*Progress in Central Asia is being hampered by the low level of investment in research and development.*

**Nasibakhon Mukhitidinova**

A 'flying machine' on display at the Tashkent Innovation Fair in 2014
*Photo: © Nasibakhon Mkhitidinova*

# 14 · Central Asia

**Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan**

Nasibakhon Mukhitdinova

## INTRODUCTION

### A quick recovery from the global financial crisis

The Central Asian economies have emerged relatively unscathed from the global financial crisis of 2008–2009. Uzbekistan has recorded consistently strong growth over the past decade (over 7%) and Turkmenistan[1] even flirted with growth of 15% (14.7%) in 2011. Although Kyrgyzstan's performance has been more erratic, this phenomenon was visible well before 2008 (Figure 14.1).

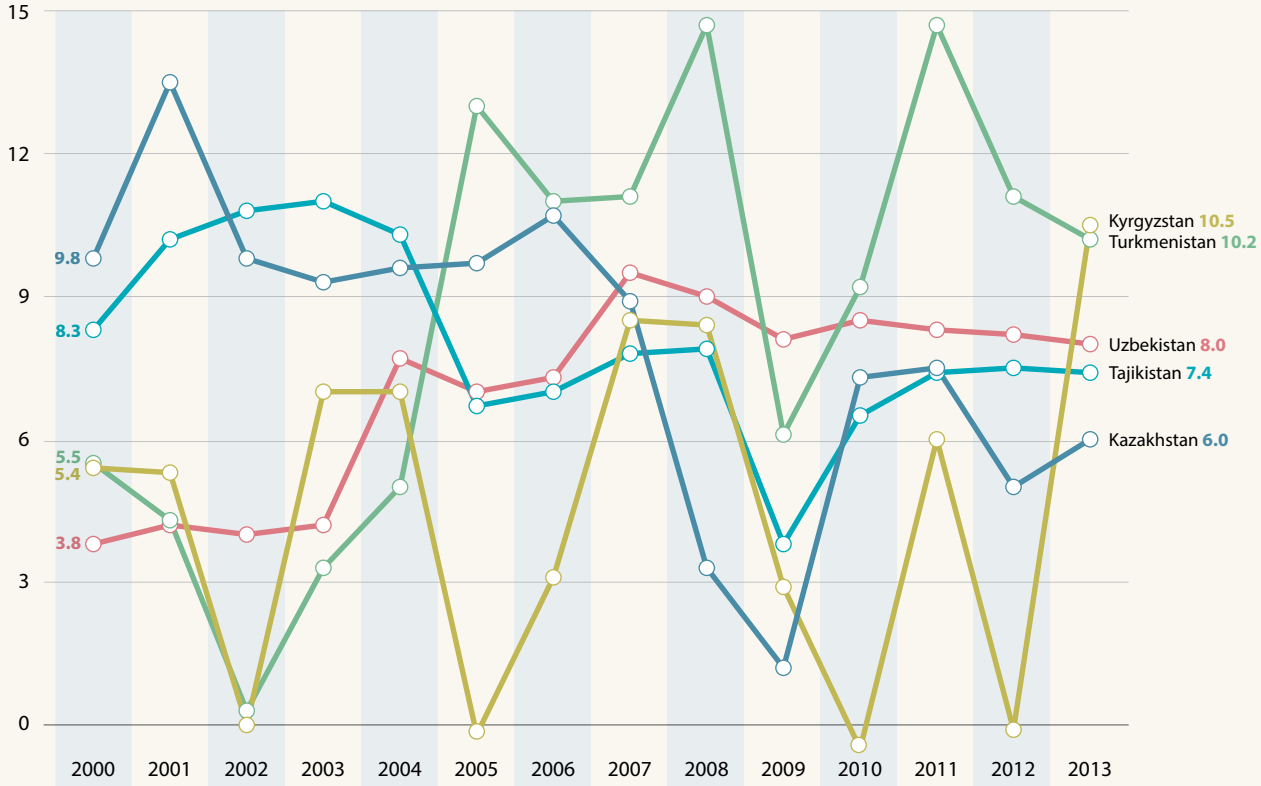
The republics which have fared best have surfed on the wave of the commodities boom. Kazakhstan and Turkmenistan have abundant oil and natural gas reserves and Uzbekistan's own reserves make it more or less self-sufficient. Kyrgyzstan, Tajikistan and Uzbekistan all have gold reserves and Kazakhstan has the world's largest uranium reserves. Fluctuating global demand for cotton, aluminium and other metals (except gold) in recent years has hit Tajikistan hardest, since aluminium and raw cotton are its chief exports – the Tajik Aluminium Company is the country's primary industrial asset. In January 2014, the Minister of Agriculture announced the government's intention to reduce the land cultivated by cotton to make way for other crops. Uzbekistan and Turkmenistan are major cotton exporters themselves, ranking fifth and ninth respectively worldwide for volume.

Although both exports and imports have grown impressively over the past decade, the countries remain vulnerable to economic shocks, owing to their reliance on exports of raw materials, a restricted circle of trading partners and a negligible manufacturing capacity. Kyrgyzstan has the added disadvantage of being considered resource poor, although it does have ample water. Most of its electricity is generated by hydropower.

The Kyrgyz economy was shaken by a series of shocks between 2010 and 2012. In April 2010, President Kurmanbek

**1**. Turkmenistan had reduced its external debt to just 1.6% of GDP by 2012 (down from 35% in 2002) and Uzbekistan's external debt is just 18.5% of GDP (2012). Kazakhstan's external debt has remained relatively stable at 66% (2012), whereas Tajikistan's external debt has climbed to 51% (up from 36% in 2008) and Kyrgyzstan's remains high at 89%, after dropping to 71% in 2009. Source: Sescric database, accessed July 2014.

Figure 14.1: **GDP growth trends in Central Asia, 2000–2013** (%)




*Source:* World Bank (2014) *Global Economic Prospects*, Table A1.1, p. 100

Bakiyev was deposed by a popular uprising, with former minister of foreign affairs Roza Otunbayeva assuring the interim presidency until the election of Almazbek Atambayev in November 2011. Food prices rose two years in a row and, in 2012, production at the major Kumtor gold mine fell by 60% after the site was perturbed by geological movements. According to the World Bank, 33.7% of the population was living in absolute poverty in 2010 and 36.8% a year later.

### A region of growing strategic importance

Former Soviet states, the Central Asian republics share a common history and culture. Situated at the crossroads of Europe and Asia, rich in mineral resources, they are of growing strategic importance. All five are members of several international bodies, including the Organization for Security and Co-operation in Europe, the Economic Cooperation Organization and the Shanghai Cooperation Organisation.[2]

Moreover, all five republics are members of the Central Asia Regional Economic Cooperation (CAREC) Program, which also includes Afghanistan, Azerbaijan, China, Mongolia and Pakistan. In November 2011, the 10 member countries adopted the *CAREC 2020 Strategy*, a blueprint for furthering regional co-operation. Over the next decade, US$ 50 billion is being invested in priority projects in transport, trade and energy to improve members' competitiveness.[3] The landlocked Central Asian republics are conscious of the need to co-operate in order to maintain and develop their transport networks and energy, communication and irrigation systems. Only Kazakhstan and Turkmenistan border the Caspian Sea and none of the republics has direct access to an ocean, complicating the transport of hydrocarbons, in particular, to world markets.

Kyrgyzstan and Tajikistan have been members of the World Trade Organization since 1998 and 2013 respectively, which Kazakhstan is also keen to join. Uzbekistan and Turkmenistan, on the other hand, have adopted a policy of self-reliance. Symptomatic of this policy is the lesser role played by foreign direct investment. In Uzbekistan, the state controls virtually all strategic sectors of the economy, including agriculture, manufacturing and finance, foreign investors being relegated to less vital sectors like tourism (Stark and Ahrens, 2012).

On 29 May 2014, Kazakhstan signed an agreement with Belarus and the Russian Federation creating the Eurasian Economic Union. They were joined by Armenia in October 2014 and by Kyrgyzstan in December 2014. The Union came into effect on 1 January 2015, four years after the initial Customs Union had removed trade barriers between the three founding countries. Although the agreement focuses on economic co-operation, it includes provision for the free circulation of labour and unified patent regulations, two dispositions which may benefit scientists.[4]

### Central Asian snow leopards not for tomorrow

Since gaining independence two decades ago, the republics have gradually been moving from a state-controlled economy to a market economy. The ultimate aim is to emulate the Asian Tigers by becoming the local equivalent, Central Asian snow leopards. However, reform has been deliberately gradual and selective, as governments strive to limit the social cost and ameliorate living standards in a region with a population growing by 1.4% per year on average.

