaporation of the covered surface (more than 20000 m3/year/ha) in arid areas where water is used for hydroelectric or irrigation purposes; moreover, large volumes of water used in the cleaning of installed solar arrays can be saved, too (Hodgins 2020). Floating solar is compact and easy to maintain and remove, but engineers still have to assess the impact of the new technology on wildlife and develop effective measures against corrosion, high winds, and waves so the installations can last for at least 25 years as other renewables (Daley 2019). Hydro and floating solar can be combined in areas with dams and other large water structures.

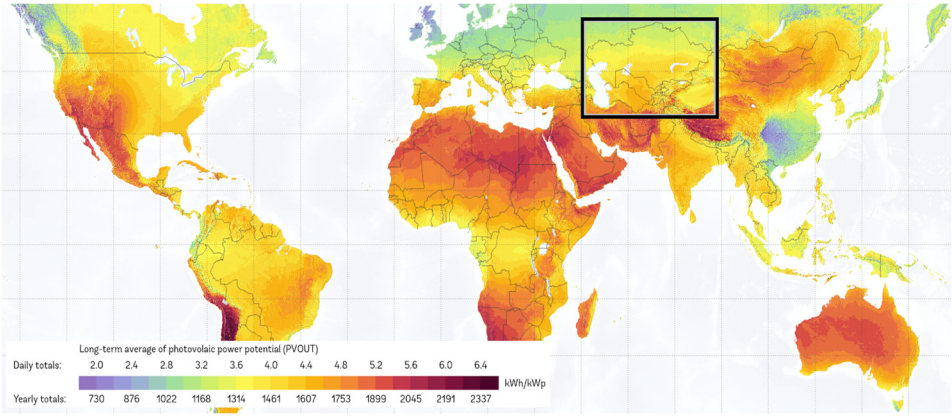


Figure 4.1 Map of long-term average for photovoltaic power potential PVOUT in kWh/kWp (Source: adapted from Solargis (2020)).

Since there are fewer technologies that can be readily adapted in any region of the world in bioenergy relative to wind and gas, this is another prospective area for local renewable R&D in Central Asia. Worldwide, a variety of technologies have been adapted for bioenergy prevalent in each region: rice husks in China, bagasse in India, and wood waste in Europe and America. Traditional forms of biofuel have long been used by the local population in Central Asia, including wood, dung, and other bioenergy in certain areas. Since traditional biofuel presents pollution, health, and

deforestation hazards, the focus should shift to new-perspective technologies (advanced biofuels). Landfill gas use is widespread in many regions of the world, but its potential is yet to be realized in Central Asia, with its waste growing fast proportional to population. Aside from municipal waste, agricultural waste in the region has potential as feedstock, which is limited but can nevertheless be exploited effectively. Since Central Asian countries do not have significant feedstock for biofuel from sources common in other regions, municipal and cotton waste present high interest for future development.

Finally, geothermal and wave energy does not seem viable in the near future due to its high costs and complexities, even though the region has areas with potential sources for this underutilized renewable.

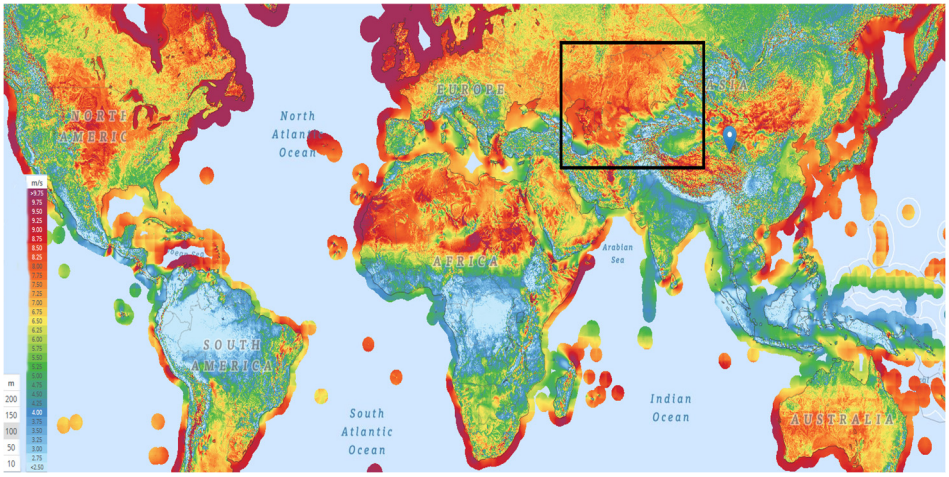


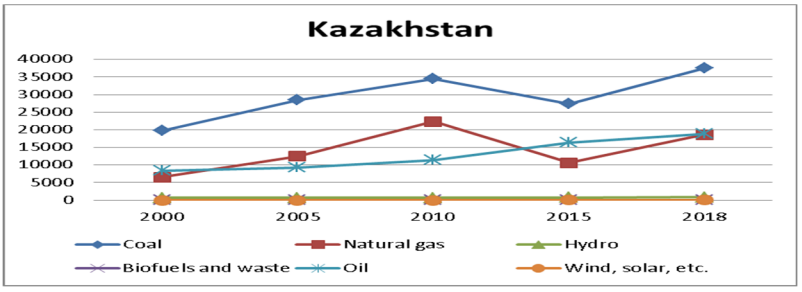
Figure 4.2 Global wind potential (Source: adapted from Energydata.info (2020)).

Possible reasons for underutilized potential of wind and solar power in Central Asia

Up until 2018, Central Asian countries mostly limited non-hydro renewable actions to participation in related conferences, exhibitions, declarations, and initial legislative steps (Marques 2018). They also showed limited participation in the activities of technical organizations and initiatives such as IRENA as corresponding reports indicate. This approach to renewables is changing but does not seem proactive enough. Figure 4.3 illustrates just how negligible the share of non-hydro renewables has been in the region, despite various supporting measures outlined in Table 4.1. Unfortunately, there were no specific targets and policies related to

renewables in the transport and heating and cooling sectors known as of 2019 (REN21 Secretariat 2020). Therefore, further discussion is limited to the main area of renewable energy – electricity power.

The energy ministries of the countries in Central Asia have been committed to the more active promotion of renewable energy since 2017 with IRENA support (Nabiyeva 2018). Still, Kazakhstan seems to lead the region in new wind and solar developments, as the country does in many other socio-economic indicators, including ease of doing business (Marques 2018, Cohen 2020). Increasing interest in the region toward renewables could also partially be motivated by the country's image and desire to follow fashionable global trends in national policies. Some observers even voiced concern that the interest could be driven by the state showcasing projects that have a weak relation to real market needs (Nabiyeva 2018). Meanwhile, neighboring Russia, Ukraine, and Azerbaijan had already implemented advanced forms of cooperation, assessments, and several large projects on a national scale. Post-Soviet Ukraine, traditionally reliant on hydrocarbon imports, increased the share of wind and solar in total energy supply almost 50-fold by adding renewable capacity notable even on a global scale in the period from 2010 to 2020 (IRENA 2020, IEA 2020). Ukraine was the largest post-Soviet country in 2019 in terms of renewables investment with $3.4 billion and 56% growth in 2018 (Ajadi et al 2020). The Russian Federation came second with $2.3 billion and 76%. As a relevant example of another post-Soviet country relying on hydrocarbon exports, neighboring Azerbaijan increased its solar and wind share ten-fold between 2010 and 2020, and already completed its formal Renewables Readiness Assessment (RRA) with the involvement of IRENA, an important step toward actual deployment of renewables capacity (IRENA 2020).



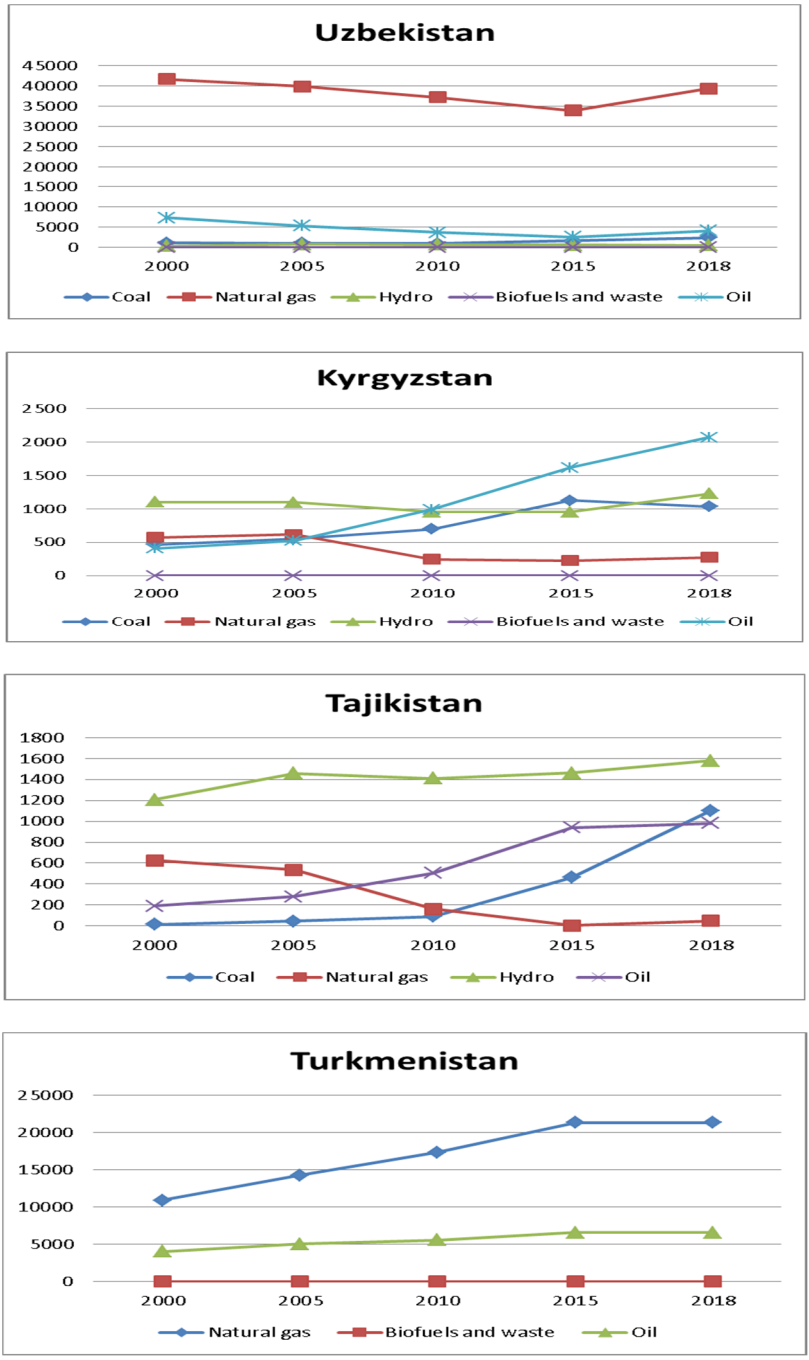


Figure 4.3 Total energy supply (TES, ktoe) by source in Central Asia, 2000-2018 (IEA 2020).

