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Abstract

Research and Development (R&D) is of high importance for economic growth because it drives technological progress in a society. The governments, therefore, stimulate both government expenditure and private business expenditure on R&D. Despite government measures to catalyse R&D initiatives throughout the globe, the pace of research and development considerably lags behind in Central Asia. We use evidence from Uzbekistan and Kazakhstan and show that despite having higher R&D capacity in Uzbekistan, Kazakhstani scientists are significantly ahead in the number and quality of publications and patents. We argue that the low productivity of researchers, low incentives for R&D, lack of private R&D investments and inefficiency of research processes has led to low quality innovation, less global impact and unsustainable R&D culture in Uzbekistan relative to Kazakhstan. We propose three policy options to produce high-quality R&D impact: [i] stimulate public- private and international partnerships (i.e. WIUT-UoW partnership, Nazarbayev University and hosting universities) to enable autonomy, internationalisation, mobility and knowledge exchange between industry, government and universities; [ii] carry out business/research process re-engineering in state-owned institutions, including national universities involved in R&D to optimise efficiency and productivity; and [iii] provide tax and financial incentives to stimulate business and academic R&D investments.

Keywords: *research, R&D, innovation, Uzbekistan, Kazakhstan, reform*

Research and Development and economic growth

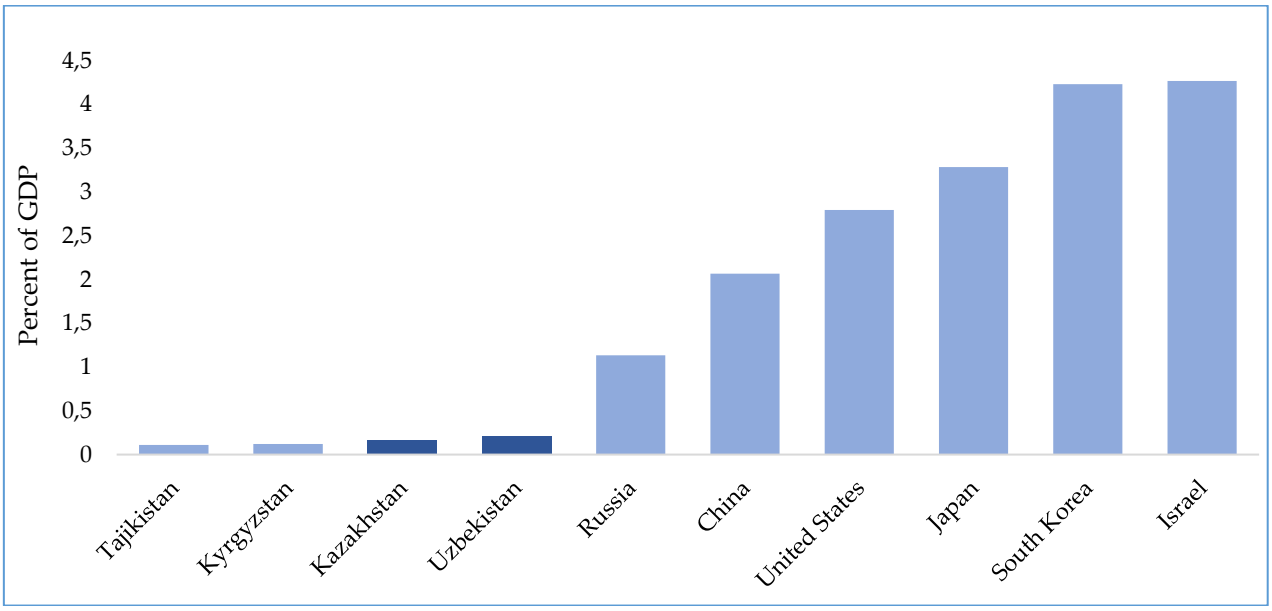
Research and development (R&D) are defined as systematic and creative activities to contribute to knowledge stock and find new uses for existing knowledge; these activities are required to be novel, creative, uncertain, systematic and reproducible (OECD, 2015). Many empirical research studies have focused on the effect of R&D on economic growth and hypothesised researchers "stand on shoulder of the past giants" (Acemoglu, 2009). Davidson and Segerstrom (1998), Janjua and Samad (2007) and Acemoglu (2009) found a positive effect of R&D spending and investments on economic growth through technological progress. Similarly, Koopmans and Donselaar (2015) concluded that a 10% increase in R&D is associated with 1.1–1.4% growth in labour productivity (Mohnen, 2018). Considering different viewpoints, Mohnen (2018) surveyed how R&D investments affect productivity and economic growth. He concluded that R&D investments bring positive outcome and knowledge spill overs whose magnitude varies across countries.

On the other hand, Bloom et al (2017) found that research productivity is declining by 5.3% annually worldwide. The authors show that research productivity halves over the course of roughly 13 years. They argue that if R&D inputs' growth rate declines, an economy grows slower. An economy, thus, has to double R&D investments every 13 years to keep the current growth rate. Frenkel et al (2015) criticised complicated and cumbersome bureaucratic approval procedures delaying market entry with novelty. Chen et al (2013) found that innovation-driven sustainable economic growth relies on both basic and applied research producing scientific journal articles and patents. They ascribed high productivity growth to patent-oriented productivity growth, especially in developing countries. Eom and Lee (2010) emphasised commercialising R&D outcomes successfully and expanding innovative products' share in sales rather than simply increasing patents' quantity. Most R&D activities are imitative R&D replicating other companies' products, while innovative R&D is focused on new high-quality products' development (Davidson and Segerstrom, 1998). Janjua and Samad (2007) outlined that as long as imitation costs are lower than innovation costs, developing countries grow faster than developed countries.

Research and Development expenditure

World economies invest certain proportion of their Gross Domestic Product (GDP) into R&D. However, R&D intensity varies across countries (Figure 1). Israel and South Korea, having the largest R&D spending as a percentage of GDP, stand out from the rest by spending more than 4% of their GDP on R&D in 2015, whereas leading economies such as Japan, United States and China allocated 3.3%, 2.8%, and 2.1% respectively. Research intensity in four Central Asian countries — Uzbekistan (0.21%), Kazakhstan (0.17%), Kyrgyzstan (0.12%) and Tajikistan (0.11%) — was substantially lower than the aforementioned countries pushing forward technological progress.

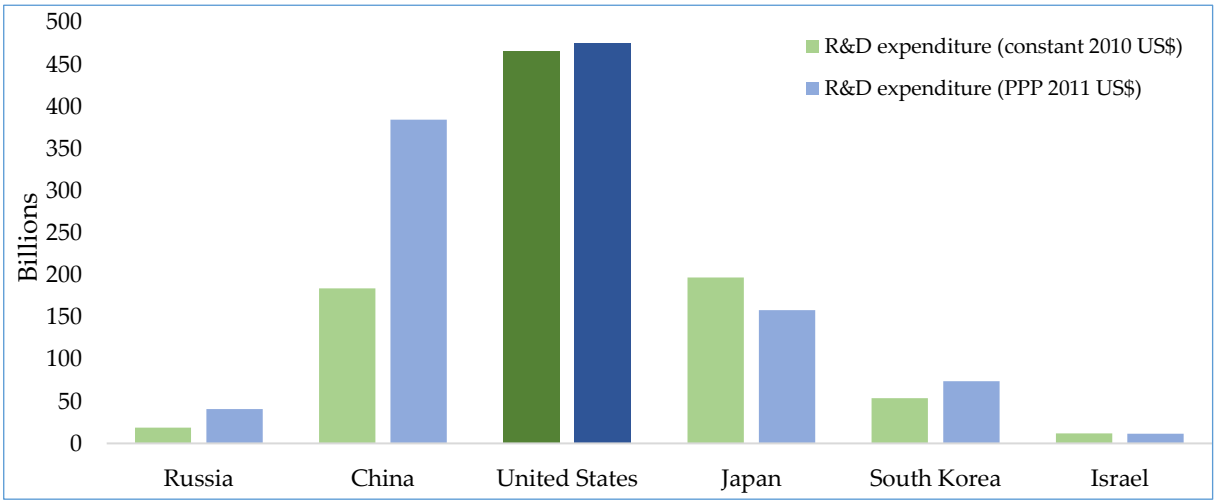
Figure 1: Gross expenditure on R&D in 2015, as percentage of GDP



Source: World Bank (2018), "Research and development expenditure (% of GDP)", World Development Indicators, http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS on the basis of the data from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics.