All five countries are implementing structural reforms to improve competitiveness. In particular, they have been modernizing the industrial sector and fostering the development of service industries through business-friendly fiscal policies and other measures, to reduce the share of agriculture in GDP (Figure 14.2). Between 2005 and 2013, the share of agriculture dropped in all but Tajikistan, where it progressed to the detriment of industry. The fastest growth in industry was observed in Turkmenistan, whereas the services sector progressed most in the other four countries.

Public policies pursued by Central Asian governments focus on buffering the political and economic spheres from external shocks. This includes maintaining a trade balance, minimizing public debt and accumulating national reserves. They cannot totally insulate themselves from negative exterior forces, however, such as the persistently weak recovery of global industrial production and international trade since 2008.

According to Spechler (2008), privatization has proceeded fastest in Kazakhstan, with two-thirds of all firms being privately owned by 2006. Prices are almost completely market-based and banking and other financial institutions are much better established than elsewhere in the region. The government can dialogue with private enterprises through Atameken, an association of more than 1 000 enterprises from different sectors, and with foreign investors through the Foreign Investors' Council, set up in 1998. Kazakhstan nevertheless remains attached to state-led capitalism, with state-owned companies remaining dominant in strategic industries. When the global financial crisis hit in 2008, the Kazakh government reacted by stepping up its involvement in the economy, even though it had created a wealth fund, Samruk–Kazyna, the same year to further the privatization of state-controlled businesses (Stark and Ahrens, 2012).

**2**. See Annex 1 for the membership of international bodies mentioned here, p. 736.

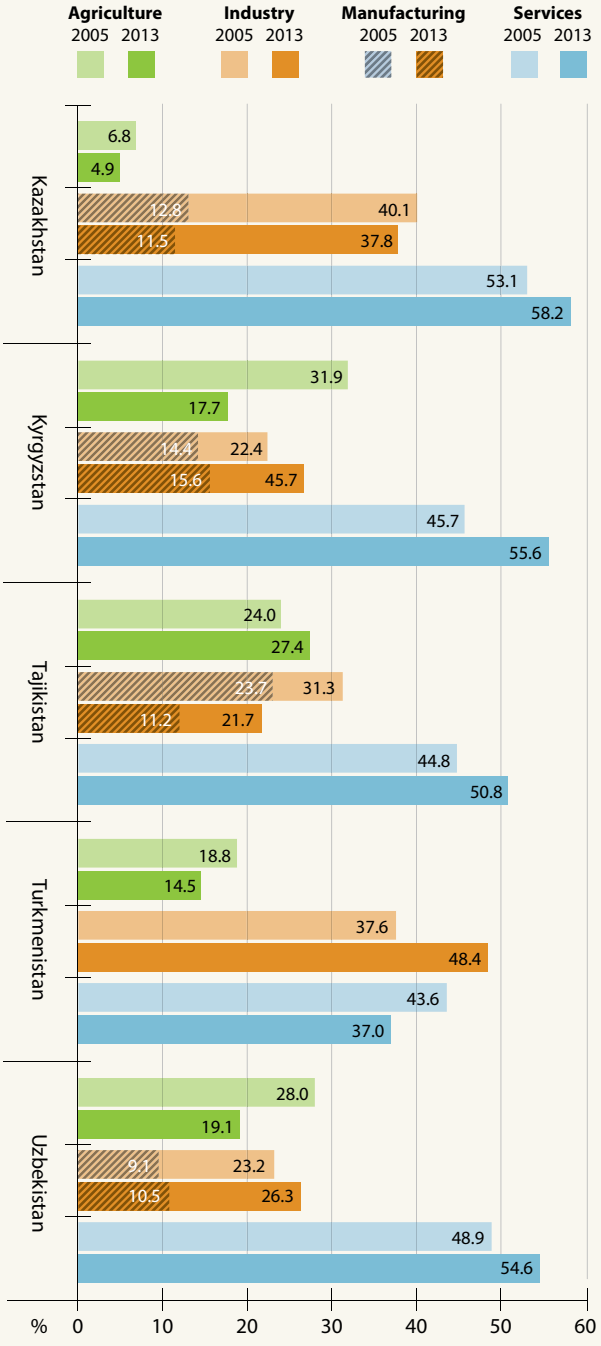
**3**. CAREC was founded in 1997. It partnered with six multilateral institutions in 2003 to help mainstream regional co-operation in transport, trade and energy, including infrastructure development: the Asian Development Bank (providing the secretariat since 2001); European Bank for Reconstruction and Development; International Monetary Fund; Islamic Development Bank; UNDP and; World Bank.

**4**. When the Eurasian Economic Union came into effect on 1 January 2015, the Eurasian Economic Community ceased to exist.

### High literacy and medium development

Despite high rates of economic growth in recent years, GDP per capita in Central Asia was higher than the average for developing countries only in Kazakhstan in 2013 (PPP$ 23 206) and Turkmenistan (PPP$ 14 201). It dropped to PPP$ 5 167 for Uzbekistan, home to 45% of the region's population, and was even lower for Kyrgyzstan and Tajikistan.

Figure 14.2: **GDP in Central Asia by economic sector, 2005 and 2013** (%)




*Note:* For Turkmenistan, the most recent data are for 2012.

*Source:* World Bank's *World Development Indicators,* September 2014

All adult Central Asians are literate and a person born today can expect to live 67.8 years on average. UNDP considers Central Asia as having a medium level of human development. Kazakhstan's ranking in the Human Development Index improved by as much as 13 points between 2009 and 2013, compared to 7 points for Turkmenistan and 5 for Uzbekistan. Kyrgyzstan's ranking actually dropped 5 points.

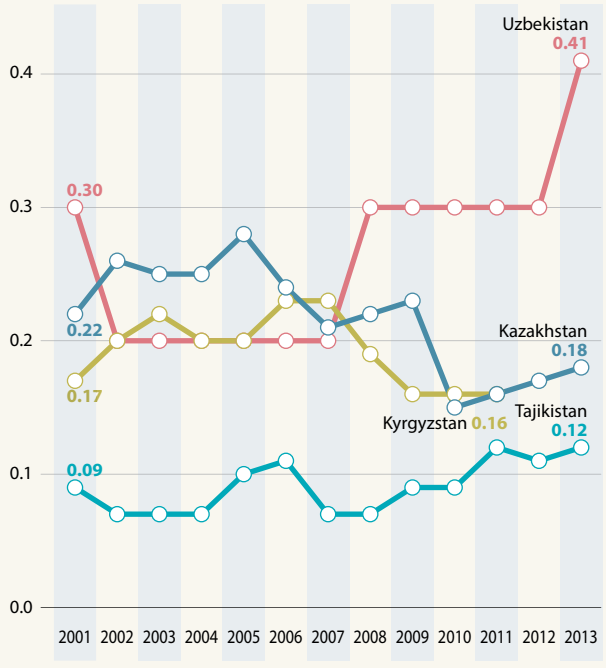
In 2013, the Earth Institute made an effort to measure the extent of happiness in 156 countries. Kazakhs (57th), Turkmens (59th) and Uzbeks (60th) were found to be happier than most, unlike the Kyrgyz (89th) and, above all, Tajiks (125th).

## TRENDS IN EDUCATION AND RESEARCH

### Persistently low investment in R&D

Common among the Central Asian republics is the persistently low investment in R&D. In the past decade, Kazakhstan and Kyrgyzstan have struggled to maintain gross domestic expenditure on R&D (GERD) at 0.2% of GDP. Uzbekistan's R&D effort intensified in 2013 to 0.4% of GDP (Figure 14.3). Kazakhstan has announced plans to hoist its own GERD/GDP ratio to 1% by 2015 (see p. 373), a target that will be hard to attain as long as annual economic growth remains strong.

Figure 14.3: **Trends in GERD/GDP ratio in Central Asia, 2001–2013**




*Note:* Data are unavailable for Turkmenistan.

*Source:* UNESCO Institute for Statistics database, July 2014; for Uzbekistan, Committee for Co-ordination of Science and Technology Development

### A focus on university and research infrastructure

The governments of Central Asia have adopted the same policy of gradual, selective reforms when it comes to science and technology (S&T). Only two research institutions opened in the region between 2009 and 2014, bringing the total to 838. Both are situated in Uzbekistan (see p. 386).

The other countries actually halved the number of their research institutions between 2009 and 2013. This is because centres set up during the Soviet period to solve national problems have become obsolete with the development of new technologies and changing national priorities. Kazakhstan and Turkmenistan are both building technology parks and grouping existing institutions to create research hubs. Bolstered by strong economic growth in all but Kyrgyzstan, national development strategies are focusing on nurturing new high-tech industries, pooling resources and orienting the economy towards export markets.