Data in Table 4.1 illustrates low to moderate levels of support for development in renewables in Central Asia, which does not seem impressive when considering the variety of measures the majority of developing countries have already taken (REN21 Secretariat 2020). Installed non-hydro capacity seems meager: even in Kazakhstan, the leader in non-hydro renewables in the region, wind and solar was below one percent in 2018 (Figure 4.3). No precise studies have been made on the reasons for such inadequate use of renewables, but the most obvious explanation could be the economic, technological, and political attractiveness of fossil fuel – its low cost, less variable output, and widespread subsidies in Central Asia (Nabiyeva 2020). Table 4.2 suggests consumers in Central Asia could have access to the cheapest electricity in the world, though the actual cost could be even lower depending on the season, industry, market exchange rates, and quotas of nearly free electricity in countries like Turkmenistan. Heavy government subsidies in the region undoubtedly distort market prices in the region (IEA 2020). Even without the effect of subsidies, actual electricity costs based on fossil and hydro are still probably among the lowest in the world. In fact, so cheap is the cost of electricity ($0.01 to $0.03 per kWh from private power plants in Kazakhstan for foreign businesses) that bitcoin miners abroad are considering moving to Central Asia (Redman 2020).

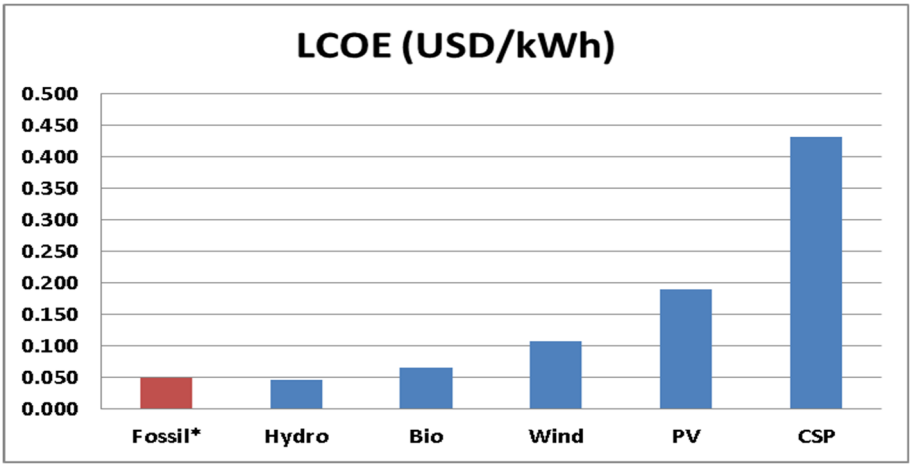
Table 4.2 Targets and policies in Central Asian renewables as of 2019 (REN21 Secretariat 2020).

	Kazakhstan	**Uzbekistan**	**Tajikistan**
Capacity targets	-Bio-power 15.05 MW at three stations by 2020 -Hydropower 539 MW at 41 stations by 2020 -Solar power 713.5 MW at 28 plants by 2020 -Wind power 1 787 MW at 34 stations by 2020	-Solar PV 157.7 MW by 2019; 382.5 by 2020; 601.9 by 2021; 1.24 GW by 2025 -Wind power 102 MW by 2021; 302 MW by 2025	Hydropower (small-scale) 100 MW by 2020
Feed-in Electricity Policies	In 2013		Date unknown
Tradable REC	Available		
Tendering	Available	Available	
Investment or production tax credits		Available	
Public investment, loans, grants, capital subsidies or rebates	Available		

The prices that consumers pay for electricity in Central Asia seem to be far below the objective measure of the cheapest LCOE when comparing Figure 4.4 and Table 4.2 using conservative estimates – a cost difference of up to five times. Figure 4.4

shows comparisons of renewable cost in Central Asia based on the assumption that fossil power is the cheapest and non-hydro renewables are the most expensive in the region, with approximate estimates based on data ranges of LCOE provided by IRENA in 2019. This rather restrictive assumption was made due to a shortage of specific project data on all Central Asian countries. However, it seems to be supported by the cost of existing projects in the region. For instance, the costs for PV (residential systems up to 10 kW) around 2018 were €1 600 to 1 800 in Kazakhstan – almost 50% more expensive than €1 200 to 1 300 in Germany due to higher customs, transport, and guarantee costs relative to Europe (Nabiyeva 2018). It seems Central Asia is among the few remaining regions of the world where traditional energy is roughly equal or slightly lower than that of modern renewables (IRENA 2020). As already mentioned, the cost of fossil energy globally exceeds renewables for over half of the recent projects (IRENA 2020). Furthermore, LCOE does not sufficiently take into account pollution, health, and other external costs of fossil. Given the relentless decline of wind and solar costs, Central Asia cannot afford to stay complacent with almost 100% reliance on fossil fuels and hydropower.

In addition to the low cost and heavy subsidies of fossil, logistical challenges, a lack of expertise, financing limitations, inadequate linkage to currency, and opposition from the fossil industry all could play a role (Nabiyeva 2018). Furthermore, conjecture can be made about other likely reasons for underdeveloped renewables such as a lack of knowledge about the true potential of renewables, the prevalence of old conservative methods of costing, and a lower priority of ecological problems for the regional governments that renewables could help solve.



Note: this assumes a low-cost range for fossil, the weighted average for mature renewables – hydro and bio, and 95th percentile for variable renewables – solar and wind.

Figure 4.4 Cost comparisons of the cheapest fossil, average hydro, average bio, and the most expensive non-hydro renewables in 2019 based on IRENA estimates (Source: IRENA 2020)

Table 4.2 Estimates of typical electricity prices in post-Soviet countries.

Country	Electricity prices for business in 2019 (kWh, $)	Electricity prices for households in 2019 (kWh, $)
Turkmenistan	0.010	0.007
Tajikistan	-	0.015
Kyrgyzstan	0.020	0.010
Uzbekistan	0.030	0.015
Kazakhstan	0.050	0.040
Azerbaijan	0.050	0.040
Georgia	0.050	0.060
Armenia	0.070	0.080
Ukraine	0.080	0.050
Russia	0.080	0.060
Moldova	0.090	0.110
Belarus	0.090	0.080
Estonia	0.110	0.190
Lithuania	0.130	0.180
Latvia	0.150	0.190

* Sources: GlobalPetrolPrices.com for most countries; some estimates were based on alternative sources that could be outdated: Enerdata (2020) for Uzbekistan, Gassner (2017) for Kyrgyzstan, Energypedia (2020) for Tajikistan, and local survey for Turkmenistan.

Logistical challenges remain in the transportation and transmission networks for flows of materials and energy related to renewables. Policymakers in Central Asia are well aware of the fact that fossil energy in the region is not only cheaper but is also a less variable technology that requires lower storage relative to bio and solar energy. Therefore, non-hydro renewables can effectively compete with fossil only in limited areas. Rural, desert, and mountainous areas have underserved populations and economies in terms of energy supply. Those locations have land available for renewable projects, but they often lack transmission and road infrastructure. Decentralized and autonomous PV systems that do not require transmission to remote areas seem suitable in many cases. CSP and wind turbine components appear challenging to deliver and install in landlocked countries of Central Asia with underdeveloped infrastructure to transport and mount the nonstandard general cargo.

A long-term solution to the issue of expertise and disadvantaged geographical location for equipment delivery and installation would be to set up local manufacturing of renewable components with direct foreign investments. Such local production would spur the development of renewables in the entire region and bring much-needed expertise. Kazakhstan and Uzbekistan, with their current investment climate, scale, and resources (importantly, including metals and machining), could be particularly attractive for manufacturing wind turbines, though all countries seem to have sufficient resources to supply energy and raw materials for manufacturing cheap PV **crystalline silicon modules.** The recent trend for manufacturers of renewable components is to move production to countries with lower costs (IRENA

2020). The Central Asian countries should consider providing the best conditions for investors in order to gain the competitive advantage of hosting such manufacturing capacities in the future. The importance of foreign partners and legal support is further discussed in the following section.

One of the issues that could hamper renewable development in Central Asia is insufficient human resources and lack of expertise. The region lagged behind most other areas of Eurasia in innovations and R&D output (UNESCO 2015). In accounting for renewable costs, state agencies should use modern methods of costing projects using LCOE and up-to-date parameters instead of obsolete calculation techniques that likely underestimate long-term values. Quantitative techniques in renewables such as SWITCH (a capacity expansion model for the electricity sector), widely used by planners and researchers in advanced countries, should aid comprehensive analysis for decision-making in the future energy mix of the region. The region has a history of renewable research, however. The reputed Sun Institute and Desert Institute within the Turkmen Socialistic Republic were established back in the Soviet era (the Sun Institute was closed temporarily after independence and then reopened in 2009). Experimental work on using solar and wind power for water purification in pastures within the desert has been conducted in the Central Karakum desert since the 1970s and continued until the mid-1990s (Kolodin and Chariev 1996). Such projects were limited in scale due to the high costs of renewables at that time, however. The priority of water (desalination) and energy supply for residents and organizations located in remote areas utilizing a decentralized network of combined solar-wind systems using the latest technology with lower costs could become a starting point for the revival of R&D in renewables in the region. Kazakh research and development could help take advantage of agricultural waste from vast fields in the country, provided the logistical issues – the big concern for biofuels – are solved cost-effectively. Using cotton biomass is another prospective area for suitable countries such as Uzbekistan and Turkmenistan. The technology for converting solid gin trash and on-farm cotton residues to energy is still in its infancy (Hamawand 2016). Uzbek and Turkmen researchers could study how using cotton stalks could generate extra revenue from the massive biomass of the plant in these countries. The share of biomass in the energy mix is still likely to remain low due to the inherent logistical challenges of the technology in collecting scarce feedstock from vast areas. In addition to R&D, the education systems of Central Asian countries would have to adapt, as they currently seem to offer little engineering and managerial training in all areas of non-hydro renewables. The International Solar Energy Institute in Tashkent was launched with the support of ADB in 2012 to address the growing need for solar energy training (Nabiyeva 2018).