As Figure 2 demonstrates, despite having lower R&D expenditure as a share of GDP than Israel, South Korea, and Japan, the U.S. spending on R&D was the highest in 2015 in terms of both constant 2010 US$ ($465bn) and PPP 2011 US$ ($475bn). Israel, despite having the largest R&D expenditure as a share of GDP, spends less in absolute terms than that of Russia.

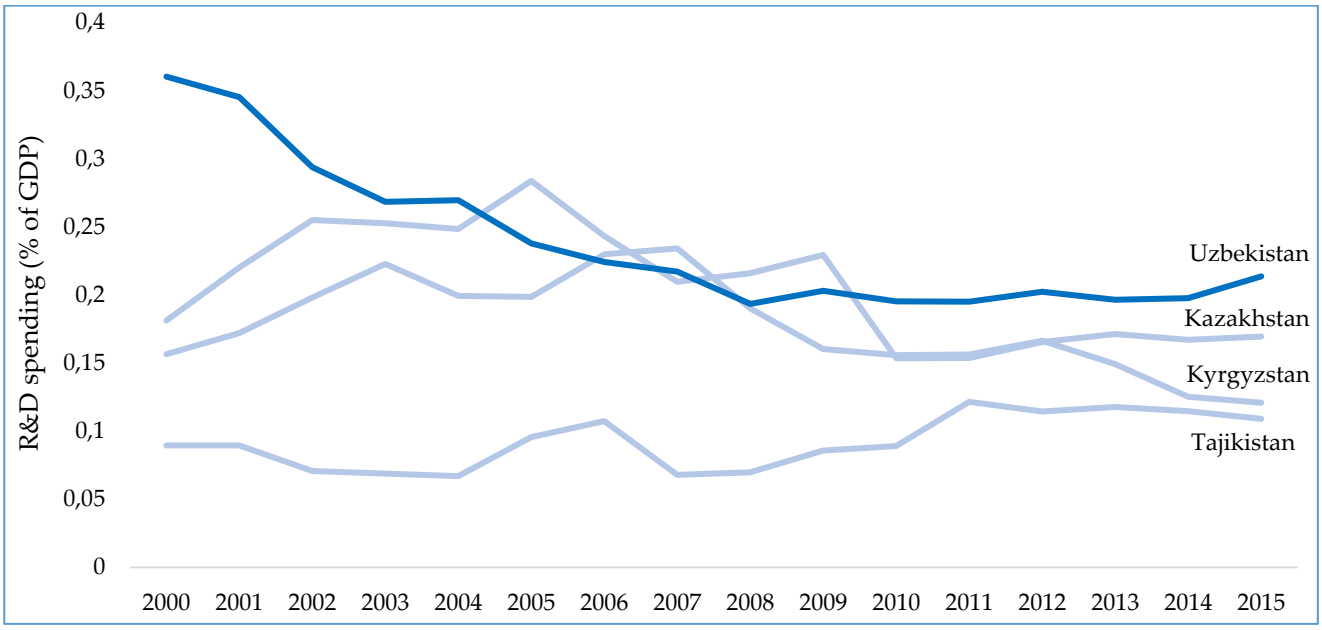
Figure 2: Developing Economies' R&D expenditures in 2015, in absolute terms



Source: The authors' estimates based on World Bank data.

Uzbekistan, Kazakhstan and Kyrgyzstan (Figure 3) experienced a downward trend over 2000–2015, while in Tajikistan we observe an upward trend, though R&D expenditure as a share of GDP was lower compared to other countries in Central Asia.

Figure 3: Gross expenditure on R&D in 2015, as percentage of GDP in Central Asian countries



Source: World Bank (2018), "Research and development expenditure (% of GDP)", World Development Indicators, http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS, on basis of the data from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics.

Research and Development legal framework

Kazakhstan strengthened its legal framework on science, technology, and innovation by enacting legislative documents over 1999–2016 (OECD, 2018), for instance:

- Law "on Education" (1999 and 2007);
- Law "on State Support for Innovative Activities" (2006);
- Law "on Science" (2011);
- A bundle of laws regarding the establishment of Nazarbayev University (2011);
- Law "on the Innovative Cluster "Park of Innovative Technologies"' (2014). For instance, the Nazarbayev University Research and Innovation System, the Alatau Park for Innovative Technologies, international techno park of IT-start-ups "Astana Hub", business incubator "MOST", business incubator/accelerator "Almau" and business accelerator "Astana Business Campus" are clear examples of scientific-production clusters;
- Entrepreneurial Code of the Republic of Kazakhstan (2015).

Despite the laws on the books, the share of R&D in Kazakhstani GDP remains at 0.17%. Nonetheless, the government of Kazakhstan took further steps to commercialise research outcomes by adopting the Law № 381-V 31.10.2015, on "Commercialisation of Results of Scientific and/or Technical Activities" and set up 26 research commercialisation offices at national universities (OECD, 2018).

Meanwhile, in Uzbekistan there has been a gap in government measures to coordinate R&D activities over 1997–2006. The government, thus, has been recently catching up with subsequent normative documents:

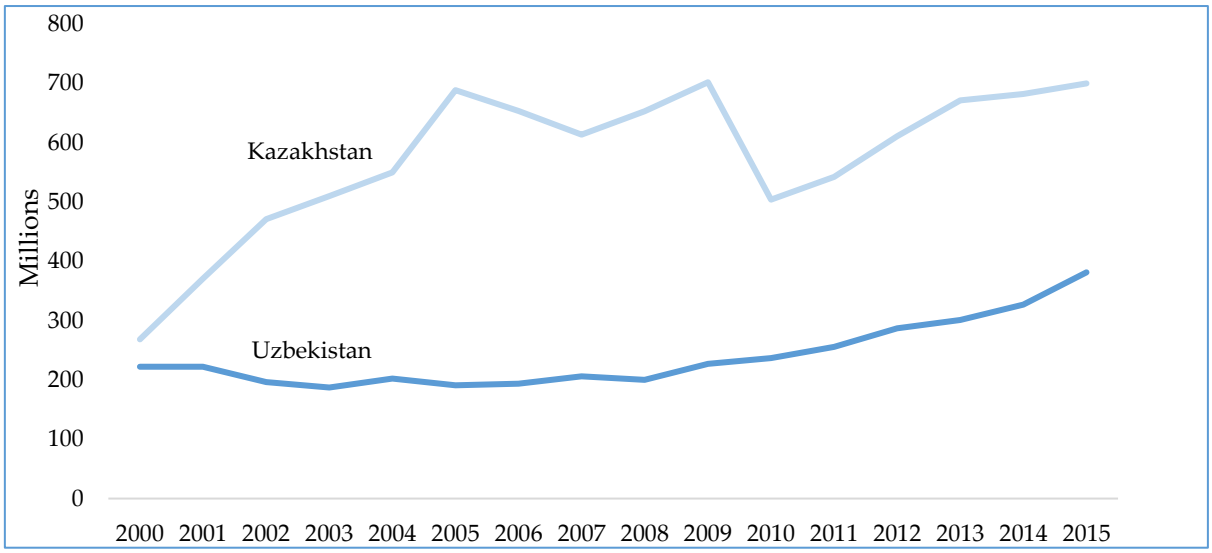
- the Decree of the President of Uzbekistan PQ-436 07.08.2006 "On measures for improving the coordination and management of science and technology development";

- the Decree of the President of Uzbekistan PQ-2204 08.07.2014 "On measures to further optimise the structure of the Academy of Sciences of Uzbekistan and strengthen the integration of academic science and higher education of the Republic of Uzbekistan";
- the Decree of the President of Uzbekistan PQ-2602 19.09.2016 "About creation of the Uzbek-Japanese Youth Center of Innovation at the Tashkent State Technical University named after Islam Karimov";
- the Decree of the President of Uzbekistan PQ-2769 10.02.2017 "On additional measures to develop basic and applied research and innovative action on genomics and bioinformatics";
- the Decree of the Cabinet of Ministers № 631 15.08.2017 "On measures to organize the activities of «Mirzo Ulugbek Innovation Center» for supporting the development and introduction of information technologies";
- the Decree of the President of Uzbekistan PQ-5264 29.11.2017 to establish the Ministry of Innovative Development of the Republic of Uzbekistan, which is responsible for developing and implementing government innovation policy with both foreign and local enterprises — public-private partnership.