Three universities have been set up in Central Asia in recent years to foster competence in strategic economic areas: Nazarbayev University in Kazakhstan (first student intake in 2011), Inha University in Uzbekistan, specializing in ICTs, and the International Oil and Gas University in Turkmenistan (2014 for both). Countries are not only bent on increasing the efficiency of traditional extractive sectors; they also wish to make greater use of ICTs and other modern technologies to develop the business sector, education and research. Internet access varies widely from one country to another. Whereas every second Kazakh (54%) and one in three Uzbeks (38%) were connected in 2013, this proportion is as low as 23% in Kyrgyzstan, 16% in Tajikistan and just 10% in Turkmenistan.

## Box 14.1: **Three neighbourhood schemes**

The following three programmes illustrate how the European Union (EU) and Eurasian Economic Community have been encouraging Central Asian scientists to collaborate with their neighbours.

*STI International Cooperation Network for Central Asia (IncoNet CA)*

IncoNet CA was launched by the EU in September 2013 to encourage Central Asian countries to participate in research projects within Horizon 2020, the EU's eighth research and innovation funding programme (see Chapter 9). The focus of the research projects is on three societal challenges considered as being of mutual interest to both the EU and Central Asia, namely: climate change, energy and health. IncoNet CA builds on the experience of earlier EU projects which involved other regions, such as Eastern Europe, the South Caucasus and the Western Balkans (see Chapter 12).

IncoNet CA focuses on twinning research facilities in Central Asia and Europe. It involves a consortium of partner institutions from Austria, the Czech Republic, Estonia, Germany, Hungary, Kazakhstan, Kyrgyzstan, Poland, Portugal, Tajikistan, Turkey and Uzbekistan. In May 2014, the EU launched a 24-month call for applications from twinned institutions – universities, companies and research institutes – for funding of up to € 10 000 to enable them to visit one another's facilities to discuss project ideas or prepare joint events like workshops. The total budget within IncoNet CA amounts to € 85 000.

*Innovative Biotechnologies Programme*

The Innovative Biotechnologies Programme (2011–2015) involves Belarus, Kazakhstan, the Russian Federation and Tajikistan. Within this programme established by the Eurasian Economic Community, prizes are awarded at an annual bio-industry exhibition and conference. In 2012, 86 Russian organizations participated, plus three from Belarus, one from Kazakhstan and three from Tajikistan, as well as two scientific research groups from Germany.

Vladimir Debabov, Scientific Director of the Genetica State Research Institute for Genetics and the Selection of Industrial Micro-organisms in Russia, stressed the paramount importance of developing bio-industry. 'In the world today, there is a strong tendency to switch from petrochemicals to renewable biological sources,' he said. 'Biotechnology is developing two to three times faster than chemicals.'

*Centre for Innovative Technologies*

The Centre for Innovative Technologies is another project of the Eurasian Economic Community. It came into being on 4 April 2013, with the signing of an agreement between the Russian Venture Company (a government fund of funds), the Kazakh JSC National Agency and the Belarusian Innovative Foundation. Each of the selected projects is entitled to funding of US$ 3–90 million and is implemented within a public–private partnership. The first few approved projects focused on supercomputers, space technologies, medicine, petroleum recycling, nanotechnologies and the ecological use of natural resources. Once these initial projects have spawned viable commercial products, the venture company plans to reinvest the profits in new projects.

The venture company is not a purely economic structure; it has also been designed to promote a common economic space among the three participating countries.

*Source:* www.inco-ca.net; www.expoforum.ru/en/presscentre/2012/10/546; www.gknt.org.by

All three new universities teach in English and work with partner universities in the USA, Europe or Asia on academic programme design, quality assurance, faculty recruitment and student admissions.

International co-operation is also a strong focus of the research institutes and hubs set up in recent years (Boxes 14.1–14.5). The mandate of these centres reflects a will to adopt a more sustainable approach to environmental management. Centres plan to combine R&D in traditional extractive industries, for instance, with a greater use of renewable energy, particularly solar.

In June 2014, the headquarters of the International Science and Technology Center (ISTC) were moved to Nazarbayev University in Kazakhstan, three years after the Russian Federation announced its withdrawal from the centre. Permanent facilities within the new Science Park at Nazarbayev University should be completed by 2016. ISTC was established in 1992 by the European Union (EU), Japan, the Russian Federation and the USA to engage weapons scientists in civilian R&D projects[5] and to foster technology transfer. ISTC branches have been set up in the following countries party to the agreement: Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan and Tajikistan (Ospanova, 2014).

## Countries at different stages of education reform

Kazakhstan devotes less to education (3.1% of GDP in 2009) than either Kyrgyzstan (6.8% in 2011) or Tajikistan (4.0% in 2012) but the needs are greater in the latter two countries, which have lower standards of living. Both Kyrgyzstan and Tajikistan have introduced national strategies to correct such structural weaknesses as ill-equipped schools and universities, inadequate curricula and poorly trained teaching staff.

Kazakhstan has made great strides in improving the quality of education over the past decade. It now plans to generalize quality education by raising the standard of all secondary schools to the level of its Nazarabayev Intellectual Schools by 2020, which foster critical thinking, autonomous research and proficiency in Kazakh, English and Russian. The Kazakh government has also pledged to increase university scholarships by 25% by 2016. The higher education sector performed 31% of GERD in 2013 and employed more than half (54%) of researchers (Figure 14.5). The new Nazarbayev University has been designed as an international research university (see p. 378).

Kazakhstan and Uzbekistan are both generalizing the teaching of foreign languages at school, in order to facilitate international ties. Kazakhstan and Uzbekistan have both adopted the three-tier bachelor's, master's and PhD degree system, in 2007 and 2012 respectively, which is gradually replacing the Soviet system of Candidates and Doctors of Science (Table 14.1). In 2010, Kazakhstan became the only Central Asian member of the Bologna Process, which seeks to harmonize higher education systems in order to create a European Higher Education Area.[6] Several higher education institutions in Kazakhstan (90 of which are private) are members of the European University Association.

**5**. In the past 20 years, ISTC has provided competitive funding for about 3 000 projects in basic and applied research in energy, agriculture, medicine, materials science, aerospace, physics, etc. Scientists from member countries interact with one another, as well as with international centres such as the European Organization for Nuclear Research (CERN) and with multinationals that include Airbus, Boeing, Hitachi, Samsung, Philips, Shell and General Electric (Ospanova, 2014).

**6**. Other non-European Union members of the Bologna Process include the Russian Federation (since 2003), Georgia and Ukraine (since 2005). The applications for membership by Belarus and Kyrgyzstan have not been accepted.

Table 14.1: **PhDs obtained in science and engineering in Central Asia, 2013 or closest year**

| | PhDs | | PhDs in science | | | | PhDs in engineering | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Women % | Total | Women % | Total per million population | Women PhDs per million population | Total | Women % | Total per million population | Women PhDs per million population |
| **Kazakhstan** (2013) | 247 | 51 | 73 | 60 | 4.4 | 2.7 | 37 | 38 | 2.3 | 0.9 |
| **Kyrgyzstan** (2012) | 499 | 63 | 91 | 63 | 16.6 | 10.4 | 54 | 63 | — | — |
| **Tajikistan** (2012) | 331 | 11 | 31 | — | 3.9 | — | 14 | — | — | — |
| **Uzbekistan** (2011) | 838 | 42 | 152 | 30 | 5.4 | 1.6 | 118 | 27 | — | — |

*Note:* PhD graduates in science cover life sciences, physical sciences, mathematics and statistics, and computing; PhDs in engineering also cover manufacturing and construction. For Central Asia, the generic term of PhD also encompasses Candidate of Science and Doctor of Science degrees. Data are unavailable for Turkmenistan.

*Source:* UNESCO Institute for Statistics, January 2015

Table 14.2: **Central Asian researchers by field of science and gender, 2013 or closest year**

| | Total researchers (HC) | | | | Researchers by field of science (HC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Natural Sciences | | Engineering and technology | | Medical and health sciences | | Agricultural sciences | | Social sciences | | Humanities | |
| | Total researchers | Per million pop. | Number of women | Women (%) | Total | Women (%) | Total | Women (%) | Total | Women (%) | Total | Women (%) | Total | Women (%) | Total | Women (%) |
| **Kazakhstan** (2013) | 17 195 | 1 046 | 8 849 | 51.5 | 5 091 | 51.9 | 4 996 | 44.7 | 1 068 | 69.5 | 2 150 | 43.4 | 1 776 | 61.0 | 2 114 | 57.5 |
| **Kyrgyzstan** (2011) | 2 224 | 412 | 961 | 43.2 | 593 | 46.5 | 567 | 30.0 | 393 | 44.0 | 212 | 50.0 | 154 | 42.9 | 259 | 52.1 |
| **Tajikistan** (2013) | 2 152 | 262 | 728 | 33.8 | 509 | 30.3 | 206 | 18.0 | 374 | 67.6 | 472 | 23.5 | 335 | 25.7 | 256 | 34.0 |
| **Uzbekistan** (2011) | 30 890 | 1 097 | 12 639 | 40.9 | 6 910 | 35.3 | 4 982 | 30.1 | 3 659 | 53.6 | 1 872 | 24.8 | 6 817 | 41.2 | 6 650 | 52.0 |