Most countries of the world will undoubtedly continue their efforts to reduce dependence on imports of fossil fuel by expanding the share of wind and solar renewables. The commodity-exporting countries of Central Asia need to reassess

both the internal and external impacts of renewables. Coal, gas, and hydropower still remained the major sources of energy in Central Asia, and the volume of coal-generated energy continues to expand in capacity and output. The majority of power plants in the region are old and would need replacement in the near future. And here lies the right timing for tapping the renewable potential that was not realized previously due to economic reasons. Not only will the expansion of renewable instead of fossil capacity help reduce the cost of the energy mix; it will have multiple benefits for the ecology, emission targets, wider distribution, security, and resilience of electricity supply.

Foreign investment opportunities in renewables for Central Asian economies

In this section, the major players that could play a significant role in developing Central Asian renewables are discussed. All neighboring countries, other post-Soviet countries, and prominent global leaders present in the region such the U.S., Japan, South Korea, and India could undoubtedly play a role in future developments in the region. Nevertheless, China, Russia, the E.U. countries, and institutional investors are all considered especially relevant for Central Asia due to their relatively high influence in the region.

China played a very positive role in the development of renewables, driving down renewable costs and increasing expertise in related manufacturing (The Economist 2020). Chinese companies could seem to be natural partners in developing renewables with their expertise and manufacturing prowess. About half of the $575 billion promised under China's Belt and Road Initiative as of 2019 is planned in energy projects, where Chinese companies such as State Grid (the world's biggest utility) and Three Gorges can invest more in renewables abroad (The Economist 2020). Especially in solar power, Chinese businesses offer integrated manufacturing and sales capacities unmatched by other firms in the global market. The world's dependence on China is huge to the extent that it worries Western partners: the country produces over 70% of solar modules, hosts nearly half of the manufacturing capacity for wind turbines, and dominates the supply chain for batteries (The Economist 2020). State-backed Chinese investors could be considered first in large-scale projects by governments in Central Asia due to their expertise and market power in renewables despite concerns about low transparency and unfavorable financing terms. As an example, AIIB is building the largest wind power plant in Kazakhstan and the region (Xinhua 2019). To summarize, Chinese investments could potentially play a very important role in the development of renewables with their finance and expertise, but the governments should exercise particular caution

in negotiating the terms of any agreements, especially in large and long-term projects, in order to avoid excessive dependence on a single big partner, unsustainable debt, and other difficulties that some developing countries involved in the massive Belt and Road Initiative have already experienced.

Besides China, Russia could become an attractive partner in renewable investments. Historical, cultural, geographical, and language proximity could make Russian businesses suitable candidates for developing renewables and supporting infrastructure. The Russian-led Eurasian Economic Union (EEU) can greatly facilitate investments and customs between member states in the region. There is an issue, however: existing Russian companies lack experience and efficiency in the field of renewable technology compared to other major players. For instance, the cost of utility-scale PV renewables in Russia exceeded averages for other regions where major projects were implemented (IRENA 2020). Operations in distant areas with harsh climatic and other geographic conditions partially explain the high costs, but other factors such as low efficiency and low transparency could play a role.

Countries and organizations in the E.U. have considerable expertise and financial resources to play a more active role in developing Central Asian renewables. European companies are highly competitive in renewable (wind in particular) technology and sales on the global level. European support has provided a market for Siemens Gamesa (the world's top wind turbine manufacturers), Enel (the single largest investor in wind and solar in developing countries, based in Italy), Iberdrola (Spain), Orsted (the world's top developer of offshore wind, based in Denmark), Electricité de France and Engie (France), and other influential companies in renewables that are all operating on a global scale (The Economist 2020). E.U. funding within Horizon Europe and other frameworks could greatly facilitate renewable developments. Within the EU, the Baltic States have historically had closer economic and cultural ties with certain countries in Central Asia that could be relevant for partnership. For instance, Latvia with its Russian-speaking businessmen and expertise in biofuels could seem to be natural partners in developing this specific type of renewables in the region.

Finally, the potential role of reputable international organizations such as the Asian Development Bank (ADB), the World Bank, and the European Bank for Reconstruction and Development (EBRD) cannot be overestimated. Sustainability, the private sector, and vulnerable populations are high on the agenda of such influential institutional investors in Central Asian economies. Leveraging favorable financing terms together with rigorous requirements towards transparency and environmental friendliness, they could make a crucial contribution to the shift in the region to sustainable post-pandemic growth now that the governments of the Central Asian countries are facing socio-economic uncertainty. EBRD, the largest institutional investor in Central Asia, prioritizes the promotion of and transition to green energy in Kazakstan and Uzbekistan (EBRD 2018). The World Bank Group

Scaling Solar Program appears as an attractive source of funding for the region (The World Bank 2020). Funding and implementing renewables projects of various scales with the involvement of a broad range of stakeholders (including foreign companies from the E.U., China, and Russia) with high standards of social responsibility would reduce the risks of giving up the sector to less stringent practices that are damaging to the local population in the long run. In doing so, both the populations of the countries and the international partners could achieve a win-win situation of getting much-needed investments without compromising on sustainability goals. While the role of international institutions is crucial, over-reliance should be avoided in the long term as domestic financial markets should develop sufficiently for much-needed diversification (Cohen 2020).

The previous experience demonstrated that the implementation of complex projects in the participation of foreign partners could be challenging on the regional scale in energy sector in particular. The massive Central Asia South Asia Electricity Transmission and Trade Project (CASA-100), funded by the World Bank Group ($526.5m), Islamic Development Bank ($155m), EBRD ($110m), European Investment Bank (EIB, $180m), U.K. Department for International Development, Afghanistan Reconstruction Trust Fund ($40m), USAID ($11.5m), U.K. Department for International Development ($46m), and Pakistan ($101m), could benefit the entire region (NS Energy 2020). It was approved in 2014, but actual operations could start from 2022 with the active participation of only two Central Asian countries – Kyrgyzstan and Tajikistan (NS Energy 2020). The implementation of projects including the 100 MW Samarkand Solar, the first on-grid PV park in the country, was to be financed by a $110 million ADB loan, but it was postponed and then canceled after the government of Uzbekistan reconsidered in 2017 (Nabiyeva 2018). Additional examples of investment projects as well as corresponding challenges are considered further in the next section.

Legislation of Central Asian countries and renewable development

Historical developments have demonstrated how government regulations were critical for the establishment of sustainable energy. Feed-in tariffs (green tariffs) and later flexible pricing mechanisms such as Power Purchase Agreements (PPA) and auctions were instrumental in supporting renewable growth before it reached the current competitive state in major countries. The feed-in tariff is a favorable rate paid for electricity fed back into the electricity grid from the source of renewable electricity generation. The countries of Central Asia have only recently started taking steps in the field of legal regulation for renewable energy sources, improving energy

efficiency, and adopting programs and strategies to increase the share of renewable energy. The process of forming a legal basis for the implementation of the measures for energy conservation and the efficient operation of enterprises in the expansion of the share of renewable energy sources in the fuel and energy balance is underway in all five Central Asian countries. All countries in Central Asia are part of the EU4Energy Programme focused on evidence-based policymaking in the energy sector. They were advised by the International Energy Agency to improve energy efficiency and slowly remove widespread subsidies for further investment and expansion of domestic energy resources. Table 4.3 and the following text list some existing and previous legislation related to energy efficiency and renewables (IEA 2020). Since the number of renewable projects in the region is relatively small, the most significant facilities planned or implemented in each country are briefly discussed below together with information on relevant legislation.

Table 4.3 Examples of legislation related to renewables in Central Asian countries (IEA 2020).

Kazakhstan	Uzbekistan	Kyrgyzstan	Tajikistan	Turkmenistan
-Kazakhstan renewable energy auction, 2018 -Green Standard of Kazakhstan, 2017. -Energy Efficiency Classes for Buildings, Construction, and Structures, 2015. -On energy saving and energy efficiency increase, 2015. -Energy Management System – ISO 50001, 2014. -Fuel and Energy Development Concept 2030, 2014. -Green Energy Concept, 2013 -Kazakhstan Energy Conservation and Energy Efficiency Law, 2012. -The Law About Support the Use of Renewable Energy Sources (amended), 2009.	-Zero duty on import, 2019. -Resolution of the President of the Republic of Uzbekistan No. PP 3012, 2017. -Resolution of the President of the Republic of Uzbekistan No. PP-2912, 2017. -Resolution on Further Development of Renewable Energy and Energy Efficiency 2017-2025, 2016. -Heating, ventilation and air conditioning, 1997.	-On Energy Performance of Buildings, 2011. -Law on Energy Savings, 1998.	-Energy Efficiency Standards on Power Sector and Appliances, 2014. -Sustainable Energy Action Plan in Somoniyon City, 2014 -On Energy Saving and Energy Efficiency, 2013. -Tajikistan tax incentives for renewable energy, 2013 -Tajikistan Energy Saving and Energy Efficiency Law, 2013. -Sustainable Energy for All Tajikistan 2013-2030, 2013. -Programme for Efficient Use of Hydropower Resources and Energy 2012-2016, 2011. -Tajikistan Law on Use of Renewable Energy Sources (Law No 587) (Renewable Energy Law of Tajikistan). -Special Program for Renewable Energy Sources Use in Tajikistan (2007-2015).	-Renewable Energy Law, 2021. -National Strategy of Turkmenistan on Climate Change, 2019. -Energy Saving Program for 2018-2024. -Law on protection of the atmospheric air, 2016. -The Law of Turkmenistan on Electricity, 2014. -Law on Environmental Information. -Law on hydrocarbon resources, 2008.

Kazakhstan is leading Central Asia in non-hydro renewables with legislative support and the share of alternative energy in the energy mix almost reaching one percent by 2020. This figure is planned to increase to 30% by 2030, and to 50% by 2050 – an ambitious target for the region (Chachine 2019). Kazakhstan was the only Central Asian country featuring in the list of the top 30 investors in renewables in the world as of 2019 with $800 million and 58% growth in 2018 (Ajadi et al 2020). Since 2009, favorable conditions have been created at the legislative level, including the introduction of fixed tariffs, guaranteed purchase of energy generated from renewable energy sources, and elimination of the tax burden. The country is still heavily reliant on coal in the energy mix, and expansion of the gas pipeline network remains a priority in order to expand access (IEA 2020). Kazakhstan appears to be actively adapting to national energy and foreign investment strategies already. The Electric Power Sector Law and the Law on Supporting Renewable Energy Sources (RES Law) provides for buying all generated renewable power at feed-in tariffs by the Center of Financial Settlement (Chachine 2019). The country is implementing various new renewable projects with the participation of EBRD, ENI, GE, and Chinese JinkoSolar Holding (Marques 2018). The 100-megawatt wind power plant (the largest of its kind in Central Asia) in Zhambyl with 319 GWh annually is operated within the Zhanatas Wind-Power Station Limited Liability Partnership by China Power International Holding Limited, a subsidiary of State Power Investment Corporation; this is also the first project funded by the Asian Infrastructure Investment Bank (AIIB) in the country with $46.7 million loans and a $136 million total estimated cost (Xinhua 2019). The EBRD made the largest investments in Kazakhstan's green economy – over $8.85 billion across 254 projects, including the largest solar (Burnoye Solar Plant), wind (Yereymentau Wind Farm), transportation, and switch from coal to renewables (Cohen 2020).