Furthermore, to coordinate R&D and stimulate applying innovations to resolve socioeconomic issues in the country, two laws — the Law of the Republic of Uzbekistan on Innovative Activities[4] and the Law of the Republic of Uzbekistan on Science[5] — have been published for public discussion and expected to come into force by December 2018.

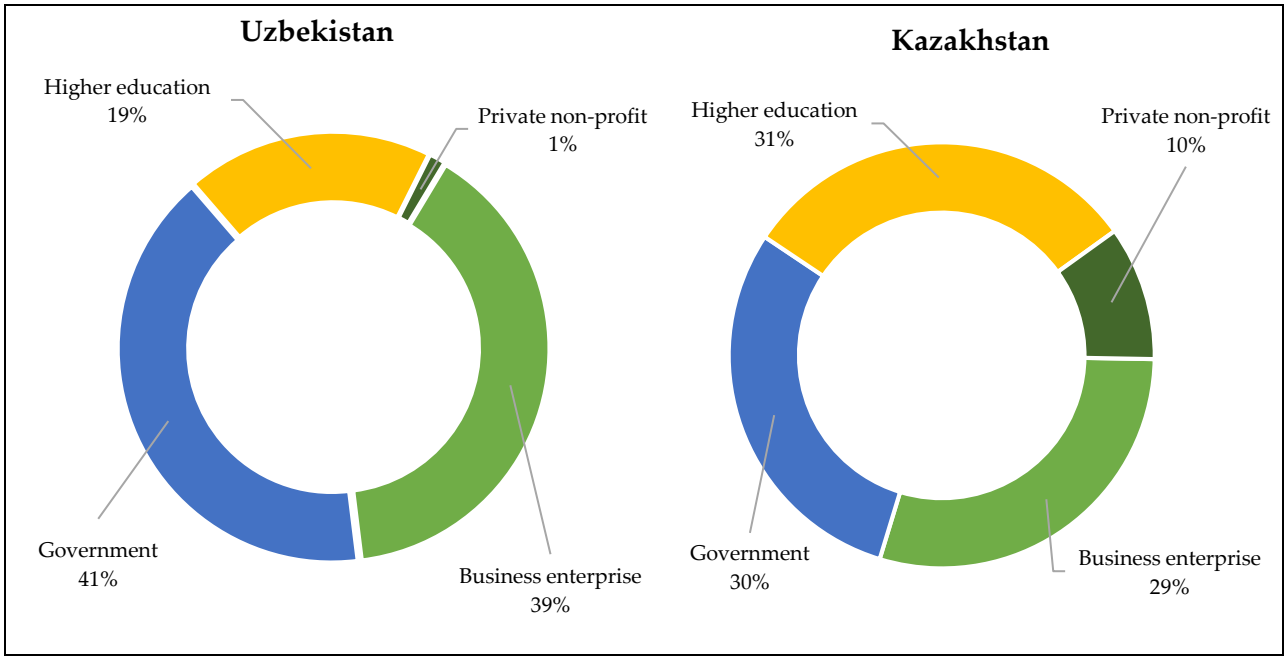
Figure 4 presents the gross expenditure on R&D in terms of PPP. R&D spending in Kazakhstan fluctuated over 2000–2015, while in Uzbekistan, it remained stable prior to growing steadily after the global financial crisis in 2007–2008. In spite of a marginally higher share of R&D in GDP of Uzbekistan, R&D expenditure in 2011 PPP dollars in Kazakhstan (699M) was roughly twice as high as in Uzbekistan (381M) in 2015.

Figure 4: Gross expenditure on R&D in Kazakhstan and Uzbekistan in terms of PPP (2011)



With respect to gross domestic expenditure on R&D (GERD) by sector of performance (Figure 5) in Uzbekistan, the largest share (41%) belongs to the government, whereas the largest portion in Kazakhstan (31%) belongs to higher educational institutions. The minuscule part of GERD (1%) in Uzbekistan is accounted for by the private non-profit sector. The private sector share, however, is ten times larger in Kazakhstan despite being the smallest share of total expenditure. The share of the business enterprise sector in Uzbekistan and Kazakhstan is 39% and 29%, respectively. Furthermore, we observe that GERD in Kazakhstan is more equally distributed across sectors compared to Uzbekistan.

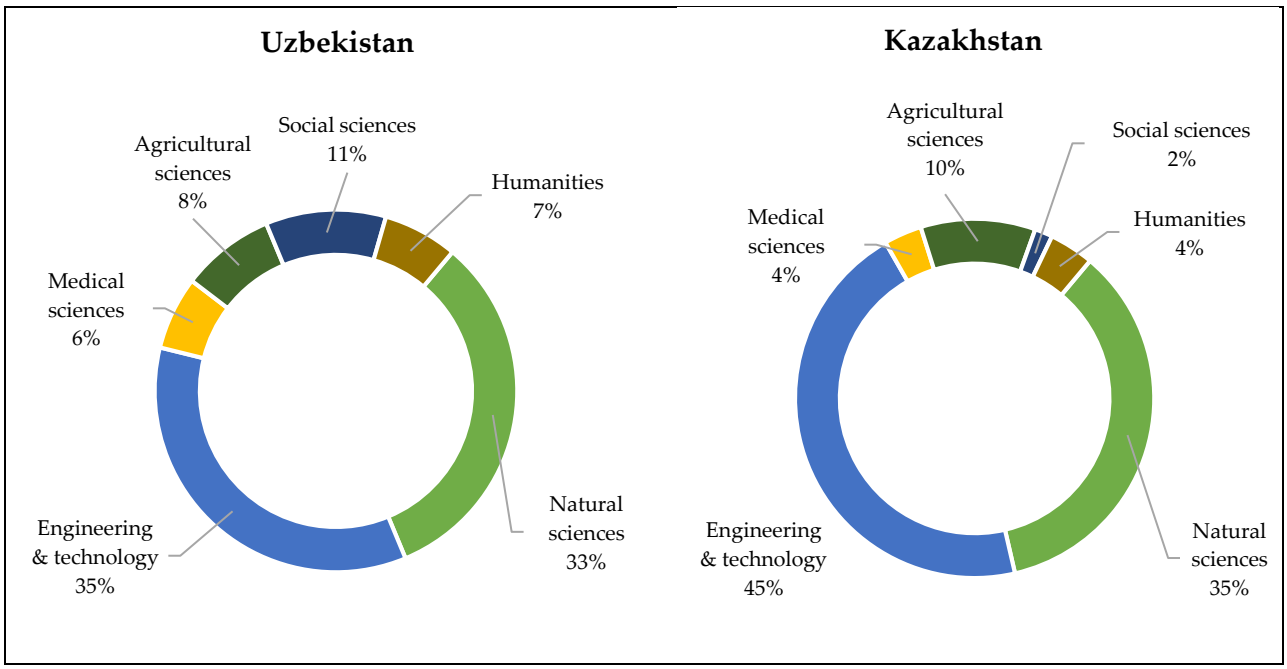
Figure 5: Gross domestic expenditure on R&D by sector of performance in Uzbekistan (2016) and Kazakhstan (2013)



Source: The State Committee of the Republic of Uzbekistan on Statistics (n.d.); UNESCO Institute for Statistics (n.d.)

Turning to the distribution of GERD amongst sciences, engineering & technology and natural sciences form over 65% of total R&D expenditure in both countries. Yet, in Uzbekistan, GERD is distributed relatively equally across sciences compared to Kazakhstan. While Kazakhstan devoted 2% of R&D expenditure on social sciences, Uzbekistan allocated 11% to this field in 2016.