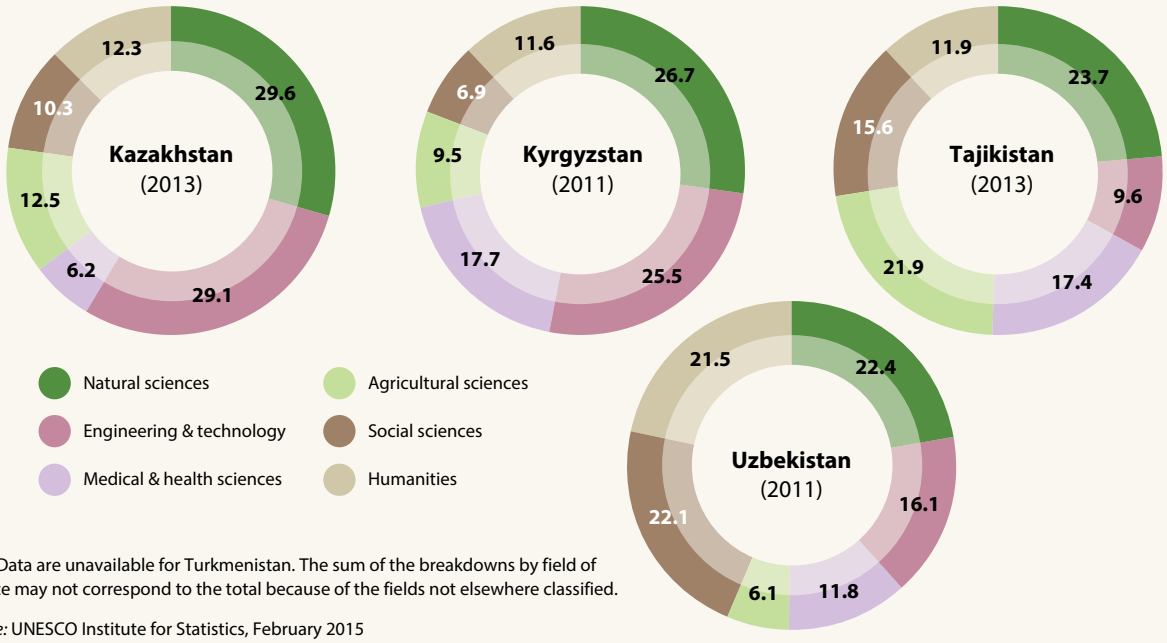
*Note:* Data are unavailable for Turkmenistan. The sum of the breakdowns by field of science may not correspond to the total because of the fields not elsewhere classified.

*Source:* UNESCO Institute for Statistics, February 2015

Kazakhstan is the only Central Asian country where the business enterprise and private non-profit sectors make any significant contribution to R&D (Figure 14.5). Uzbekistan is in a particularly vulnerable position, with its heavy reliance on higher education: three-quarters of researchers are employed by the university sector, at a time when many are approaching retirement age and 30% of the younger generation hold no degree qualification at all.

Kazakhstan, Kyrgyzstan and Uzbekistan have all maintained a share of women researchers above 40% since the fall of the Soviet Union. Kazakhstan has even achieved gender parity, with Kazakh women dominating medical and health research and representing some 45–55% of engineering and technology researchers in 2013 (Table 14.2). In Tajikistan, however, only one in three scientists (34%) was a woman in 2013, down from 40% in 2002. Although policies are in place to give Tajik women equal rights and opportunities, these are underfunded and poorly understood (see p. 381). Turkmenistan has offered a state guarantee of equality for women since a law adopted in 2007 but the lack of available data makes it impossible to draw any conclusions as to the law's impact on research.

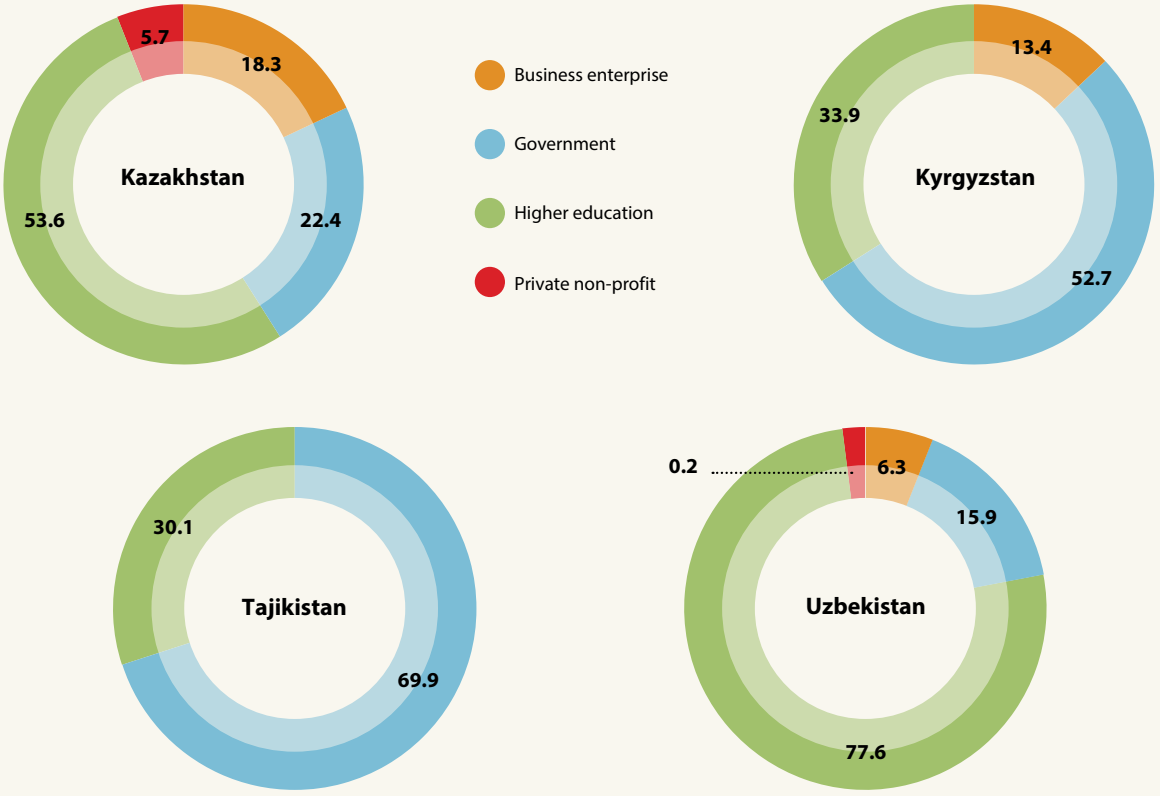
**Figure 14.4: Central Asian researchers by field of science, 2013 (%)**




*Note:* Data are unavailable for Turkmenistan. The sum of the breakdowns by field of science may not correspond to the total because of the fields not elsewhere classified.

*Source:* UNESCO Institute for Statistics, February 2015

Figure 14.5: **Central Asian researchers by sector of employment (HC), 2013** (%)




*Note:* For Kyrgyzstan and Uzbekistan, the most recent data are for 2011. Data are unavailable for Turkmenistan.

*Source:* UNESCO Institute for Statistics, February 2015



## Kazakhstan leads the region for scientific productivity

Despite persistently low investment in R&D among the Central Asian republics, national development strategies are nonetheless focusing on developing knowledge economies and new high-tech industries. Trends in scientific productivity are useful indicators of whether these strategies are having an impact or not. As Figure 14.6 shows, the number of scientific papers published in Central Asia grew by almost 50% between 2005 and 2013, driven by Kazakhstan, which overtook Uzbekistan over this period. Kazakhstan and Uzbekistan both specialize in physics, followed by chemistry, which also happens to be Tajikistan's speciality. Kyrgyzstan, on the other hand, publishes most in geosciences and Turkmenistan most in mathematics. Articles related to agriculture trail far behind and are almost non-existent in computer sciences.

Of note are the strong international ties of Central Asian scientists – but not with each other. At least two out of every three articles were co-authored by foreign partners in 2013. The biggest change has occurred in Kazakhstan, suggesting that international partnerships have driven the steep rise in Kazakh publications recorded in the Science Citation Index since 2008. The three main partners of Central Asian scientists are based in the Russian Federation, Germany and the USA, in that order. Kyrgyz scientists are the only ones who publish a sizeable share of their articles with their peers from another Central Asian country, namely Kazakhstan.

The number of patents registered at the US Patent and Trademark Office is minimal. Kazakh inventors were granted just five patents by this office between 2008 and 2013 and Uzbek inventors three. No patents at all were recorded for the other three Central Asian republics.