A number of renewable initiatives including decentralized PV (private rooftop) have been approved in Uzbekistan recently (Bellini 2020). In addition, a law on public-private partnerships has been adopted, and a draft law on the use of renewable energy sources was under consideration. Renewables could play an increasing role in the diversification of the energy sector of Uzbekistan while modernizing the aging infrastructure. Losses, overuse, and financing remain problematic to meet the domestic demand of Uzbekistan's growing economy and population with energy that currently relies heavily on gas (IEA 2020). The State Action Plan on Renewable Energy includes 810 projects with a total value of $5.3 billion for the period from 2017 to 2025; however, investors could become cautious after the experience of PV projects that were planned by ADB since 2013 but canceled at the government's request in 2017 (Nabiyeva 2018). Nevertheless, more cooperation with international companies and feasibility studies are currently being developed. The World Bank and International Finance Corporation Boards of Executive Directors approved the Navoi Scaling Solar Independent Power Producer (IPP) Project in 2020 under the World Bank Group Scaling Solar Program. The project, which relies upon

competitively selected private investment to connect the first solar plant of 100-megawatt capacity to the national electricity network, is the first World Bank guaranteed operation in Uzbekistan (The World Bank 2020). Canadian developer SkyPower Global signed an agreement with state-owned JSC Uzbekenergo power utility in 2018 to invest a staggering $1.3 billion to construct and operate several large-scale PV plants with a combined capacity of 1 GW (Nabiyeva 2018).

Development of the electric power industry, with the exploration of the potential use of alternative sources of energy such as sun, wind, geothermal, and biogas, has been considered a priority area for national R&D in Turkmenistan since 2010 (UNESCO 2015). More recently, smaller water supply and purification systems driven by PV power were installed in the villages of Karakum under UNDP cooperation with the Sun Institute (UNDP 2020). Turkmenistan has yet to develop a much-needed capacity for renewables in remote desert areas. The country adopted the Energy Saving Program for 2018-24, which considers an increase in the share of renewable and non-traditional energy sources, alternative fuels, and secondary energy resources in Turkmenistan's balance of, as well as the development and implementation of innovative technologies in the field of renewable energy and the creation of new generating capacities based on the use of renewable energy sources. The implementation of the Program involves strengthening government regulations in the field of energy saving. This would require the adoption of a large number of regulatory legal acts, including the preparation of the Law on Alternative Energy Sources, as well as the necessary standards, regulations, and rules for their use. The Interdepartmental Working Group was established to develop a National Strategy for the Development of Renewable Energy. The joint project of the UNDP and the Ministry of Agriculture and Environmental Protection of Turkmenistan, "Sustainable Cities in Turkmenistan: Integrated Green Urban Development in Ashgabat and Awaza Project", took an active part in the development of drafts of two new Laws in Turkmenistan – "On Renewable Energy Sources" and "On Energy Efficiency and Energy Saving" – as part of the National Strategy for the Development of Renewable Energy (United Nations in Turkmenistan 2020). The National Strategy of Turkmenistan on Climate Change (2019) provides for a set of measures for the implementation of renewable energy sources, including support for R&D and testing of technologies for renewable and alternative energy, introducing small and medium-sized installations of renewable in remote and sparsely populated areas, introducing production facilities and increasing the share of renewable energy in the country's energy mix, creating economic incentives for the use of alternative energy sources; disseminating knowledge about renewables, and so forth. The Law of Turkmenistan on Electricity (2014) and the Renewable Energy Law (2021) provide for the development and implementation of measures for the use of renewables. In 2018, Turkmenistan became a member of IRENA, which involves creating a plan for bilateral and multilateral events for 2019-2023 to develop further cooperation with the agency. The support of potential private investors is covered

under the Law on State Support of Small and Medium Business, the Law on Innovation Activities, and the planned law on joint state and private partnerships. The country would have to improve transparency in statistics and information sharing among government and international organizations in order to further streamline energy sector governance (IEA 2020).

In Kyrgyzstan, a legal framework for renewable energy was being developed to adopt a national energy program, which includes a provision on the development of renewable energy sources, their wider use in the power supply of the rural population, and autonomous facilities located in mountainous regions of the republic. Still, not many pieces of legislation on renewables were adopted in the past, and interest in non-hydro renewables seems to be low, with the absence of significant projects in the field. There was little information known on specific targets or policies related to wind or solar as of 2019 (REN21 Secretariat 2020). Kyrgyzstan continues to rely on abundant and cheap hydro energy, but the sector is based on an aging infrastructure that has had significant losses (IEA 2020). Developing new cheaper capacity in non-hydro renewables could help address energy security concerns.

In Tajikistan, most of the electricity is still generated by hydroelectric power plants. The country is the renewables leader of the region with almost half of the energy generated by hydropower, and the share could increase further (REN 21 Secretariat 2020). Meanwhile, non-hydro renewables are insignificant. Tajikistan was the world's fifth-largest investor in hydropower additions below 50MW in 2019 (REN21 Secretariat). Tajikistan's energy sector experienced seasonal shortages in the past (IEA 2020). Despite several laws and programs on renewables adopted over the past decade, any significant wind and solar capacity is yet to be built. The country has great potential for the development of solar and wind that could contribute to uninterrupted energy access – an important goal to benefit the population.

That the development of the energy sector of Central Asian countries requires the attraction of resources, as a capital-intensive industry, is a notable fact. Central Asia had great potential to become an electricity generation hub, which remained largely unrealized due to the inability of independent governments to replicate the scale of legacy Soviet investments in thermal and hydropower power – systems that currently suffer from seasonal shortages, poor integration of power grids, energy losses, and inadequate upgrade of transmission lines (EIU 2020). Unlike in Central Asia, investments via corporate R&D, public markets, venture capital, private equity, and asset financing have long been dominant in new renewable projects (Ajadi et al 2020). Governments in the region recognize the importance and necessity of attracting private-sector capital to drive large-scale changes in the energy sector. This should be facilitated by the legislation on foreign investment and public-private partnerships, which has already been adopted in the majority of the countries of the region. Private investment will reduce government spending, and the transfer of some functions to a private investor can improve the efficiency and quality of service,

control costs, and increase the availability of new technologies and innovative management methods. At the same time, the governments will likely keep the greatest power to exercise control and regulate the sector in the public interest, while supporting the business through favorable taxation and other benefits and guarantees. More support is needed for renewables in distributed systems, transport, and heating and cooling, since Central Asia lags behind other regions in respective legislation (REN21 Secretariat 2020). However, attracting private investors could prove to be difficult since the energy sector is heavily monopolized by the state in most Central Asian countries. Therefore, one of the necessary conditions for renewables development is a gradual and adequate de-monopolization of the sector and the adoption of legislation to create the conditions necessary for commercial organizations to generate, transmit, and distribute electricity. Furthermore, it is important to provide an effective mechanism for the implementation of laws on renewables. This should also support joining consortiums under funding from major institutional investors as a multilateral alternative beneficial for stakeholders. Meanwhile, the state could preserve its role in general regulation to ease the concern of losing tight control over key sectors common for governments in the region. The countries in the region could start from state-backed pilot projects to gather experience and gradually shift to wider implementation in a wider area with various forms of ownership.

In all the countries of the region, a number of other factors that hinder the implementation of efficient energy measures remain, such as geopolitical considerations, inadequate integration, tariff policies, high investment risks, and capital requirements. Harmonization of electricity transmission systems among the Central Asian countries alone could save up to $5.2 billion over a five-year period, which is the target of the ADB's Central Asia Regional Co-operation (CAREC) program (EIU 2020). Such important initiatives as the planned CASA-1000 were hindered in the past by the lack of trade pricing mechanisms, low transparency, the absence of harmonized regulatory and technical frameworks governing trade, institutional weaknesses in regional governance institutions, the absence of a regional transmission system regulator with authority over regional market, difficulty in aligning national and regional investments, differences in regulatory environments between countries, changes in political framework, and concerns about national sovereignty and energy independence (Vallely 2017). Legal instruments coupled with non-hydro renewables should play a more important role in solving all these issues pertaining to inadequate legislative and political support.

Threats presented by renewable energy to Central Asian economies dependent on fossil and hydropower

Only a decade ago, in 2010, the price of oil and gas seemed to remain high and promised to even increase in the foreseeable future. This all changed in a span of several years. First, fracking technology developed by American producers has disrupted the pricing in global markets since 2012 with an extra supply of shale gas (BP 2013). Then, several countries increased oil and liquefied natural gas (LNG) output, while Iran returned to the market as a major exporter. Outside of changes in global supply and demand, the American shale revolution is not the only technological development disrupting the energy markets. The biggest disruptor coming yet for hydrocarbon consumption is renewable technology rapidly replacing fossils, with unprecedented declines in the competitiveness of traditional energy sources (IRENA 2020). As a result, tumbling hydrocarbon revenues threaten the very economic models of development of the countries that appeared sound only a few years ago (Cohen 2020). Hydrocarbon exporters in Central Asia should take steps for adapting their national economies to the global changes happening in the energy sectors of the major importing countries. Exports of coal and oil are likely to drop worldwide in the coming decades. Though consumption of Central Asian gas is not likely to decrease in main import markets, its price would probably never get back to the high levels that were the norm in the recent past.

Policymakers in Central Asia cannot be complacent with abundant hydrocarbon and hydropower resources providing cheap energy at the current levels. First, fossil fuel will be depleted sooner or later, so the expensive long-term infrastructure for renewable energy should be developed in advance. Second, with the current pace of development, wind and solar power could well become cheaper than the lowest-cost fossil or hydropower. The dependency of Kazakhstan, Uzbekistan, and Turkmenistan on hydrocarbon exports for state revenues and fossil fuel for electricity will become increasingly problematic. Warnings to countries excessively relying on exports of hydrocarbon resources have long been made, but it is an enormous challenge to wean off of oil and gas in the growth of the economies (Cohen 2020). Many import markets would still need coal, oil, and gas in their energy mix in any scenario as the transition to 100% renewables is hardly attainable in liberalized markets – a consequence of the so-called "energy paradox" when increasing the share of renewables requires co-existence with fossil (Blazquez et al 2018). Moreover, the share of gas in energy consumption in the key Chinese market is non-decreasing under realistic scenarios. The share of oil and coal as particularly heavy polluting fossils in the global energy mix will continue to decline. The main issue for fossil fuel exporters is not volume but value: state budgets of commodity exporters will suffer from prices expected to be lower than planned after post-pandemic shocks, increasing efficiency, greater supply, and of course disrupting technology such as

non-hydro renewables. Furthermore, the decline in fossil fuel prices can have negative effects on the sociopolitical stability of countries that rely excessively on hydrocarbon resources (de Jong 2017).