Figure 6: Gross domestic expenditure on R&D by sciences in 2016

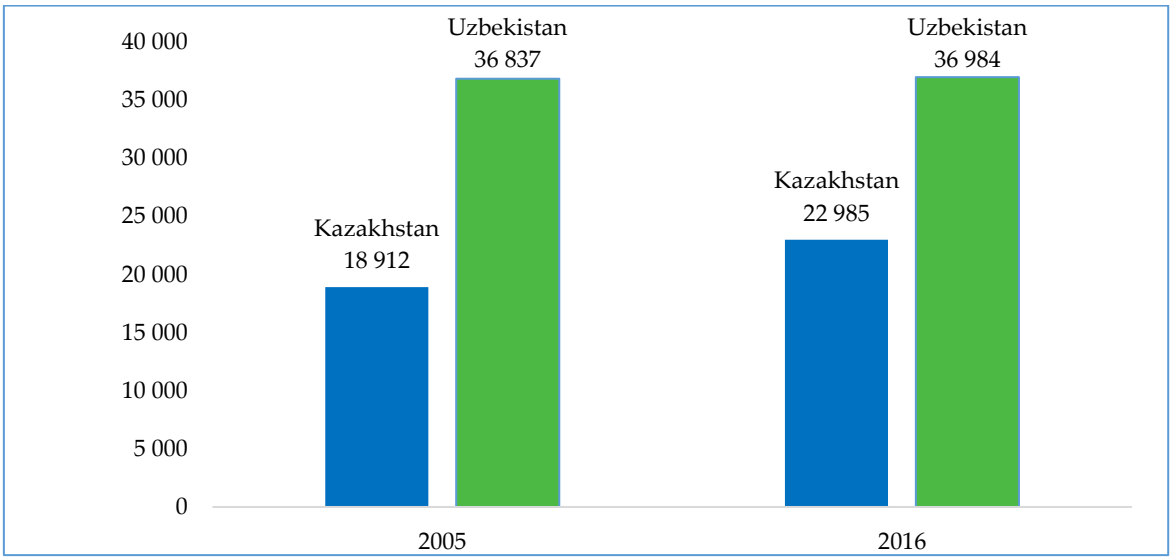


Source: The State Committee of the Republic of Uzbekistan on Statistics (n.d), "Expenditure on R&D across sectors by fields of science in 2016", https://goo.gl/1qPM3v; Committee on statistics of the Republic of Kazakhstan (n.d), "Internal current expenses for researches and development on areas of a science", https://goo.gl/8JSGxa.

Research and Development personnel

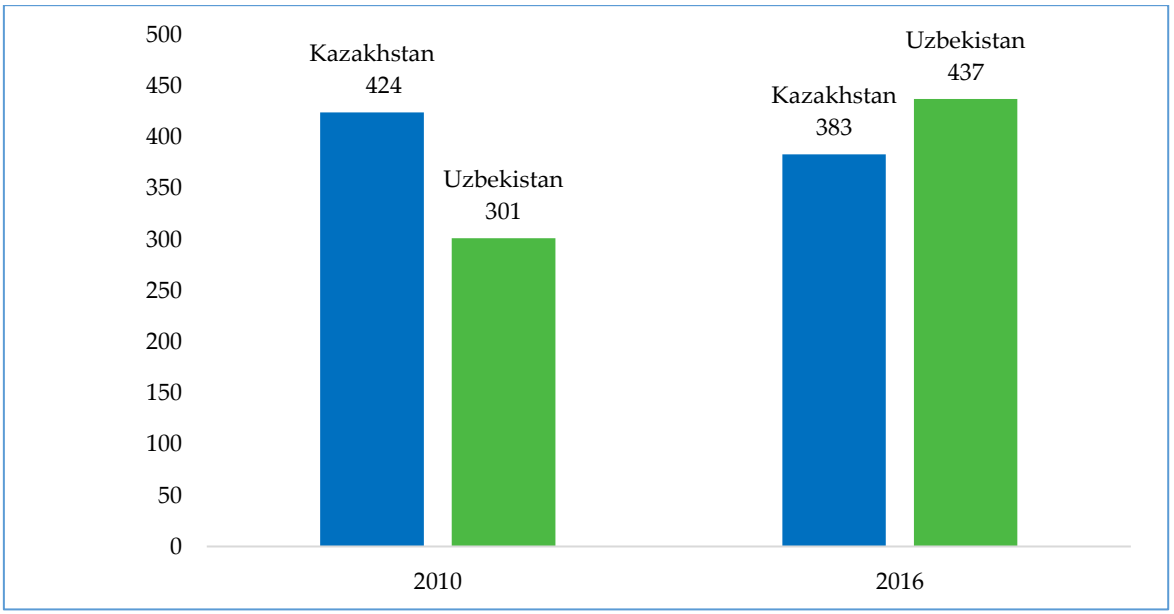
Comparing the data on the number of R&D staff in Uzbekistan and Kazakhstan over 2005-2016 (Figure 7), the number of personnel involved in R&D in Uzbekistan remained almost at the same level with a slight increase from 36,837 to 36,984 units, while this figure for Kazakhstan increased by 21.5%, rising from 18,912 in 2005 to 22,985 in 2016. At the same time, the number of organisations involved in R&D (Figure 8) is much higher in Uzbekistan, growing by almost one-third from 301 to 437 organizations between 2010 and 2016. On average, Uzbekistan has 85 people working on R&D in one organization, and Kazakhstan has about 60 R&D workers per organisation, and they are more productive.

Figure 7: Number of R&D staff in Uzbekistan and Kazakhstan



Source: The State Committee of the Republic of Uzbekistan on Statistics (n.d), "Number of R&D personnel (2000-2016)", https://goo.gl/1qPM3v; Committee on statistics of the Republic of Kazakhstan (n.d), "Main Indicators on the State and development of science", http://stat.gov.kz/getImg?id=ESTAT096029.

Figure 8: Number of organisations involved in R&D in Uzbekistan and Kazakhstan

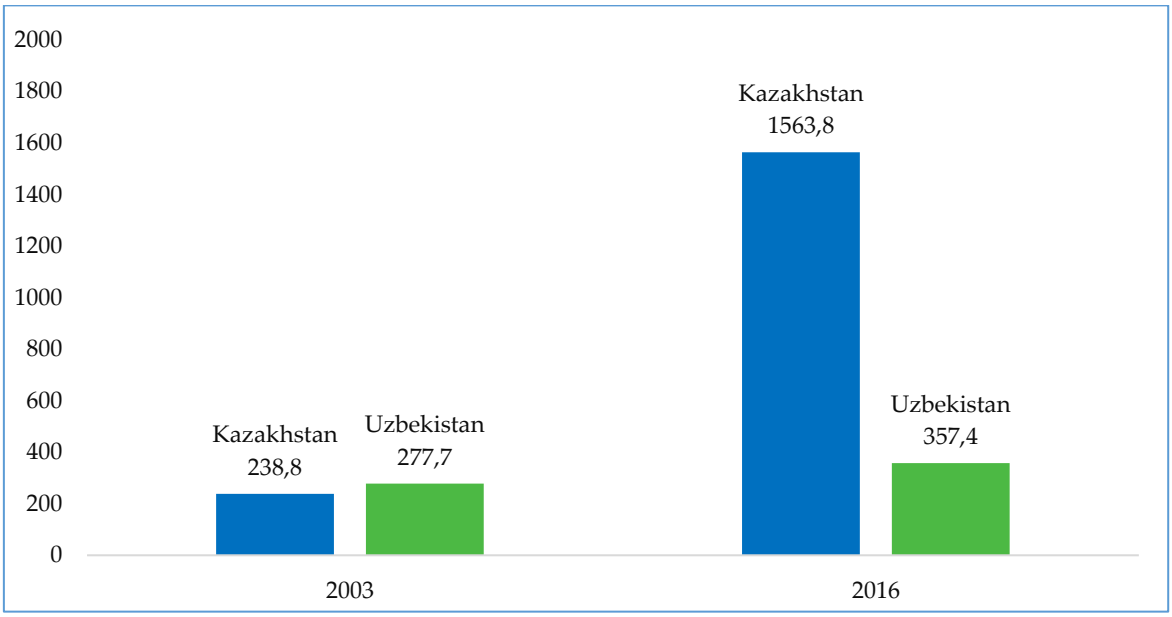


Source: The State Committee of the Republic of Uzbekistan on Statistics (n.d), "Number of organizations engaged in R&D (2010-2016)", https://goo.gl/1qPM3v; Committee on statistics of the Republic of Kazakhstan (n.d), "Number of Organizations Conducting R and D", http://stat.gov.kz/getImg?id=ESTAT096028.