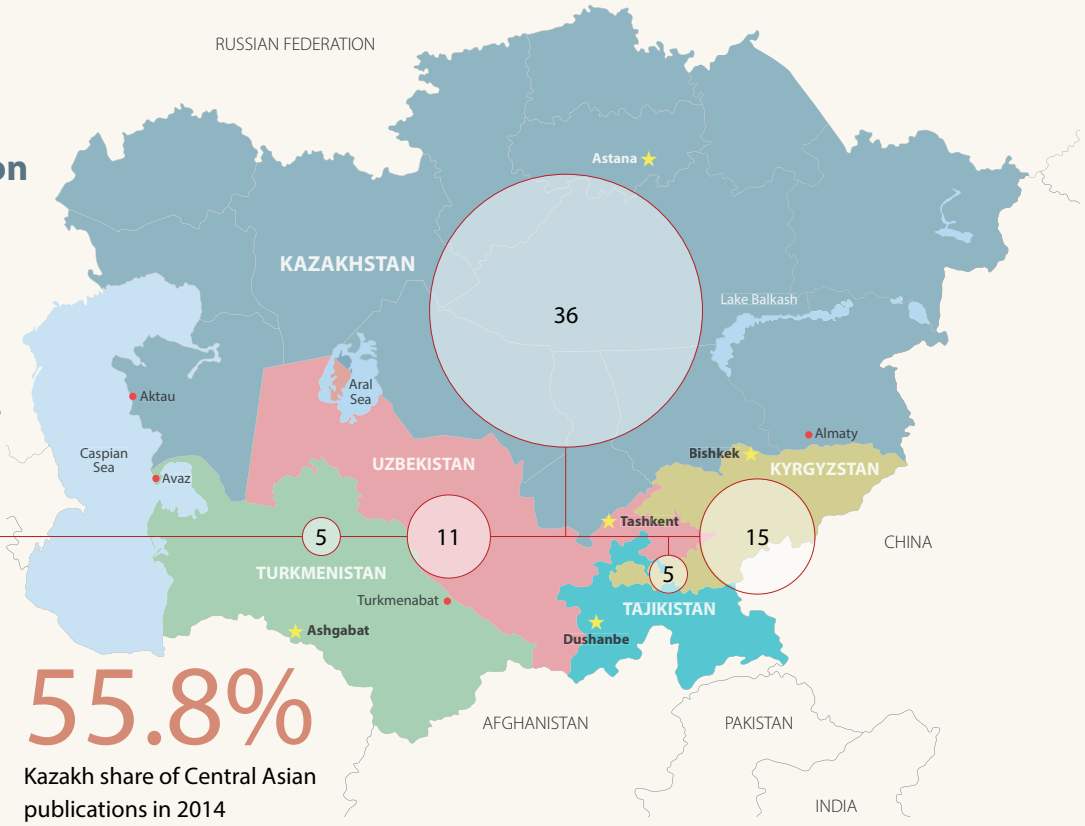
Kazakhstan is Central Asia's main trader in high-tech products. Kazakh imports nearly doubled between 2008 and 2013, from US$ 2.7 billion to US$ 5.1 billion. There has been a surge in imports of computers, electronics and telecommunications; these products represented an investment of US$ 744 million in 2008 and US$ 2.6 billion five years later. The growth in exports was more gradual – from US$ 2.3 billion to US$ 3.1 billion – and dominated by chemical products (other than pharmaceuticals), which represented two-thirds of exports in 2008 (US$ 1.5 billion) and 83% (US$ 2.6 billion) five years later.

Figure 14.6:

# Scientific publication trends in Central Asia, 2005–2014

## Kazakhstan publishes most but output remains modest

*Publications per million inhabitants, 2014*



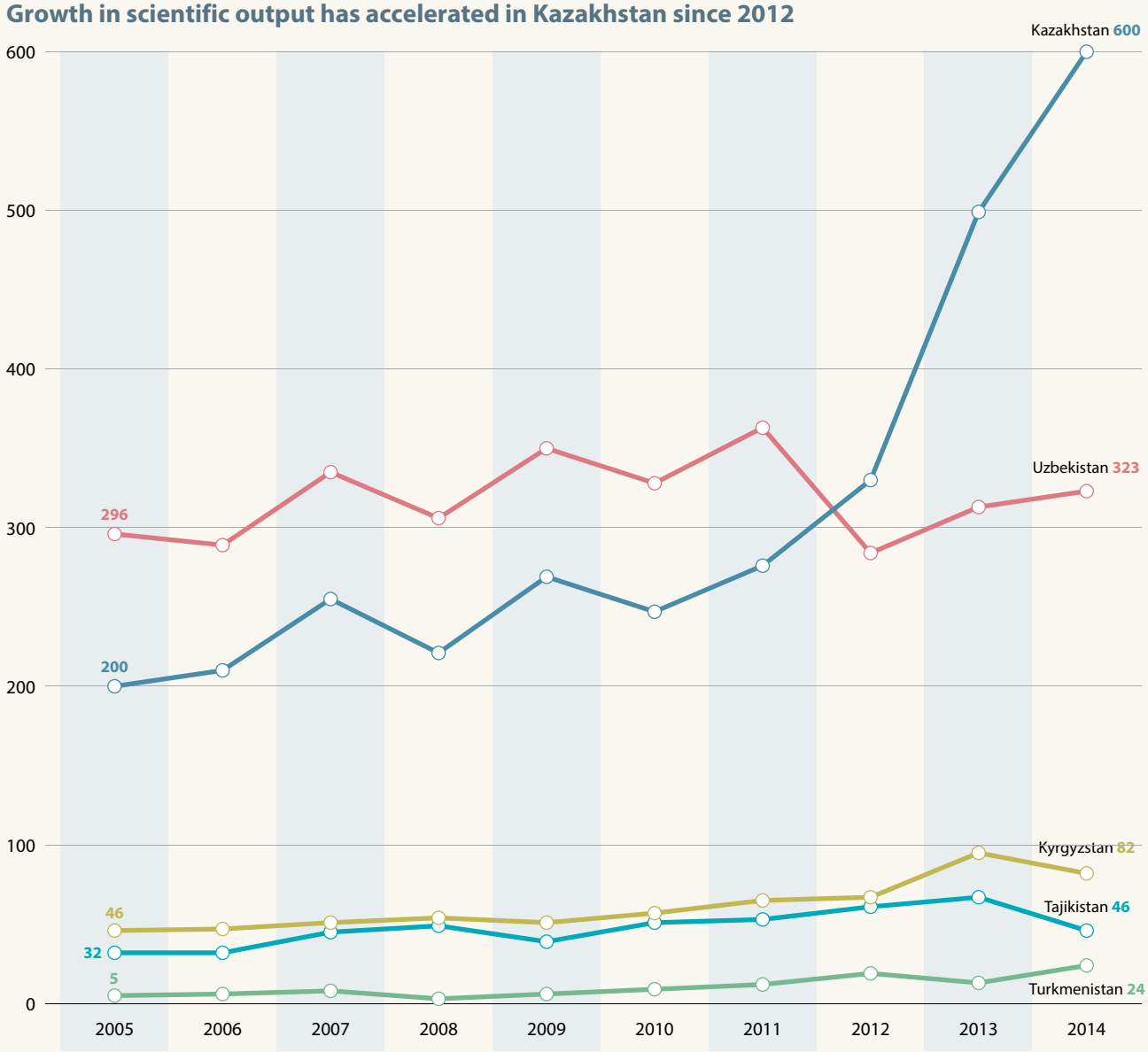

**34.5%**

Kazakh share of Central Asian publications in 2005

**55.8%**

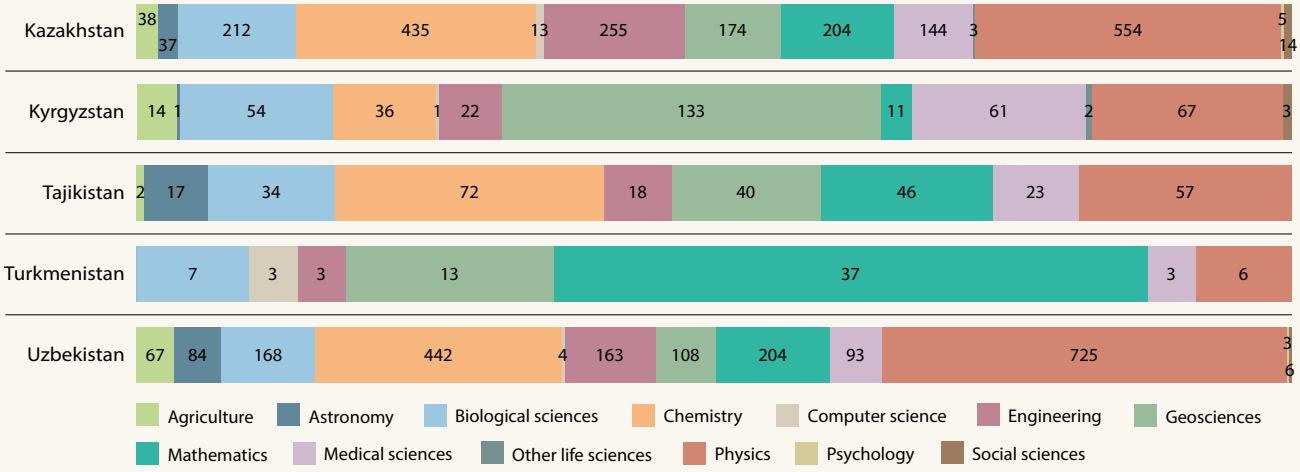
Kazakh share of Central Asian publications in 2014