State planners in Uzbekistan, Kazakhstan, and Turkmenistan should thoroughly review the structure of their economies and export strategies as renewables increase their global share. This must include a continuous review of the costs and risks of planned pipeline projects for delivering hydrocarbon to countries that already managed to reach the most competitive renewable generation such as India, China, and an increasing number of European countries. Countries that previously declared a willingness to import more fossil fuel could soon revise their plans as cheap renewables become abundant internally and more suppliers become available externally. Measures that were taken to diversify exports in all the mentioned Central Asian countries so far appear to demonstrate limited or moderate performance or their impact is yet to be seen in the future. Renewables thus should become part of the solution in efforts for diversification and the shift to a knowledge economy. Massive costs directed towards fossil subsidies and investments should be reconsidered in favor of renewables.

The impact of renewables is not limited to the aforementioned three countries in the region that depend on hydrocarbon resources. Tajikistan and Kyrgyzstan should rethink the role of hydropower in electricity exports and supply for national economies. The perspective for the expansion of environmentally friendly hydro energy is vast in both countries. While the generation of cheap electricity using current hydropower plants would remain economically effective, governments of the two Central Asian countries rich in hydro resources should exercise caution about future expansion and modernization plans. With the current pace, a wider introduction of cheap wind and solar energy is expected to become a viable alternative to additions to the existing hydropower facilities in the energy mix. If policymakers in those countries also consider geopolitical and environmental factors, the expediency of choosing wind or sun instead of excessive hydro capacity becomes all the more evident. Planning and building massive hydropower plants requires a great amount of time and resources that even larger countries find difficult to afford. This means inherently higher risks for investments in hydro energy. For instance, the construction of the Rogun Dam in Tajikistan was planned already in the Soviet era. This project involved controversy and transboundary tensions, leading to a lack of funding from major institutional investors, which in turn increased the already high dependency of the country on Chinese investments. The Naryn cascade project in Kyrgyzstan involving small hydropower plants had a similar history of controversy involving Russian and Czech investors and tensions with neighbors. Though irrigational benefits and other factors not considered in this report always play role in corresponding decision-making, energy supply and exports in any planned expansion of related hydropower capacity looks increasingly questionable.

Governments in Central Asia have to various extents favored grand projects with heavy public spending in major sectors of their national economies that showcase development to a local and international audience. This could apply to investments in renewables, too (Nabiyeva 2018). Meanwhile, the creation of a modern competitive economy requires a shift from the elements of centralized government planning to a decentralized structure that favors the private sector with strong small to medium enterprises. The development of distributed PV and small-scale onshore wind should be mentioned separately here. Until recently, most power plants all around the world required investments in projects of medium to large scale with the unavoidable involvement of the public sector. Rooftop and other PV together with onshore wind allows smaller businesses and even households to benefit from their relatively cheap costs and contribute to the national energy mix. With enough beneficiaries and support, an advanced level of virtual power plants using digital technologies to control energy demand, storage and distributed generation can be achieved. Advanced transport, heating, and cooling systems should not be neglected as a growing area of renewables.

The example of the E.U. response to the coronavirus pandemic appears highly relevant for Central Asia. European funding will increasingly support sustainable development where renewables play a major role. The timing seems right in this respect for Central Asia, too, now that the power infrastructure in the region needs modernization. Instead of grand government projects with risky financing terms that favor plants based on fossil fuels or hydropower, the focus should shift to smaller wind and solar plants based on private or mixed ownership that are located in underdeveloped areas. As much as possible, such projects should involve global institutional investors that are reputable for applying rigorous practices and consider the socioeconomic and sustainability interests of the local and neighboring populations. The EBRD, ADB, UNDP, USAID, GIZ, JAICA, World Bank, and similar organizations and institutions already present in the region could all play an active role. In addition, Central Asia should more actively involve technical assistance and conduct evaluation from international organizations specializing in renewables such as IRENA and REN21. This strategy would make the respective economies less exposed to volatile exports of commodities after the pandemic outbreak while simultaneously helping to solve the economic and environmental problems associated with fossil and hydropower in the long term.

Conclusions

The long-term development plans of Central Asian countries did not and, in fact, could not sufficiently take into account the impact of wind and solar renewables that few policymakers could envision several years ago. Countries of the region already

seem to be late in adapting to the ongoing green energy revolution. Given the decreasing cost trend of renewables and the long-term nature of investments in power plants, governments of the region might miss the opportunity for the creation of a more sustainable energy mix because the current plans to expand fossil power and hydropower likely underestimate the region's vast potential for renewable energy. Policymakers are increasingly incorporating renewables into strategies for further national development. The role of foreign partners could be crucial for the development of renewables in Central Asia after the pandemic outbreak and the slump in commodity markets. Global institutional investors could work closely with private and public sectors in the region to ensure high standards of transparency and sustainability for stakeholders. In particular, governments and international organizations could be highly selective when approving the form of renewables in which to invest. Taken as a region, Central Asia has a higher potential for onshore wind and sun compared to other parts of Eurasia. Distributed low-cost PV that benefits individual consumers and small businesses in rural and other underprivileged areas with poor infrastructure seems to be a suitable case. At the same time, legal and other supporting reforms should be encouraged and considered in international agreements to support vulnerable populations and other target beneficiaries with policies such as feed-in tariffs.

In view of the low availability of country-specific data on renewables in Central Asia, more research would be needed to gain deeper insight into the subject. Statistical and other agencies in the region should work on gathering and disclosing more information on renewables so the policymakers and investors could make more informed decisions on how best to contribute to development in this sector. Future work should also involve precise research on actual costs and the reasons for low development levels of non-hydro renewable energy in the region.

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5 Comparisons between Central Asian Countries in Online Presence on Wikimedia and Google

Introduction

As lesser-known areas of the former Soviet Union, the Central Asian countries each have a national culture, language, and related information that seems to be relatively less available and recognized globally even after almost three decades of independence (Rossabi 2021). Governments in Central Asia recently showed increased attention and made efforts to promote digital transformation, recognizing that they are still far behind developed countries in this respect, though the related national policies seem to focus on the public sector, government infrastructure, economy, and business (Chikoniya 2019). The facilitation of content creation and promotion has received less attention. At the time when users worldwide primarily search and utilize information from online resources, the issue of insufficient online presence has to be addressed as a matter of digitalization and nation branding.

This study is among the few attempts made in the academic literature to compare Central Asian countries in terms of global interest and content creation towards online information on the national level. This study topic is relevant because of the growing importance of the digital economy and nation branding for newly independent states. To the best of the authors' knowledge, no academic publication has been entirely dedicated to discussing online presence and its corresponding implications in Central Asia.

The main questions asked about online presence in this study are as follows: (i) What is the level of interest in Central Asian countries according to the most popular search engine online? (ii) How well are Central Asian countries presented within the most popular sources of reference materials online? Free tools provided by Google and the Wikimedia Foundation provided data for analysis. In the absence of accurate information on soft power in the region, the online presence in the aforementioned sources of information worldwide can serve as an imperfect but nonetheless useful indicator of a country's image and interest in its culture in Central Asia. In addition, the creation and popularity of online resources can approximately indicate the level of digitalization in each Central Asian country.

In the following sections, the Central Asian online presence for all countries and their main languages are presented separately on the Wikipedia language level, the country level, and the ethnic level. The report ends with a discussion of alternative names, implications, and conclusions for digitalization and country branding in Central Asia.

Methods of measuring online presence

Trending topics on the web are increasingly used to measure the popularity of a topic and the effectiveness of creating new content (Althoff 2013). This can concern entire countries and regions. Comparisons between Central Asian countries in terms of their online presence are based on the following tools made available by Google and Wikipedia: Google Trends, Google Books Ngram Viewer, and Wikimedia Foundation Statistics in the main languages of Central Asia. Google is the leading search engine in the world, while Wikipedia is the top website in the category of reference materials (Similarweb 2021). Google Books aims to be the repository for the whole of human knowledge (Bergquist 2006). Technology access (internet use) combined with creative capacity (education, science, talent, and other components of human capital) are among the key prerequisites for the knowledge economy (Veugelers 2011). The search, access, creation, and dissemination of knowledge online thus can be considered indicators of digital literacy and recognition with regard to nations where such processes occur.

Analysis of Google search engine data has been used successfully in the past to forecast near-term economic indicators such as automobile sales, travel destinations, and consumer confidence (Choi and Varian 2012). Analogously, there is no reason to exclude the possibility of Google search data predicting interest in the national products and services offered by a country. Meanwhile, the promotion of exports and tourism are among the main objectives of nation branding (Fan 2010). The geolocated Wikipedia articles can be useful for the prediction of a country's socio-

economic development, which includes health and education – highly relevant outcomes for human capital (Sheehan et al 2019). The number of Wikipedia edits is a globally recognized innovation indicator (GII) of online creativity in ranking countries (Dutta and Lanvin 2013).

The central assumption of this study is that online presence in terms of created resources, mentions, and trending search terms can be valid measures of interest in Central Asian countries and their progress in digitalization and nation branding. This assumption could indeed be deemed strong given the limited size of the empirical and theoretical evidence on the links between the studied phenomena. Admittedly, the analysis has other limitations in representativeness since it excludes alternative search engines that are less popular than Google globally but could be the top platforms in certain regions, including Yandex (a particularly popular search engine in the post-Soviet area), Yahoo, and Baidu. Moreover, the study does not consider social networks (i.e. Twitter and Facebook), video hosting sites (i.e. YouTube), shopping sites (i.e. Amazon and AliExpress), and other categories of online resources that could reflect progress in digitalization and interest in the country and the national culture. Finally, the descriptive study of selected indicators cannot fully reveal the underlying causes of the observed changes. Possible causes are only briefly discussed in the section on implications. The chosen method and scope of the analysis is still justified as suitable for the exploration of the study topic in view of the limited availability of data, its relevance, and the accuracy offered by alternative approaches.