The number of scientific and technical publications in Uzbekistan and Kazakhstan (Figure 9) has increased considerably between 2003–2016. Kazakh scientists recorded more than six-fold increase in publications

increasing their research output from 238.8 in 2003 to 1,563.8 in 2016. In Uzbekistan, however, the increase is less than 30%, rising from 277.7 to 357.4. As mentioned previously in Figure 5, a third of R&D activities in Kazakhstan are conducted in higher educational institutions and university research work that contribute primarily to journal articles and/or research grants. This six-fold increase can also be attributed partially to an increase in R&D expenditure in PPP dollars (Figure 4) in Kazakhstan, while in Uzbekistan R&D spending has been relatively slow and more volatile.

Figure 9: Number of published technical and scientific journal articles[6]



Source: World Bank (2018), "Scientific and technical journal articles", https://data.worldbank.org/indicator/IP; JRN.ARTC.SC; World Development Indicators, on basis of the data from National Science Foundation, Science and Engineering Indicators.

According to Web of Science data, the number of published technical and scientific journal articles peaked in 2016 in both Kazakhstan and Uzbekistan (Figure 10). In Kazakhstan, the top drivers of this productive peak in 2016 were mainly contributed (in percentage terms) by universities that were recently established (Figure 11) – Kazakhstan National University (19%), followed by Nazarbayev university (7%) and Eurasian National University (6%). On the other hand, in Uzbekistan, the peak productivity was mainly driven by medical scientists – Tashkent Medical Academy (24%), followed by the Academy of Sciences of Uzbekistan and National University of Uzbekistan (Figure 12). Moreover, the work of Kazakhstani scientists is cited more often and has higher impact. For instance, in 2017, the number of times published articles in Kazakhstan were cited was more than the twice the number of published works in Uzbekistan (Figure 13).

Figure 10: Number of published technical and scientific journal articles using Web of Science

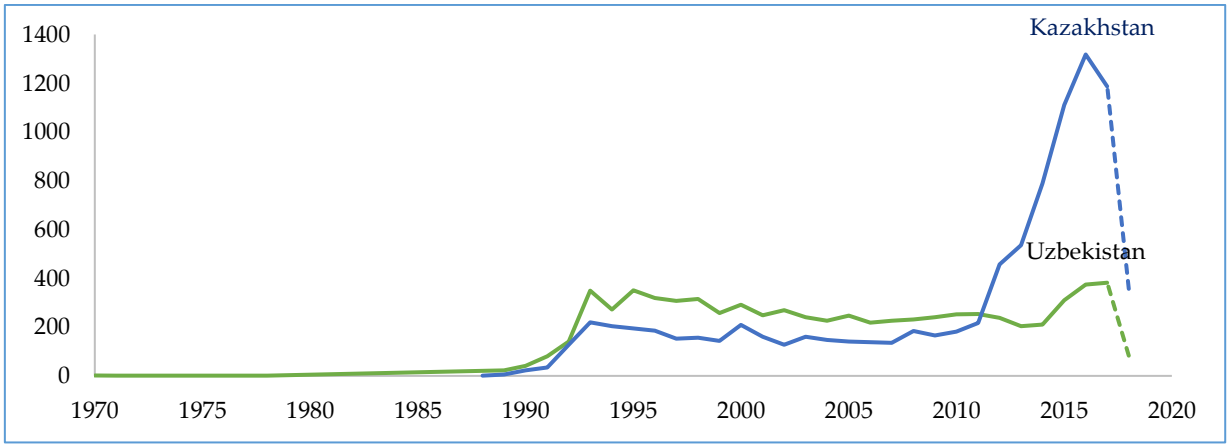


Figure 11: Percentage contribution of published technical and scientific journal articles by institutions in Kazakhstan using Web of Science

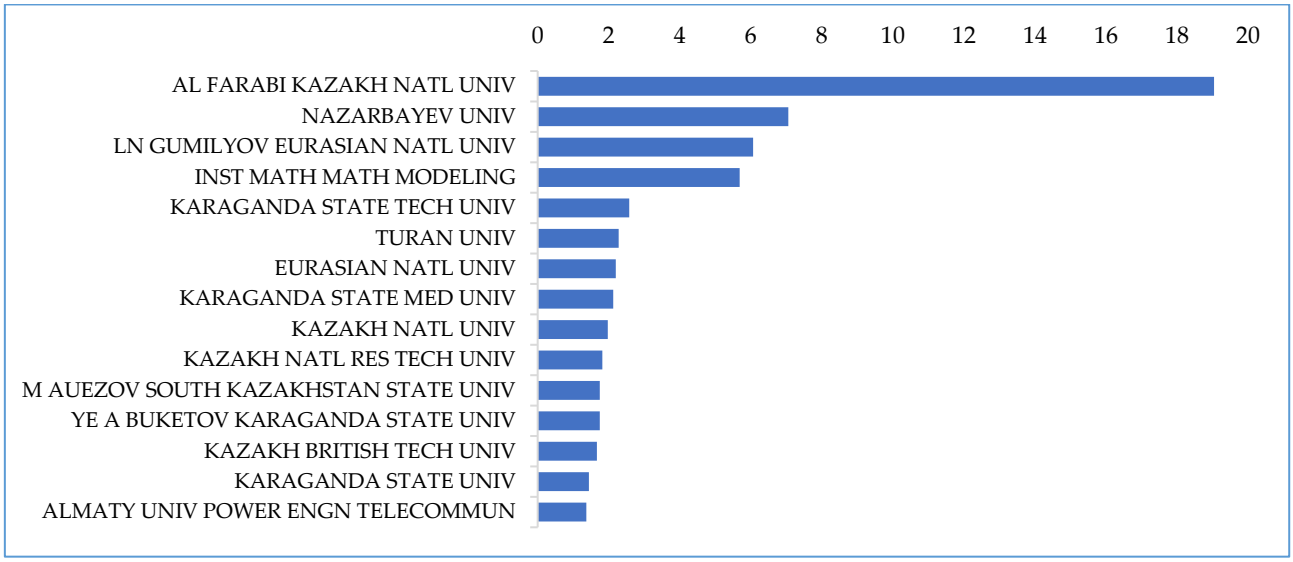


Figure 12: Percentage contribution of published technical and scientific journal articles by institutions in Uzbekistan using Web of Science

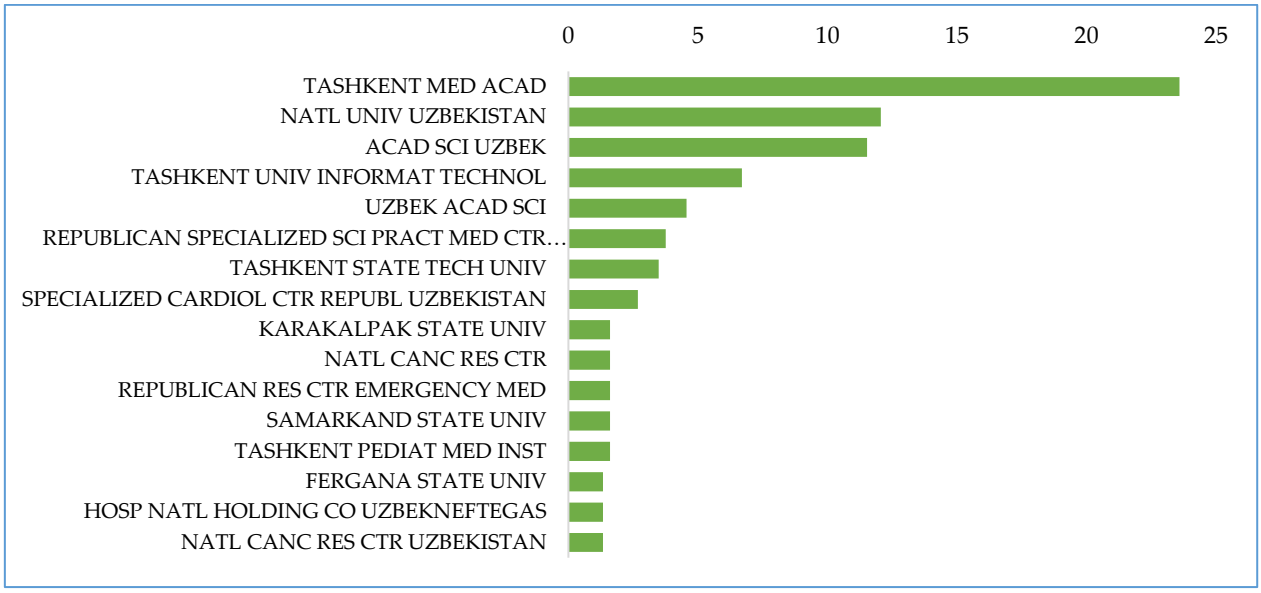
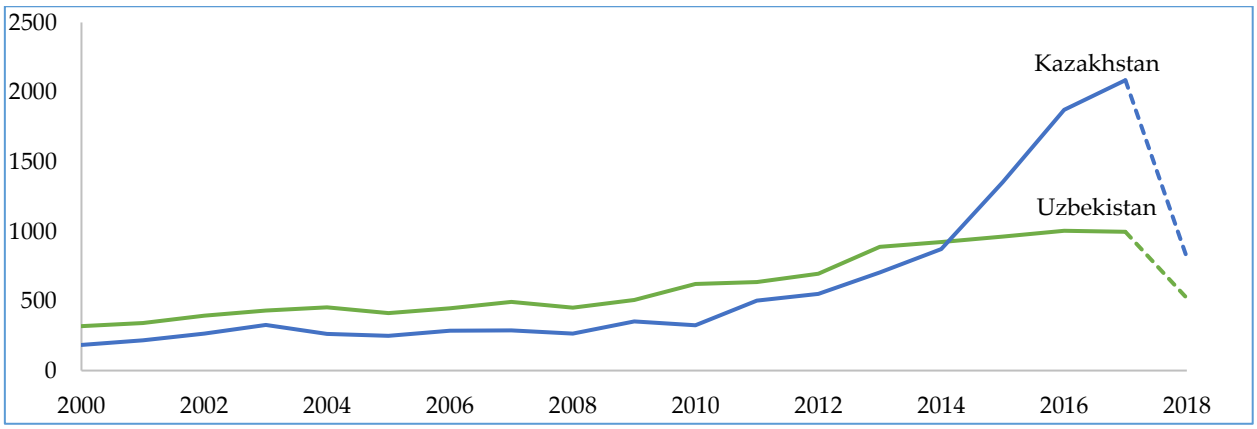