## Growth in scientific output has accelerated in Kazakhstan since 2012



## The most prolific countries – Kazakhstan and Uzbekistan – specialize in physics and chemistry

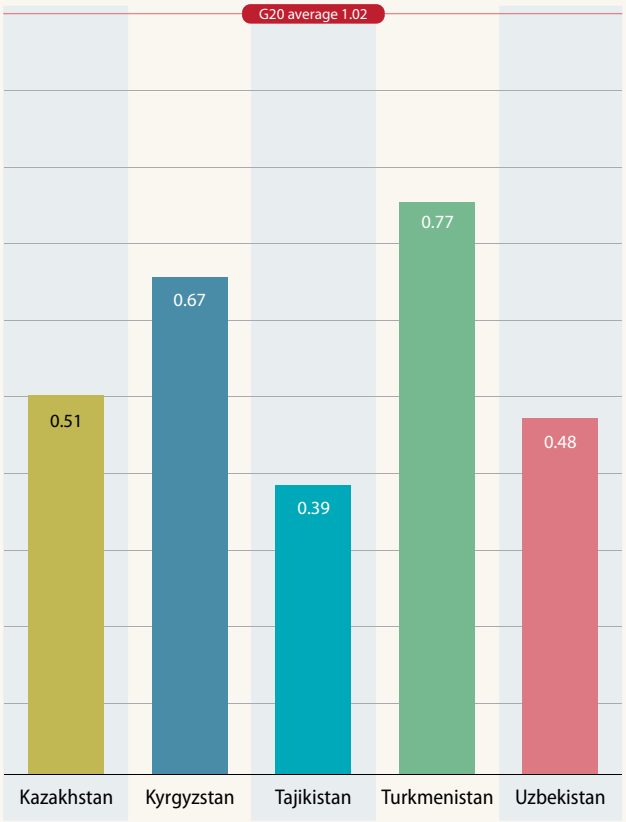
*Cumulative totals by field, 2008–2014*



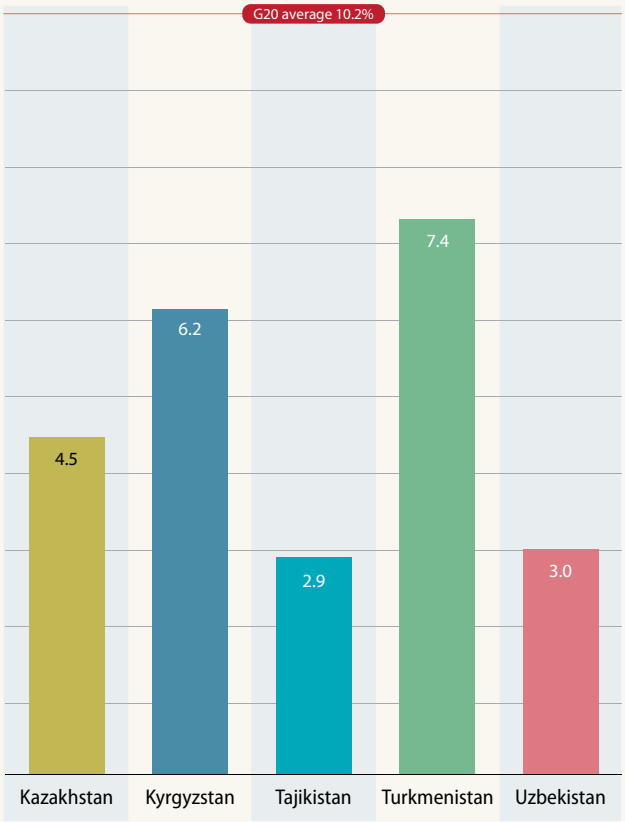

*Note:* Totals exclude unclassified articles.

## The average citation rate is low

*Average citation rate for publications, 2008–2012*




*Share of publications among 10% most cited, 2008–2012 (%)*




## The Russian Federation, Germany and the USA are the region's top partners

*Main foreign partners, 2008–2014 (number of papers)*

| | 1st collaborator | 2nd collaborator | 3rd collaborator | 4th collaborator | 5th collaborator |
|---|---|---|---|---|---|
| **Kazakhstan** | Russian Fed. (565) | USA (329) | Germany (240) | UK (182) | Japan (150) |
| **Kyrgyzstan** | Russian Fed. (99) | Turkey/Germany (74) | | USA (56) | Kazakhstan (43) |
| **Tajikistan** | Pakistan (68) | Russian Fed. (58) | USA (46) | Germany (26) | UK (20) |
| **Turkmenistan** | Turkey (50) | Russian Fed. (11) | USA/Italy (6) | | China/Germany (4) |
| **Uzbekistan** | Russian Fed. (326) | Germany (258) | USA (198) | Italy (131) | Spain (101) |

*Source:* Thomson Reuters' Web of Science, Science Citation Index Expanded; data treatment by Science–Metrix

# COUNTRY PROFILES

## KAZAKHSTAN

### Little industrial R&D

Kazakhstan devoted 0.18% of GDP to research and development (R&D) in 2013, down from 0.23% in 2009 and a decadal high of 0.28% in 2005. The economy has grown faster (Figure 14.1) than gross domestic expenditure on R&D (GERD), which only progressed from PPP$ 598 million to PPP$ 714 million between 2005 and 2013.

In 2011, the business enterprise sector financed half of all research (52%), the government one-quarter (25%) and higher education one-sixth (16.3%). Since 2007, the share of the business sector in research has progressed from 45%, to the detriment of the government share, down from 37%. The share of the private non-profit sector has climbed from barely 1% in 2007 to 7% four years later.

Research remains largely concentrated in the country's largest city and former capital, Almaty, home to 52% of R&D personnel (UNECE, 2012). As we have seen, public research is largely confined to institutes, with universities making only a token contribution. Research institutes receive their funding from national research councils under the umbrella of the Ministry of Education and Science. Their output, however, tends to be disconnected from market needs.

Few industrial enterprises in Kazakhstan conduct R&D themselves. Investment in R&D by the business enterprise sector represented just 0.05% of GDP in 2013. Even those engaged in modernizing their production lines feel disinclined to invest in the purchase of products resulting from R&D. Only one in eight (12.5%) manufacturing firms was active in innovation[7] in 2012, according to a survey by the UNESCO Institute for Statistics.

Paradoxically, enterprises spent 4.5 times more on scientific and technological services in 2008 than in 1997, suggesting a growing demand for R&D products. Most enterprises prefer to invest in 'turnkey' projects which embody technological solutions in imported machinery and equipment. Just 4% of firms purchase the license and patents that come with this technology (Government of Kazakhstan, 2010).

### A fund for science to accelerate industrialization

In 2006, the government set up the Science Fund within the State Programme for Scientific Development 2007–2012, in order to encourage market-oriented research by fostering collaboration with private investors. According to the United Nations Commission for Europe (UNECE, 2012), about 80% of the funds disbursed go to research institutes. The fund provides grants and loans for projects in applied research in priority areas for investment, as identified by the government's High Scientific Technology Committee, which is headed by the prime minister. For the period 2007–2012, these were:

- hydrocarbons, mining and smelting sectors and correlated service areas (37%);
- biotechnologies (17%);
- information and space technologies (11%);
- nuclear and renewable energy technologies (8%);
- nanotechnologies and new materials (5%);
- other (22%).

The State Programme for Scientific Development 2007–2012 stipulated that the Science Fund should channel 25% of all science funding by 2010 (UNECE, 2012). However, after the global financial crisis hit in 2008, the government's contribution to the fund dropped. The fund adapted by offering more flexible terms, such as interest- and tax-free loans, and by extending the loan period up to 15 years. In parallel, Kazakh scientists were encouraged to reach out to Western partners.

### A law which could transform Kazakh science

In February 2011, Kazakhstan adopted the Law on Science. Encompassing education, science and industry, the law propelled leading researchers to the highest echelons of the decision-making process. It established national research councils in priority areas, comprised of both Kazakh and foreign scientists. The decisions adopted by national research councils are executed by the Ministry of Education and Science and line ministries.