Language presence in Wikipedia articles and Google search results

Though its credibility is often questioned, Wikipedia is popular as a source of information on serious topics, including healthcare and legislation; many users even prefer it to the descriptive information provided by the organizations themselves (Okoli et al 2014). The number of Wikipedia pages in the main languages of Central Asian countries has steadily increased since its launch, and, as Figure 5.1 shows, contributions in the Kazakh and Uzbek languages sharply increased in 2012. Pages in the Tajik and Kyrgyz languages have also increased since 2012, though slower relative to Kazakh and Uzbek ones. The number of pages in the Turkmen language remained lowest in the region and grew at a much slower pace.

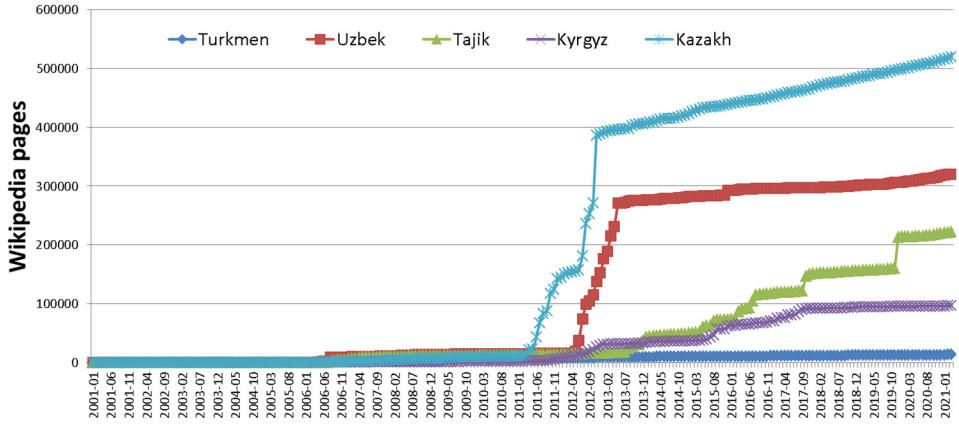


Fig. 5.1 The change in the total number of Wikipedia pages in five Central Asian languages (Wikimedia Commons 2021).

Table 5.1 illustrates that the total number of active users, pages, and media in the national languages of post-Soviet countries, where many countries with smaller populations mostly outperform their larger Central Asian counterparts. This relative productivity does seem to depend on the achieved level of liberalization and economic development, and this dependence is likely stronger than with population size. Articles in Kazakhstan's national language showed the highest Wikipedia presence among Central Asian countries and a decent ranking within the entire post-Soviet area.

Table 5.1 Productivity of Wikipedia contributors in the main languages of post-Soviet countries (Source: Wikimedia Commons 2021).

Language	Articles	Admins	Active users	Images
Russian	1 723 439	79	11 681	230 863
Ukrainian	1 091 925	45	3 460	111 098
Armenian	284 302	11	581	10 642
Kazakh	228 213	18	371	10 067
Estonian	219 204	33	737	726
Belarusian	204 599	10	284	3 340
Lithuanian	199 231	10	400	23 134
Azerbaijani	180 766	16	977	23 895
Georgian	152 727	4	301	14 760
Uzbek	140 329	11	239	1 670
Latvian	107 527	13	315	24 874
Tajik	103 193	6	79	463
Kyrgyz	80 763	2	72	2 688
Turkmen	5 916	1	45	319

Note: Language spoken in Moldova excluded due to significant overlap with Romanian.

This section ends with an estimate of the volume of online resources available within all post-Soviet countries. Table 5.2 presents Google search results using the *site:* term followed by the top-level domains of the countries. Kazakhstan was far ahead of other Central Asian countries in creating online resources. Kyrgyzstan offered a decent volume of content for country of its population size in the region. The comparison suggests a low online presence of Central Asian countries compared to countries of similar or even lower population size. Again, liberal democracies achieved impressive performance here relative to the size of their population and economy.

Table 5.2 Google search results for the domains of post-Soviet countries.

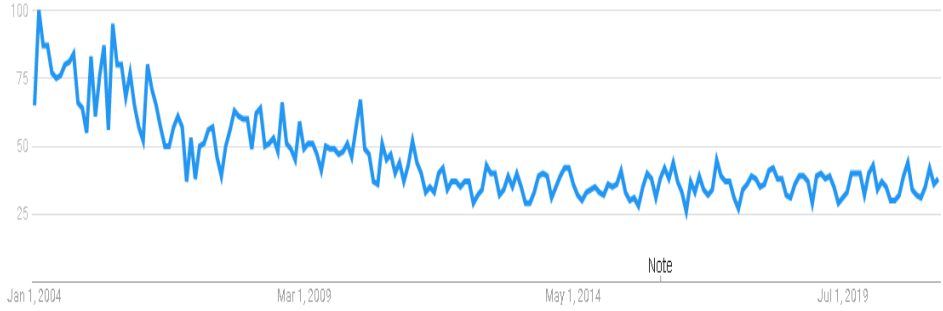
Country	Domain	Google search results
Russian Federation	.ru	2 200 000 000
Ukraine	.ua	395 000 000
Estonia	.ee	256 000 000
Lithuania	.lt	157 000 000
Belarus	.by	103 000 000
Kazakhstan	.kz	88 700 000
Latvia	.lv	80 300 000
Azerbaijan	.az	37 900 000
Uzbekistan	.uz	31 300 000
Armenia	.am	28 600 000
Georgia	.ge	28 400 000
Moldova	.md	19 300 000
Kyrgyzstan	.kg	14 500 000
Tajikistan	.tj	6 220 000
Turkmenistan	.tm	3 530 000

Note: values of search results are approximate and given as of May 22, 2020.

Country names

Google Trends represents search interest relative to the highest 100 points (the peak popularity) on the chart for the given region and time, so a value of 50 means that the term is half as popular, and 0 means there was not enough data. It should be emphasized that the search interest in the subsequent figures is relative, not absolute. While Google search represents interest in a certain topic, Google Books reflects the coverage given to a theme in published literature available online. Specifically, the Ngram Viewer displays percentages showing how phrases have occurred in a corpus (large and structured set of texts) available on Google Books over the selected years. In the Ngram Viewer parameters, the terms included minimum smoothing and all cases (reflected by the word "all" in parentheses).

Interest in Central Asia as a whole declined in the 2010s compared to the preceding decade, according to online search data in Figure 5.2. Figure 5.3 shows how Kazakhstan dominated other Central Asian countries in most periods, though Uzbekistan seems to be closing the gap since the new government undertook liberalization reforms after 2016. Search interest in Turkmenistan was higher overall relative to Tajikistan and Kyrgyzstan, which showed comparable levels. Interest in the region and in each country has been cyclical. Spikes in interest, as illustrated by Figure 5.3, often happened in the years of major changes in governments or the periods immediately following them (such connections were particularly strong for Kyrgyzstan and less visible for Tajikistan).



Note: In 2017, a change in the data collection system was applied by Google.

Fig. 5.2 Interest in Central Asia over time, according to Google Trends (2021).

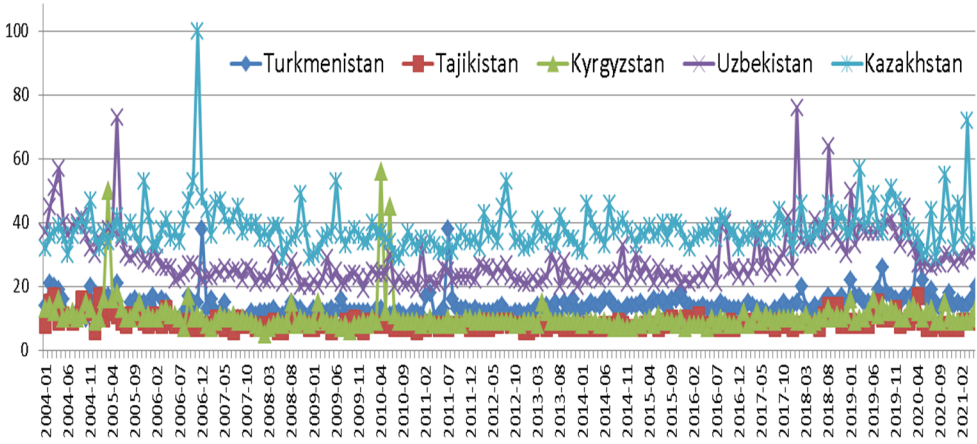


Fig. 5.3 Interest in Central Asian countries over time, according to Google Trends (2021).

Figure 5.4 shows that the highest interest in Central Asia came from within the region itself, the neighboring areas, and the countries where migration from the region occurs. The same pattern can be observed with individual countries in the region. Google Trends data thus suggest that the global interest in Central Asian countries largely reflects the interest of the local or neighboring population.

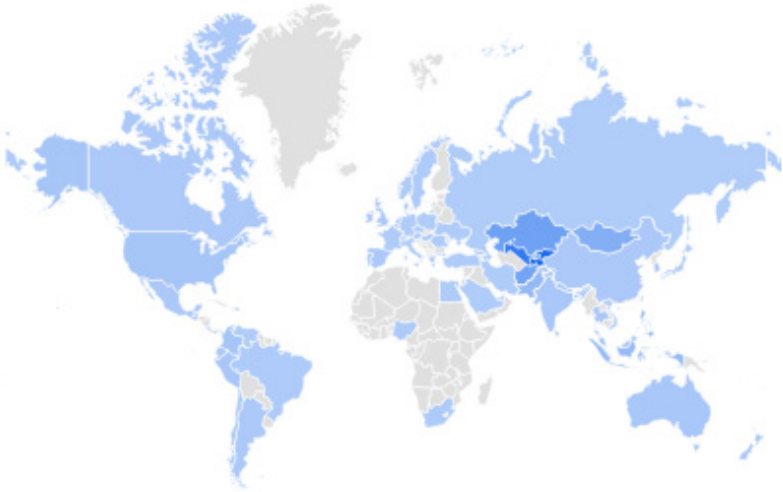


Fig. 5.4 Interest in Central Asia by region according to Google Trends (2021).

Figure 5.5 shows interesting patterns in the mentions of Central Asian countries by books in foreign languages over the past hundred years. The patterns could also reflect the increasing share of publications by local authors in the English language written or translated within Central Asia, though the exact proportions cannot be determined. First, an increase happened for a brief period of limited liberalization during the 1950s and 1960s (the so-called "Khrushchev Thaw") after the end of the Stalin era. Second, the highest presence was observed in the early 1990s immediately after the collapse of the Soviet Union. Finally, the decline happened after 2008, the year of the global financial crisis, which had a severe impact on Central Asian economies. Kazakhstan was mentioned most frequently in all periods, followed by Uzbekistan. The overall trend does not appear favorable, with Central Asian countries mentioned significantly less by foreign books in the recent decade.