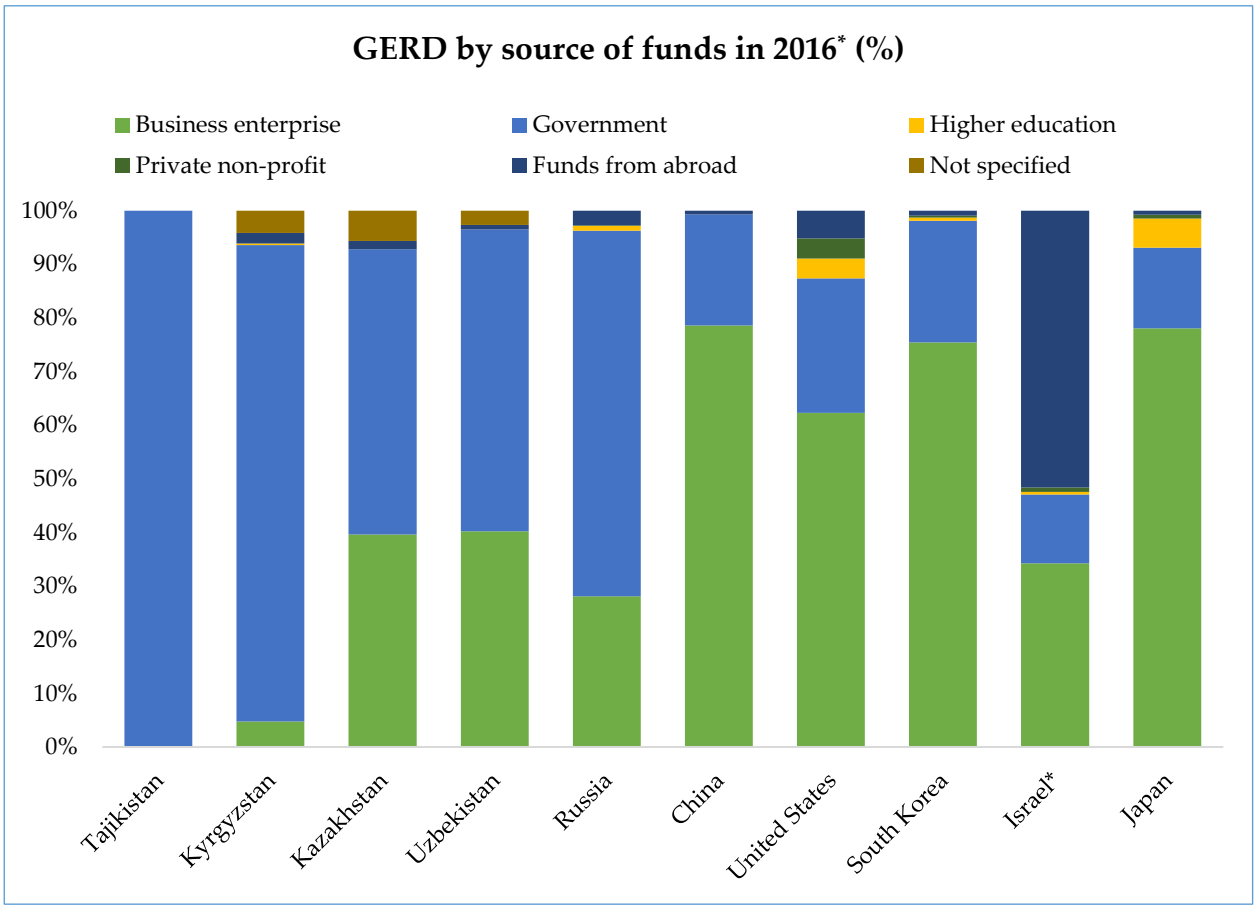
Figure 13: Citations impact of published technical and scientific journals In Uzbekistan and Kazakhstan using Web of Science



Research and Development funding sources

According to Figure 14, the government tends to be the largest or the single funding source on R&D in Central Asia. However, the experience of China, Japan, South Korea and the United States shows that roughly two-thirds of funding for research and development comes from the business enterprises/firms and not the government.

Figure 14: Gross expenditure on R&D by funding source



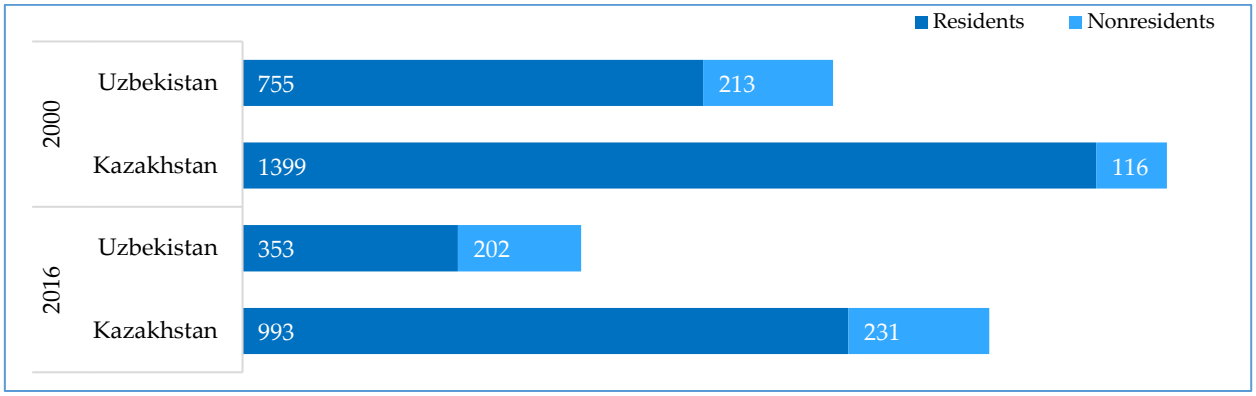
Source: United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics (n.d), "Science, Technology and Innovation", http://uis.unesco.org/en/country/uz

** Data from 2015*

Intellectual Property

The national intellectual property (IP) system in both countries has developed after independence (Intellectual Property Agency, no date b; OECD, 2016). Regarding patent applications in 2000 and 2016 (Figure 15), both countries' figures demonstrate a downward trend. In Uzbekistan, the number of applications by residents almost halved compared to 2000, whereas in Kazakhstan it decreased by 30%. While the number of patent applications by non-residents doubled in Kazakhstan, it declined from 213 to 202 over the course of sixteen years in Uzbekistan. Although the number of people and organisations engaged in R&D was higher in Uzbekistan than Kazakhstan, the number of total patent applications in Kazakhstan exceeded Uzbekistan by 669 applications in 2016.