The law prioritized the following areas: energy research; innovative technologies in the processing of raw materials; ICTs; life sciences; and basic research (Sharman, 2012).

It introduced three streams of research funding:

- basic funding to support scientific infrastructure, property and salaries;
- grant funding to support research programmes; and
- programme-targeted funding to resolve strategic challenges.

The originality of this funding framework is that public research institutions and universities may use the funding to invest in scientific infrastructure and utilities, information and communication tools and to cover staffing costs. Funding is disbursed via calls for proposals and tenders.

7. Firms qualify as active in innovation if their activity has led to the implementation of a product or process innovation, or if the firm is performing ongoing innovation or has recently abandoned innovation.

The Law on Science established a system of peer review for research grant applications from universities and research institutes. These competitive grants are examined by the national research councils. The government also plans to increase the share of funding for applied research to 30% and that for experimental development to 50%, leaving 20% for basic research. The law introduced a change to the tax code which reduces corporate income tax by 150% to compensate for businesses' R&D expenditure. In parallel, the law extends intellectual property protection. In addition, public and private enterprises are eligible for state loans, so as to encourage the commercialization of research results and attract investment.

In order to ensure coherence, independence and transparency in the management of STI projects and programmes, the government created the National Centre for State Scientific and Technical Expertise in July 2011. A joint stock company, the centre runs the national research councils, monitors ongoing projects and programmes and evaluates their impact, while maintaining a project database.

### Long-term planning for coherent development

The *Kazakhstan 2030 Strategy* was adopted by presidential decree in 1997. Apart from national security and political stability, it focuses on growth based on an open-market economy with a high level of foreign investment, as well as on health, education, energy, transport communication infrastructure and professional training.

After the first medium-term implementation plan expired in 2010, Kazakhstan rolled out a second plan to 2020. It focuses on accelerating diversification of the economy through industrialization and infrastructure development; the development of human capital; better social services, including housing; stable international relations; and stable interethnic relations.[8]

Two programmes underpin the *Strategic Plan to 2020*, the State Programme for Accelerated Industrial and Innovative Development and the State Programme for Educational Development, both adopted by decree in 2010. The latter is designed to ensure access to quality education and fixes a number of targets (Table 14.3). The former focuses on the twin goals of diversifying the economy and improving Kazakhstan's competitiveness by creating an environment more conducive to industrial development and developing priority economic sectors, including via effective interaction between the government and business sectors. Kazakhstan's economic priorities to 2020 are agriculture, mining and metallurgical complexes, the energy sector, oil and gas, engineering, information and communication technologies (ICTs), chemicals and petrochemicals. One of the most ambitious targets of the State Programme for Accelerated Industrial and Innovative Development is to raise the country's GERD/GDP ratio to 1% by 2015 (Table 14.3).

UNECE (2012) observes that innovation expenditure more than doubled in Kazakhstan between 2010 and 2011, representing KZT 235 billion (*circa* US$ 1.6 billion), or around 1.1% of GDP. Some 11% of the total was spent on R&D. This compares to about 40–70% of innovation expenditure in developed countries. UNECE (2012) attributes this augmentation to a sharp rise in product design and the introduction of new services and production methods over this period, to the detriment of the acquisition of machinery and equipment which has traditionally made up the bulk of Kazakhstan's innovation expenditure. Training costs represented just 2% of innovation expenditure, a much lower share than in developed countries.

### Using innovation to modernize the economy

Within the State Programme for Accelerated Industrial and Innovative Development, a law was adopted in January 2012 to provide state support for industrial innovation; it establishes the legal, economic and institutional bases for industrial innovation in priority sectors of the economy and identifies means of state support.

Within the same programme, the Ministry of Industry and New Technologies has developed an *Inter-industry Plan* to stimulate innovation through the provision of grants, engineering, services, business incubators and so on.

The Council on Technology Policy, established in 2010 within the same programme, is responsible for formulating and implementing the state policy on industrial innovation. The National Agency for Technological Development – established in 2011 – co-ordinates technology programmes and government support. It carries out foresight exercises and planning, monitors programmes, maintains a database on innovation projects and their commercialization, manages relevant infrastructure and co-operates with international bodies to obtain information, education and funding.

The main focus of innovation policy for the first three years (2011–2013) is to make enterprises more efficient through technology transfer, technological modernization, the development of business acumen and the introduction of relevant technologies. The following two years will be devoted to developing new competitive products and processes for manufacture. The focus will be on developing project finance, including through joint ventures. In parallel, efforts will be made to organize public events, such as seminars and exhibitions, to expose the public to innovation and to innovators.

**8**. According to the 2009 census, Kazakhs make up 63% of the population and ethnic Russians 24%. Small minorities (less than 3%) make up the remainder, including Uzbeks, Ukrainians, Belarusians and Tatars.

Table 14.3: **Kazakhstan's development targets to 2050**

| **KAZAKHSTAN 2030 STRATEGY** Targets to 2020 | | **KAZAKHSTAN 2050 STRATEGY** Targets to 2050 |
|---|---|---|
| State Programme for Educational Development, 2011–2020 | State Programme for Accelerated Industrial and Innovative Development, 2011–2014 | |
| ■ Kazakhstan to possess the requisite human resources for the development of a diversified economy and infrastructure;<br>■ Completion of transition to a 12-year education model;<br>■ 100% of 3–6 year olds to be provided with pre-school education;<br>■ 52% of teachers to hold a bachelor's or master's degree (or equivalent);<br>■ 90% of secondary schools to use an e-learning system;<br>■ Secondary schools to be of the same quality as the Nazarbayev Intellectual Schools, teaching Kazakh, Russian and English, and fostering critical thinking, autonomous research and a deep analysis of information;<br>■ 80% of university graduates who complete education under the government grant scheme to be employed in their field of specialization in their first year after graduation;<br>■ The leading universities to enjoy academic and managerial autonomy; two of them to rank among the world's 100 best (Shanghai list);<br>■ 65% of universities to pass independent national accreditation in accordance with international standards;<br>■ Government scholarships for university students to increase by 25% [by 2016]. | ■ Kazakhstan to figure among the 50 most competitive countries in the world with a business climate conducive to foreign investment in non-primary economic sectors;<br>■ The economy to grow in real terms by more than one-third in relation to 2009; annual GDP growth to attain no less than 15% (KZT 7 trillion in real terms);<br>■ The population living beneath the poverty line to drop to 8%;<br>■ Contribution of manufacturing sector to increase to at least to 12.5% of GDP;<br>■ Share of non-primary exports to increase to at least 40% of total exports [by 2014];<br>■ Labour productivity in manufacturing to grow by a factor of no less than 1.5;<br>■ GERD to represent 1% of GDP [by 2015];<br>■ 200 new technologies to be in use;<br>■ Two centres with industrial expertise, three design bureaux and four technology parks to open;<br>■ Share of innovative activity in enterprises to increase to 10% by 2015 and 20% by 2020;<br>■ Basic research to represent 20% of all research; applied research 30%; and technological development 50%, in order to favour the introduction of innovative technologies;<br>■ Number of internationally recognized patents to increase to 30. | ■ Kazakhstan to figure among the top 30 developed nations;<br>■ Kazakhstan to increase per capita GDP from US$ 13 000 in 2012 to US$ 60 000;<br>■ With the urban population due to rise from 55% to 70% of the total, towns and cities are to be linked by high-quality roads and high-speed transport (trains);<br>■ Small and medium-sized businesses are to produce up to 50% of GDP, compared to 20% at present;<br>■ Kazakhstan to be a leading Eurasian centre of medical tourism (possible introduction of universal medical insurance);<br>■ Annual GDP growth to reach at least 4%, with the volume of investment rising from 18% to 30%;<br>■ Non-resource goods to represent 70% of exports and the share of energy in GDP to be halved;<br>■ GERD to rise to 3% of GDP to allow for the development of new high-tech sectors;<br>■ As part of the shift to a 'green economy', 15% of acreage to be cultivated with water-saving technologies; agrarian science to be developed; experimental agrarian and innovation clusters to be established; drought-resistant GM crops to be developed [by 2030];<br>■ Launch of a research centre on future energy and the green economy [by 2017];<br>■ Launch of a Geological Cluster of Schools at Nazarbayev University [by 2015], see Box 14.3. |

## Box 14.2: **The Caspian Energy Hub**

The Caspian Energy Hub is under construction on a site of 500–600 ha in the Kazakh city of Aktau; it will form part of a cluster planned for Asia and the Middle East, with a similar hub already existing in Qatar.

The project's main objectives are to improve staff training and develop the energy sector's scientific potential, while modernizing infrastructure to serve the oil and gas industries better. The hub will comprise a specialized laboratory, a Centre for Geophysical Data Analysis, a Centre for Oil and Gas Technologies and an administrative pole responsible for state security and environmental protection. The site will also host an international technical university. Three foreign universities plan to set up campuses there: Colorado University and the University of Texas at Austin in the USA and Delft University in the Netherlands.