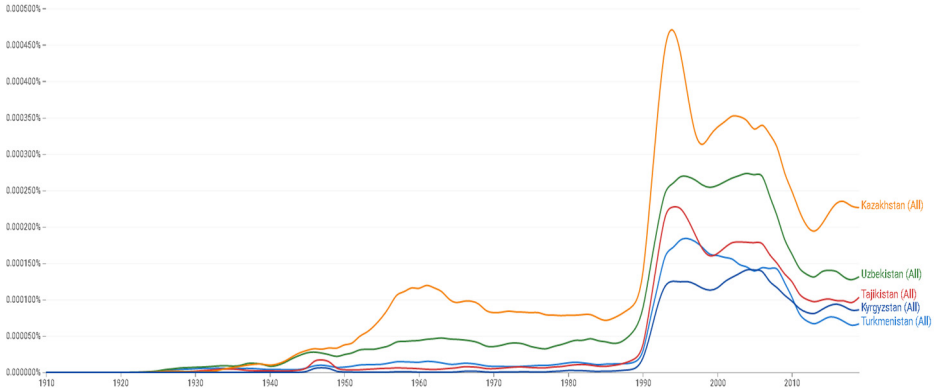


Fig. 5.5 The presence of the names of Central Asian countries in the English-language literature according to the Google Ngram Viewer (2021).

Ethnic and cultural presence

The ethnic groups of Central Asia are present all around the world. Furthermore, elements of national culture could be better represented by adjectives rather than country names. Therefore, Figure 5.6 could illustrate national online presence worldwide more accurately compared to the previous figures. The terms here could reflect both people and adjectives. A significant diaspora of various ethnic groups is present in Central Asian and other post-Soviet countries. Uzbek presence here seems substantially stronger compared to the corresponding country, and its growth in search interest is more stable. Interest in Turkmen came as surprising second in online search since 2010, exceeding even Kazakh, which was at the lower levels, close to Tajik and Kyrgyz.

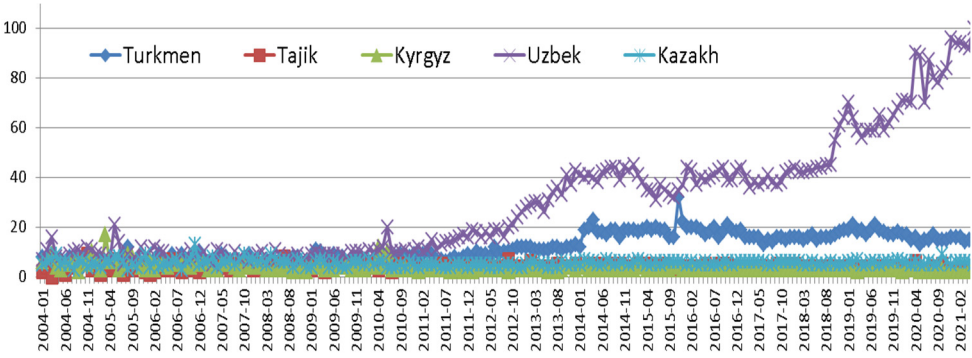


Fig. 5.6 Interest in the five ethnic groups of Central Asia and related terms over time according to Google Trends (2021).

Figure 5.7 reveals the earliest mentions of the five ethnic groups and related terms in English documents dating back to the 1700s. The presence of those Central Asian terms remained at lower levels until 1920, during the periods of expansion of the Russian Empire and before the establishment of the Soviet Union. The presence generally increased during Soviet rule, peaking during the 1960s around the brief period of liberalization, then plateauing or declining during the 1970s and 1980s (the lowest mention of Kyrgyz in earlier periods is a notable exception to the pattern, probably due to the higher use of the alternative name, Kirghiz). The post-Soviet pattern is similar to results for country names, with mentions increasing during the 1990s and declining during the 2010s. Kyrgyz was the highest overall in the recent decade, closely followed by Uzbek and Kazakh. Turkmen was mentioned more often than Tajik or Kyrgyz during the Soviet period but declined to lower percentages during the 2010s. Analyzing the entire period of publications shows the uneven presence of Central Asian countries with relatively higher mentions of Uzbek (during the earlier periods in particular). The dominance of Uzbek in books, however, is not as obvious as in Google Trends.

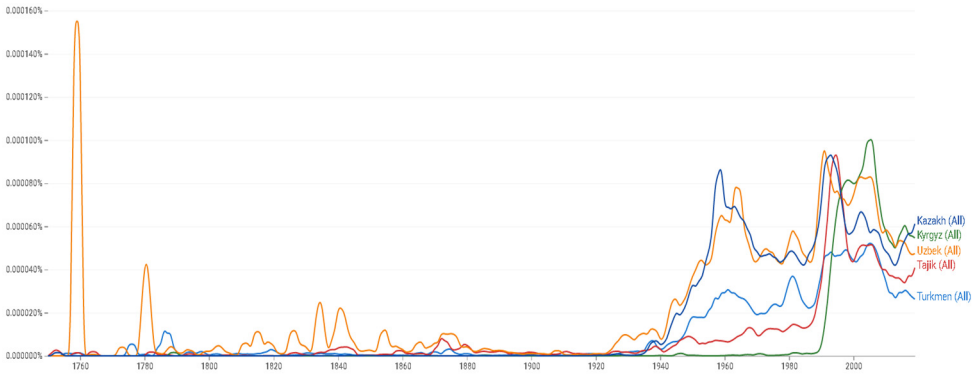


Fig. 5.7 The presence of the five ethnic groups of Central Asia and related terms in the English-language literature according to the Google Ngram Viewer (2021).

The interpretation of data in the study should be preceded by words of caution. The figures presented in this chapter provide relative or percentage values. Absolute values of online interest were unfortunately unavailable, though they could provide more objective dynamics in the studied variables. Furthermore, searches in English for a specific term cannot claim to exhaustively define a certain country or ethnic group, as various names for each exist in different languages (differing results with alternative names would be discussed further). During the analysis, errors were found in the metadata on Google Books; for instance, several books shown as published before the nineteenth century actually belonged to later periods.

Alternative and Russian names

The previous figures showed the prevailing names of Central Asian countries and corresponding ethnic groups found in a review of literature in English. While searches in the English language might better reflect the interest of foreign countries towards Central Asia, many users within the region and generally in the post-Soviet area might prefer the Russian language (this particularly concerns higher age groups). Even in the English language, various names were used in different periods. This section makes an attempt to present a more balanced view of interest and mentions online.

Figure 5.8 shows interest reflected by online searches in Russian names related to the main ethnic groups in Central Asia. Similar to the English-language literature, Uzbek was mentioned significantly more, but Kyrgyz was the second and Kazakh only third. The overall trend was an increase for all countries since 2009.

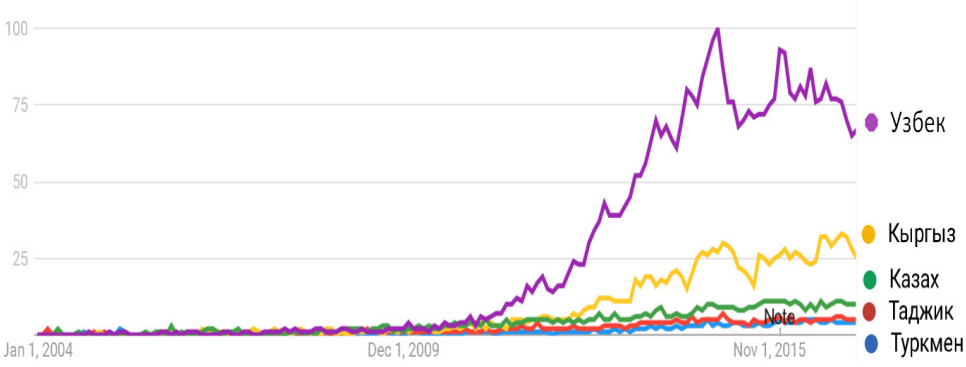


Fig. 5.8 Interest in five ethnic groups of Central Asia in the Russian language over time according to Google Trends (2021).

Figure 5.9 illustrates how Kazakhstan was the Central Asian country with the most mentions in the Russian language. Unlike in the English language, the second position of Uzbekistan was less obvious during most periods, and it has increasingly been challenged by Tajikistan since 2000. The presence of Turkmenistan and Kyrgyzstan would be higher if not for the prevalence of two alternative names for each country frequently used in Russian publication (which were often transliterated as Turkmenia and Kirghizia in less formal publications, and Turkmenistan and Kyrgyzstan, in official documents). Overall, recent publications in Russian media appeared to be reluctant to recognize and adopt the official name of the independent states, continuing use of habitual names from the Soviet time. The names of the states were occasionally the subject of disputes within Central Asia. In the Kyrgyz Republic, nationalists might favor the official republic name, clearly denoting the

ethnic character, while others prefer Kyrgyzstan as the name denoting all people in the country (Asanalieva (2015). There were official suggestions at higher levels in Kazakhstan to change the country name and eliminate the ending “-stan” due to the perceived effect on the interest of foreigners, and the possible confusion with similarly sounding country names with the suffix "-stan" that has Persian root (Ford 2014).

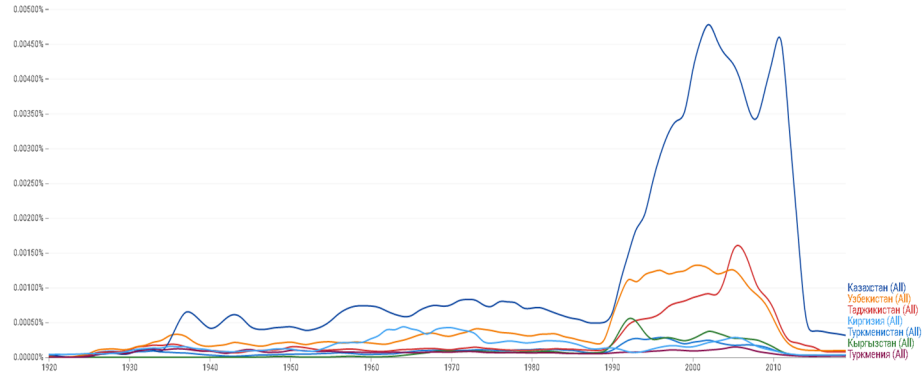


Fig. 5.9 The presence of names of Central Asian countries in the Russian-language literature according to the Google Ngram Viewer (2021).