Figure 15: Number of patent applications by applicants' residence status



Source: World Bank (2018), "Patent applications, residents", World Development Indicators, https://data.worldbank.org/indicator/IP.PAT.RESD; "Patent applications, non-residents", World Development Indicators, https://data.worldbank.org/indicator/IP.PAT.NRES, World Development Indicators, on basis of the data from World Intellectual Property Organization (WIPO).

Policy issues

Productivity and quality of research and innovations

Despite that more organisations and personnel engaged in R&D in Uzbekistan, the number of patents and the number of technical and scientific articles significantly lag behind than that of in Kazakhstan. These findings raise questions about the productivity of workers or the efficiency of processes involved in research and development and quality of research and innovations in Uzbekistan. It is also possible to highlight the problem of under-stimulation of scientific and innovative activities, which was confirmed by the rating of Uzbekistan in 2015 in the Global Innovation Index (0.14 out of 1); Uzbekistan was not included in this rating in 2016 and 2017. The incentives to innovate can be traced to the share of the government in R&D expenditure (Figure 5). Since the lion's share of gross domestic expenditure on R&D belongs to the government, R&D organisations may practice overstaffing from which most state-owned organisations suffer around the globe (Weil, 2012). This issue indicates that R&D personnel may be shouldered with unproductive and bureaucratic activities unrelated to creating new and original ideas; and capital or human resources could be misallocated to wrong places preventing them from fulfilling their true potential. The number of registered inventions in Uzbekistan duplicate inventions made in developed countries to some degree (Intellectual Property Agency, no date a). This tendency is widespread throughout the world, not only in Uzbekistan.

Unproductive policies such as demanding a greater number of publications from graduate students in Uzbekistan has led to aggressively pursuing more publications. For example, Master's students have to publish at least two research articles or theses during studies to be eligible to defend their Master's thesis and obtain a Master's degree (The Cabinet of Ministers, 2015). PhD students to be eligible to defend their dissertations are required to publish at least three research articles (one in a foreign journal) that present main findings of the dissertation in scientific journals, approved by the Supreme Attestation Commission (ibid.). Meanwhile, researchers are required to have published at least ten research articles to be allowed to defend Doctor of Science (DSc) dissertation (one in a foreign journal) in scientific journals, approved by the Supreme Attestation Commission (The Cabinet of Ministers, 2017). Likewise, in Kazakhstan to obtain a PhD degree, researchers have to publish at least seven articles related to the topic of the dissertation, including at least three in journals, approved by a commission; and one research paper in a foreign journal having a non-zero impact factor according to the Thomson Reuters Web of Knowledge or within the database of Scopus; and three papers in international conferences, including one in an international conference held in a foreign country or other country where the dissertation was defended (The Ministers of Education and Science of the Republic of Kazakhstan, 2011).

These dissertation requirements indicate that current policies evaluate the quantity of publications rather than their quality or their citation impact. Such a "numbers game" could lead to predatory publishing incidents. Predatory publishers lure researchers with rapid peer-review and high rate of publication acceptance or impact factors (i.e. Global Impact Factors). Although using predatory publishers raises the number of publications, these papers are of low quality, so-called "junk papers"; and, therefore, have zero or little contribution to the stock of knowledge. Unlike publishers with high reputation and strict quality control, predatory publishers are driven by profit and involved in academic dishonesty (INANE Predatory Publishing Practices Collaborative, 2014). These publishers mimic titles of reputable peer-reviewed journals to attract potential victims willing to publish their "junk" research (ibid).

Underinvestment in research and development

Relatively high government contribution (roughly two-thirds) to total R&D expenditure in Uzbekistan and Kazakhstan indicates that the private sector is less motivated in investing in R&D. Yang (2014) empirically studied that allocating more resources on R&D catalyse firms' performance, especially, for small firms. Although the direct government support of R&D brings fruitful outcome in basic research, the government is not as successful in supporting applied research studies due to "its lack of profit motive" (Stiglitz & Rosengard, 2015). Higher rate of return of R&D investments catalyses private firms' motivation to take risks and maximise profits. Firms, thus, invest in R&D to enhance their competitiveness and increase their productivity (Sterlacchini & Venturini, 2018).

Take the sector of Information and Communication Technologies (ICT) as an example. The decree PQ-2834 (15.03.2017) of the President of Uzbekistan on "Measures on modernising the function of Tashkent University of Information Technologies" outlined establishing a scientific and innovation development fund for the Tashkent University of Information Technologies named after Muhammad Al-Khwarizmi. The fund is financed by the 1% of total amount gained from a monthly fee for the mobile network operators for each mobile subscriber number, an amount of US$111,717[7] approximately. This measure emphasises the effort of the government to stimulate R&D in the ICT sector. Its positive impact, however, could be shadowed by the Decree № 2759-1 28.02.2018 of the Ministry of Finance and State Tax Committee on "Changes in rules of application of corporate income tax rates, providing mobile network services in line with the rate of return" and the subsequent ordinance PF-5468 (29.06.2018) of the President of the Republic of Uzbekistan "On the concept of tax policy modernisation". While the former increased taxes for mobile network operators from 7.5 to 14%, the latter suggested raising taxes to 20%, which is comparatively similar to the corporate tax rate in Kazakhstan.

On one hand, this change in fiscal policy enables the government to increase tax revenues. On the other hand, high corporate taxes prevent firms from realising profits, which could have been invested in R&D and network infrastructure to be more competitive, productive and provide better services. In Uzbekistan, the tandem of an increase in tax rates for mobile network operators and monthly fee for each mobile subscriber number serve as a progressive and excise tax respectively; which are shifted to subscribers and making them worse off. These taxes increase the cost of mobile services and make it unaffordable for consumers at the lower income quantiles; and, thus, expanding digital inequality among citizens at various income quantiles (GSMA, 2018).

Policy options

Based on the analysis of the policy issues mentioned above, we review available measures towards the resolution. We point out a few empirically grounded options: [i] establishing public-private partnerships and international collaborations in R&D; [ii] carrying out business and research process reengineering in state-owned R&D organisations; [iii] implementing innovative financing mechanisms to promote R&D; [iv] providing fiscal incentives.

i. Establishing public-private partnerships and international collaborations in R&D

Countries with a higher share of private R&D investments achieve relatively high R&D efficiency (Chen, Hu & Yang, 2011). The share of business R&D expenditure, for instance, in China is roughly 70% which has enabled China to overtake the second largest patent filer. Japan and China published more research articles than the United States in 2016 (Guarino et al, 2018).

According to Kwon (2011), South Korea and Singapore commercialised academic research to connect academia with government and industry. Universities can be regarded as "effective incubators for high-tech start-ups" (Chen et al, 2011). Taking into account researchers' abilities and institutions, multiple forms of cooperation between universities and industry, such as, but not limited to, spin-off activities, licensing, setting up science parks, public-private joint research, research facility sharing, and researcher exchange programmes should be stimulated (Eom & Lee, 2010; OECD, 2018).

In the 1980s, the United States enacted the Bayh-Dole Act to regulate government-funded research inventions ownership. This policy allows grantees to patent publicly funded inventions, thereby, providing an incentive to commercialise inventions and transfer technology to the market (Mireles, 2007). The Act enabled universities and non-governmental organisations conducting publicly funded research studies to increase the number of patents and licenses, thus, generating an additional economic activity (ibid). Several developed EU countries and developing countries, such as Japan, South Korea, China and India, enacted similar acts to catalyse technology transfer and industry-university interactions. China went further and imposed preferences to stimulate creation of foreign-owned R&D centres and international R&D alliances (Li & Zhong, 2003). In Central Asia, Kazakhstan enacted a law on "Commercialisation of results of scientific and/or technical activities" in 2015 to transfer research outcomes to local and global markets and has been working on improving successful commercialisation (OECD, 2018). The government of Uzbekistan, however, lacked initiatives to bring research outcomes to the market until 2018; but a recent Presidential Decree (PQ-3855 14.07.2018) aims to increase efficiency of research outcome commercialisation.

ii. Conduct Business Process Reengineering (BPR) in organisations involved in R&D

Carrying out BPR provides an evaluation of how current business processes function, to what extent revising these procedures reduce unproductive activities of workers and boost efficiency; and how these changes should be applied to gain competitiveness and task achievement (Chen, 2001). In Kazakhstan, according to the National Education and Science concept, state and national universities were obliged to be in the list of top universities in the world (Karatayev, 2016). This improvement in ranking has been achieved through targeting at key indicators of the QS World University Rankings (QS Quacquarelli Symonds Limited, no date).