Figure 5.10 shows patterns of mentioning the representatives of ethnic groups in Russian-language literature. Uzbek and Kyrgyz were frequently mentioned already in the earliest literature. All five Central Asian groups received more mentions during the Soviet era compared to the period of independence after 1991 (the last time peaking around 1960 for Tajik and 1985 for Kazakh). Interest in Kyrgyz seemed to increase during 2000s.

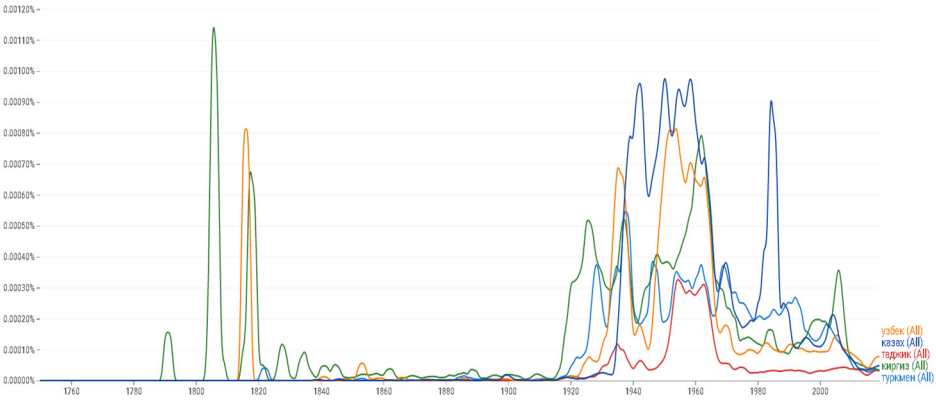
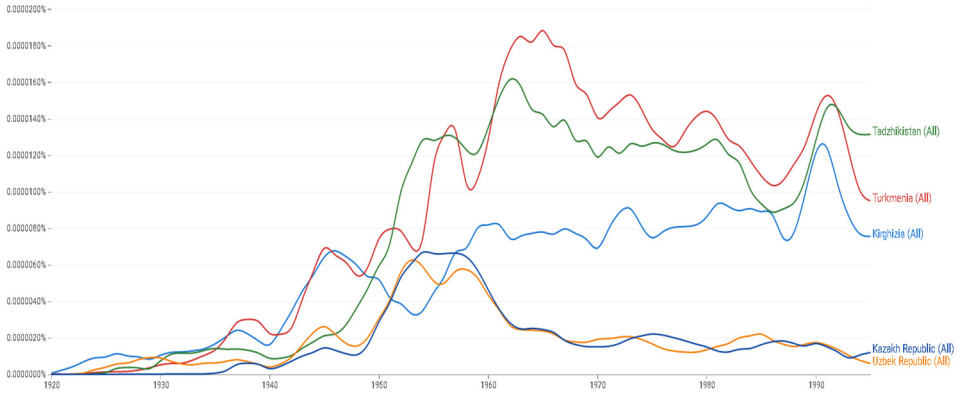


Fig. 5.10 The presence of the five ethnic groups of Central Asia and related terms in Russian-language literature according to the Google Ngram Viewer (2021).

Figures 5.11 and 5.12 illustrate the variety of names used as alternatives in the English language to define the Central Asian countries and corresponding ethnic groups or adjectives. Official country names with the addition of "republic" did not appear to be particularly popular. Less formal names such as Turkmenia, Tadzhikistan, and Kirghizia were significant in frequency. Older adjectives and nouns in English, such as Turkoman and Kirghiz, were frequently used in the earliest literature. Other alternatives existed in both Russian and English languages but were not included in the analysis due to their low frequency.



Note: the Kyrgyz Republic as an alternative and increasingly used name was excluded for reasons of balance in country representation in this figure.

Fig. 5.11 The presence of alternative names of Central Asian countries in English-language literature, according to the Google Ngram Viewer (2021).

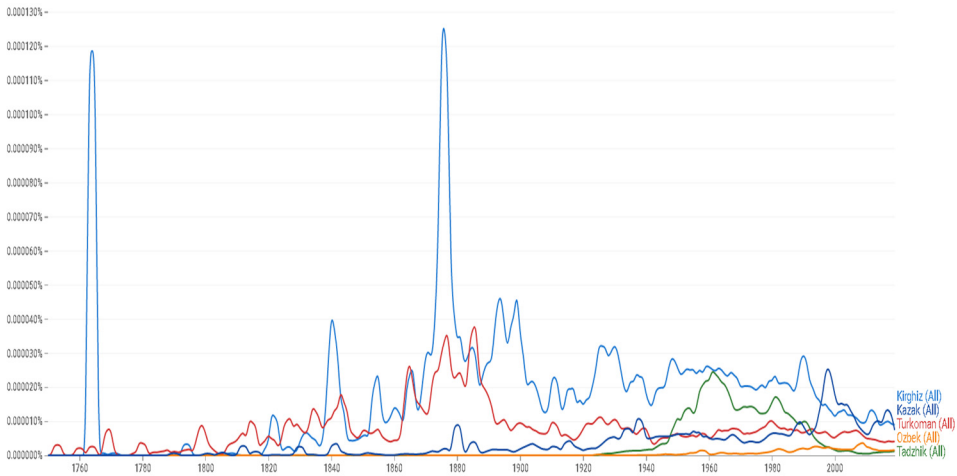


Fig. 5.12 The presence of the alternative names of five ethnic groups of Central Asia and related terms in English-language literature according to the Google Ngram Viewer (2021).

Implications for digitalization and nation branding

Online presence has broad implications for policymakers, but the focus of this section is on digitalization and nation branding. Despite difficulties in establishing cause-and-effect relationships, policies in the two spheres in which the online presence often has a direct impact should take into account statistical data from the most popular resources on the web.

Considering the various business-oriented definitions of the term available, digitalization in this report is used as a more general term for the way social life is restructured around digital communication and media infrastructures (Bloomberg 2018). Despite the clear realization of digitalization's benefits, the digital gap among the developed and Central Asian countries appears to be further widening (Chikoniya 2019). Central Asia experienced slow growth in E-commerce and a declining share of ICT service exports (Erokhin 2020). The region particularly lagged behind comparators among post-Soviet countries in the indicators of content creation, with a relatively low number of Wikipedia pages.

With some confusion about its definition in practice, nation branding at various levels could mean communicating a nation's image to the rest of the world through diplomacy, marketing, trade, exports, and tourism. Nation branding is practiced to enhance soft power, form national identities, enhance a nation's competitiveness, embrace certain activities, promote interests, and improve reputation (Fan 2010). In the context of Central Asian countries, such branding often involves advertisement via foreign media, organization of conferences, publication of books, leaflet distribution, creation of slogans, and other elements of public diplomacy that were tightly controlled according to centralized plans by governments (Marat 2009). The internet has seemingly been lower in priority as an outlet used in nation branding strategies compared to traditional media.

Kazakhstan has been a leader in various aspects of digital transformation in Central Asia (Erokhin 2020). The same country was among the first and leading countries in the region that started attracting the attention of the international audience and reacting to increased (and sometimes unwanted) interest abroad (Stock 2009). The economy of Kazakhstan has been prominent since the Soviet era and became relatively open compared to most Central Asian counterparts during the period of independence. It is perhaps not surprising, then, that the country attracted the highest online interest and coverage in literature in most periods. Uzbek as an ethnic group and adjective appeared higher relative to others in Central Asia in attracting search interest, which could reflect the largest population size in the region.

Liberalization has to be mentioned at the end of this discussion as an underestimated factor in encouraging both digitalization and nation branding efforts. Productivity and quality in the creation of online content within a country are heavily dependent

on national talent and foreign investment. Human capital, technology, and institutions in Central Asia did not score high on essential prerequisites for knowledge-based growth as compared to the majority of transition countries in Central and Eastern Europe (Veugelers 2011). Progress in the digital transformation and improving country image within Central Asia should involve loosening excessive government control over access to the internet, education, research, business, and investment within the respective countries. Allowing greater freedom and eliminating the barriers to information and other resources online can become a big area for building creative capacity.

Conclusions

Google search interest, the volume of Wikipedia pages in national languages, and coverage on Google Books can be used together as a novel measure of an online presence. The comparison in online presence between the five Central Asian countries and their main ethnic groups allowed the identifying of a peak in coverage in both the English and Russian languages during the 1990s and 2000s, followed by a relative decline of interest and mentions on the web and literature over the recent decade. Kazakhstan was relatively more frequently mentioned in the literature, while Uzbek-related search terms seemed to attract relatively higher interest online. Users of the languages and domains of Central Asian countries overall created less online content indexed in the top sites for reference materials and searches online as compared to post-Soviet countries of comparable economic and population size. The analysis also showed the use of a variety of names in English and Russian languages dating back to pre-Soviet times. The results have implications for digitalization and nation branding. Future work should address the underlying causes of the changing interest in the region in a deeper analysis while addressing the issues of possible data errors and alternative names.

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56. Peter Bergwall: (ska fyllas i när Peter B. är klar med sin titel)

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Larsson, Stefan: Between daring and deliberating – 3g as a sustainability issue in Swedish spatial planning. Licentiatavhandling (2008).

Central Asian Law

This research report was written by guest researchers at the Department of Sociology of Law, Lund University, who conducted interdisciplinary research on various topics related to sustainable development and business environments in Central Asia. The stays of these researchers from Central Asia took place in the framework of the EU-funded project "Central Asian Law: Legal Cultures and Business Environments in Central Asia" (project number 870647 H2020 MSCA-RISE 2019-2023), which runs from 01/03/2020 through 28/02/2024. The project is coordinated by Lund University, and the project consortium includes European universities (University of Zurich, Charles University Prague, Riga Graduate School of Law, Marmara University, University of Latvia) as well as Central Asian partner institutions (L.N. Gumilyov Eurasian National University, Khujand Polytechnic Institute of the Tajik Technical University, SIAR Research and Consulting, Tebigy Kuwwat Public Association, Academy of the General Prosecutor's Office of Uzbekistan, Westminster International University in Tashkent).

The report includes studies on selected development topics in Central Asian countries. The purpose is to contribute insights on the role played by human capital and liberalization in four essential areas concerning sustainable development: science, foreign investment, renewables, and online presence. Methodologically, the presented studies mainly rely on the analysis of data available from international organizations. The strength of the analysis is derived from the scale of the data on the countries accumulated over the three decades of their independence. The comparative studies offer new ways of understanding Central Asia, considering the distinct features of the countries in the region and how these changed over the period from 1991 to 2020. The authors made an effort to write the report in a manner accessible to non-specialists. Findings and implications could be of interest to policymakers, scholars, and students in the field of Central Asian studies.

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