On the one hand, BPR allows R&D state-owned organisations, including national institutes and universities to function efficiently, coordinate with the Ministry of Innovative Development, and achieve national innovation policy goals. On the other hand, BPR is associated with employees' objections to change since it is a radical change, not incremental. Because a number of workers would be made redundant, this resistance is arguably the main obstacle for successful BPR. Nonetheless, as suggested by Chen (2001), the barrier can be overcome by involving employees to be affected in comprehensive re-designing process to gain their support for implementing BPR successfully. These reforms should be carried out considering human, organisational, cultural and political aspects; otherwise, the BPR will not be implemented successfully and fail to achieve its main objectives.

iii. Implementing innovative financing mechanisms to promote innovations

Since financing is of high importance for innovation and growth, finding and accessing financial resources are the crucial issues for both policymakers and innovators. One way of resolving the problem is to

establish crowdfunding[8] platforms for small ventures. Crowdfunding enables small companies or project-based initiatives to raise funds for the risky state-of-the-art projects from the public since they act as an intermediary between entrepreneurs and the community (Belleflamme et al, 2014). Furthermore, this fundraising method allows companies not only to find solutions, but also observe consumers' reaction and potential demand to the new product (Schwienbacher & Larralde, 2010). On the other hand, authors of the project, for which the fundraising campaign has been launched, will have to disclose considerable part of the project ideas to the public. This may endanger a novel and unique idea since it could be stolen with minimum effort.

iv. Providing tax incentives

The main actor in funding innovation activities in Central Asia is currently the government. Financial and fiscal incentives are fundamental prerequisites for attracting entrepreneurs to innovative activities around the globe. For instance, Korea Economic Research Institute found tax incentives to be more effective than R&D subsidies (Kang & Park, 2012). Falk (2006), similarly, found that there is a positive impact of tax incentives to stimulate private R&D expenditure in OECD countries (Frenkel et al, 2015). The private sector in Central Asia, namely Uzbekistan and Kazakhstan, should be stimulated through incentives of various forms and tax deductions to invest in R&D.

Kazakhstan designed regulations and incentives to catalyse business R&D activities and attract foreign investments (OECD, 2018). These measures, however, are insufficient and suggested to be generalised to cover more enterprises (ibid). Meanwhile, the tax system of Uzbekistan has problems related to excessive tax burden and insufficient tax impact on modernisation processes. For example, tax incentives for a simplified tax system are ineffective as subjects of simplified regimes are usually small enterprises having low R&D intensity. The practice of levying VAT under the prevailing conditions of Uzbekistan does not stimulate innovative activity since development and manufacturing of innovative products and services are time-consuming. At the same time, the amounts received in advance payments and received to the current account are subject to VAT before delivery of goods or performance of works. Current fiscal policy does not consider successful foreign experience in funding innovations.

In developed economies, firms can deduct a certain percentage of R&D expenditure from their taxable income. Australian companies, for instance, deduct 38.5% or 43.5% of R&D costs from taxable income (Australian Taxation Office, 2017). The experience of Ireland, India, China, Israel, Taiwan and Belarus in providing unprecedented tax incentives[9] has boosted economic growth and shifted economic focus to high-tech industries. The Norwegian experience of providing tax incentives to stimulate private R&D activities were successful (Hægeland & Møen, 2007). Their analysis of firm-level data unveiled companies receiving tax incentives raised R&D investments significantly, when compared to firms not receiving tax deductions.

Policy recommendation

Having analysed R&D in Uzbekistan and Kazakhstan, we identified a few policy issues and reviewed possible policy options to resolve such issues based on empirical evidence. We propose a combination of three measures: [i] stimulating public-private partnerships and international collaborations in R&D; [ii] conducting business and research process re-engineering (BPR) in state-owned R&D organisations, including universities; and [iii] attracting business R&D through tax incentives.

Universities have a great potential to generate new ideas and transfer knowledge to the market. In this case, the government should enact a legislative document to regulate ownership of publicly funded research outcomes, provide an adequate legislative basis to protect intellectual property rights and stimulate autonomy, internationalization and collaborative partnerships. The private sector should be linked to universities through techno parks or experimental labs to collaborate in searching for answers on their research questions and increase productivity by commercialising research outcomes. Technology

transfer offices, however, should not necessarily be established under businesses or universities, they can also be founded under non-governmental organisations given that they stimulate and maintain knowledge transfer channel. (Balduzzi & Rostan, Boardman & Ponomariov, Rolfo & Finardi, Chang et al, and Fu & Li, as cited in Ripoll Feliu & Díaz Rodríguez, 2017). Once the university-industry link has been established, the private sector will transfer research outcomes into new entrepreneurial activities. For example, four Korean programmes[10] of commercialising academic research to strengthen university-industry interactions, according to Kwon (2011), increased considerably enrolment rate, teaching and research funding; furthermore, being able to contribute to the economy directly enabled universities to be involved in technology licensing, patenting and spin-off activities.

The second recommendation is conducting business and research process reengineering. BPR enables state-owned R&D organisations, businesses and national institutes and universities investing in R&D to re-organise and optimise internal procedures through implementing new technologies, reducing unproductive and R&D unrelated activities. However, in this case, employees' attitude towards potential reforms has to be considered and stakeholders whom changes affect has to be involved in the re-designing process. Considering cultural, organisational and political aspects contribute to the successful BPR (Chen, 2001). Carrying out re-organisation is essential since if productivity is low, it will probably deteriorate well-developed other policy measures, thus, contributing to the failure of those policy measures.

A further policy recommendation for the government is to provide tax incentives through introducing "patent box" and a special tax regime for innovative enterprises. A number of EU countries introduced the former and it taxes at the end of the chain when the research outcome generates income. European countries' experience on the "patent box" could be useful for the Uzbek economy given that the tax regime or its individual elements are adapted to the local economic and legislative conditions. The introduction of a special tax regime for innovative enterprises would allow these organisations to solve problems related to tax accounting, reporting and tax administration. The specified special tax regime should free scientific and innovative organisations from tax on profits, single social tax, VAT (excluding imported goods) and tax on property and land. The implementation of the special tax regime will reduce overall the tax burden on innovative organisations. Previously, the funds of the scientific and innovative organisations in Uzbekistan, directed to R&D were exempted from all kinds of taxes, except for single social payment. This special regime of tax preferences was provided until 2013 (Academy of Science, no date). Resuming this successful government practice would catalyse enterprises' engagement in innovation-oriented activity.

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[6] Technical and scientific journal articles are related to the number of articles published in physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space.

[7] According the data from Ministry for Development of Information Technologies and Communications of the Republic of Uzbekistan, the total number of mobile subscribers was 22.8 million at the beginning of 2018; a monthly fee for each subscriber number is 4,000 sums in accordance with the Decree of the President of Uzbekistan PQ-3454 as of 29.12.2017;
1 USD = 8,163.46 UZS as reported by the Central Bank of Uzbekistan as of 7 March 2018.

$$Total = \frac{22.8 \cdot 10^6 \cdot 4000}{8163.46} = \text{US\$}11.17M \text{ or } 91.2bn \text{ sums}; 1\% = \$111{,}717 \text{ or } 912M \text{ sums};$$

[8] An online based collective funding instrument enabling small enterprises to attract funds at the initial phases (OECD, 2012).

[9] Introduction of "patent box" tax regime phenomenon in stimulating innovation activity through fiscal incentives is lowering tax rates for corporate revenues gained from patented products' sales. This practice has already been introduced in several European countries and China. Another example is an introduction of a specified special tax regime to release scientific and innovative organizations and research centres from tax on profits, single social tax, VAT, tax on property and land. Introducing both/either tax regime could reduce the overall tax burden of innovative firms.

[10] (i) The Brain Korea 21 project; (ii) The New University for Regional Innovation project; (iii) The Connect Korea project; and (iv) The Hub University for Industrial Collaboration project.