The project was launched in May 2008 by two joint stock companies, the Kazakhstan Holding for the Management of State Assets (Samruk) and the Sustainable Development Fund (Kazyna), which were subsequently merged in October 2008. Other partners include the PFC Energy international consulting company, the Gulf Finance House investment company and the Mangystau investment company. Samruk–Kazyna is charged with modernizing and diversifying the Kazakh economy by attracting investment to priority economic sectors, fostering regional development and strengthening inter-industry and inter-regional links.

Oil and gas represent 60–70% of Kazakh exports. A 2% reduction in oil revenue in 2013, subsequent to a drop in prices, cost the Kazakh economy US$ 1.2 billion, according to Ruslan Sultanov, Director-General of the Centre for Development of Trade Policy, a joint stock company of the Ministry of the Economy and Budget Planning. More than half (54%) of processed products were exported to Belarus and the Russian Federation in 2013, compared to 44% prior to the adoption of the Customs Union in 2010.

*Source:* www.petroleumjournal.kz

Between 2010 and 2012, technological parks were set up in the east, south and north Kazakhstan oblasts (administrative units) and in the capital, Astana. A Centre for Metallurgy was also established in the east Kazakhstan oblast, as well as a Centre for Oil and Gas Technologies within the new Caspian Energy Hub (Box 14.2).

The Centre for Technology Commercialization has been set up as part of the Parasat National Scientific and Technological Holding, a joint stock company established in 2008 that is 100% state-owned. The centre supports research projects in technology marketing, intellectual property protection, technology licensing contracts and start-ups. The centre plans to conduct a technology audit in Kazakhstan and to review the legal framework regulating the commercialization of research results and technology.

### 'Strong business, strong state'

In December 2012, the Kazakh president announced the *Kazakhstan 2050 Strategy* with the slogan 'Strong Business, Strong State.' This pragmatic strategy proposes sweeping socio-economic and political reforms to hoist Kazakhstan among the top 30 economies by 2050.

In his January 2014 state of the nation address, the president observed[9] that 'OECD members have covered a journey of deep modernization. They also demonstrate high levels of investment, research and development, labour efficiency, business opportunities and standards of living. These are the standards for our entrance into the ranks of the 30 most developed nations.' Promising to explain the strategy's goals to the population in order to ensure public support, he stressed that 'the well-being of ordinary citizens should serve as the most important indicator of our progress.'

At the institutional level, he pledged to create an atmosphere of fair competition, justice and rule of law and to 'shape and implement new counter-corruption strategies.' Promising local governments more autonomy, he recalled that 'they must be accountable to the public.' He pledged to introduce principles of meritocracy into human resources policy for state-owned enterprises and companies.

The president recognized the 'need to update relationships between the state and NGOs and the private sector' and announced a privatization programme. A list of state enterprises to be privatized was to be drawn up by the government and the Samruk–Kazyna sovereign wealth fund in the first half of 2014.

The first stage of the *2050 Strategy* focuses on making a 'modernization leap' by 2030. The aim is to develop traditional industries and create a processing industrial sector. Singapore and the Republic of Korea are cited as models. The second stage to 2050 will focus on achieving sustainable development via a shift to a knowledge economy

**9.** The information here on the *2050 Strategy* is taken from the president's address: www.kazakhembus.com/in_the_news/president-nursultan-nazarbayevs-2014-the-state-of-the-nation-address

reliant on engineering services. High value-added goods are to be produced in traditional sectors during this second stage. In order to smooth the transition to a knowledge economy, there will be a reform of laws related to venture capital, intellectual property protection, support for research and innovation and commercialization of scientific results. Knowledge and technology transfer will be a key focus, with the establishment of R&D and engineering centres, in co-operation with foreign companies. Multinational companies working in major oil and gas, mining and smelting sectors

## Box 14.3: **An international research university for Kazakhstan**

Nazarbayev University is a public research university founded in Astana in 2009 by the President of Kazakhstan, who chairs the Supreme Board of Trustees. The first intake of students dates from 2011.

By law, the Supreme Board oversees not only the university but also Kazakhstan's first endowment fund, the Nazarbayev Fund, which ensures sustainable funding for the university, and the 20 or so Nazarbayev Intellectual Schools which supply most of the university's students. Pupils are selected for these elite English-language secondary schools – and later for admission to Nazarbayev University – by University College London. Although students may apply directly for undergraduate programmes, most students choose first to complete a one-year programme at the Centre for Preparatory Studies run by University College London. All undergraduate courses are free to students, some of whom receive a stipend. The university also offers scholarships to selected international students.

The university faculty and other staff are recruited internationally and the language of instruction is English. In 2012, the three undergraduate schools counted a cumulative roll of 506 students, 40% of whom were women: the School of Science and Technology (43% of admissions in 2012), School of Engineering (46%) and the School of Humanities and Social Sciences (11%). The university's *Strategy for 2013–2020* aims to offer a full complement of graduate programmes by 2014 and to increase the undergraduate student roll to 4 000 and the number of graduates to 2000 by 2020, 15% of whom should be pursuing a doctoral degree by this time. The university has adopted the three-tier degree system (bachelor's, master's and PhD) in line with the European Union's Bologna Process to harmonize national education systems.

A particularity of the university is that each school twins with one or more partner institutions on curriculum and programme design, quality assurance, faculty recruitment and student admissions. The School of Science and Technology partners with the Carnegie Mellon University (USA), the School of Engineering with University College London, and the School of Humanities and Social Sciences with the University of Wisconsin–Madison (USA).

The three graduate schools welcomed their first cohort of students in 2013: the Graduate School of Education partners with Cambridge University (UK) and the University of Pennsylvania (USA); the Graduate School of Business with Fuqua School of Business at Duke University (USA) and the Graduate School of Public Policy with Lee Kuan Yew School of Public Policy at the National University of Singapore.

According to the *Strategy for 2013–2020*, a School of Medicine will open in 2015, in partnership with the University of Pittsburgh (USA). A School of Mining and Geosciences is also on the cards. Together with a Centre for Geological Research, it will form a Geological Cluster of Schools at Nazarbayev University, in partnership with the Colorado School of Mines in the USA. This cluster is part of the government's Kazakhstan *2050 Strategy*.

Nazarbayev University hosts several research centres, in addition to the research conducted by faculty and students: the Centre for Education Policy, the Centre for Life Sciences and the Centre for Energy Research. The research priorities of the latter for *2013–2020* include renewable energy and energy efficiency and energy sector modelling and analysis. Established in 2010, the Centre for Energy Research was renamed the Nazarbayev University Research and Innovation System two years later. In line with Kazakhstan's 2030 and 2050 strategies, the university is also establishing a Centre for Growth and Competitiveness with an initial focus on developing research excellence in global value chain analysis.

One hindrance to innovation in Kazakhstan has been the lack of geographical proximity between innovation hubs and the country's main universities. In January 2012, the president announced the construction of the Innovation Intellectual Cluster, which aims to surround the university gradually with a belt of high-tech companies. The hub encircling the university consists of a business incubator, technopark, research park, prototyping centre and commercialization office.

In 2012, the university published the first issue of *The Central Asian Journal of Global Health*, a peer-reviewed scientific journal developed in partnership with the University of Pittsburgh.

*Source:* www.nu.edu.kz

will be encouraged to create industries to source required products and services. Technology parks will be reinforced, such as the new Innovative Intellectual Cluster at Nazarbayev University in Astana (Box 14.3) and the Alatau Information Technology Park in Almaty.

### Fifteen years to become a knowledge economy

In its *2050 Strategy*, Kazakhstan gives itself 15 years to evolve into a knowledge economy. New sectors are to be created during each five-year plan. The first of these, covering the years 2010–2014, focused on developing industrial capacity in car manufacturing, aircraft engineering and the production of locomotives, passenger and cargo railroad cars. During the second five-year plan to 2019, the goal is to develop export markets for these products.

To enable Kazakhstan to enter the world market of geological exploration, the country intends to increase the efficiency of traditional extractive sectors such as oil and gas. It also intends to develop rare earth metals, given their importance for electronics, laser technology, communication and medical equipment.

The second five-year plan coincides with the development of the *Business 2020* roadmap for small and medium-sized enterprises (SMEs), which will make provision for the allocation of grants to SMEs in the regions and for micro-credit. The government and the National Chamber of Entrepreneurs also plan to develop an effective mechanism for helping start-ups.

During subsequent five-year plans to 2050, new industries will be established in fields such as mobile, multi-media, nano- and space technologies, robotics, genetic engineering and alternative energy. Food processing enterprises will be developed with an eye to turning the country into a major regional exporter of beef, dairy and other agricultural products. Low-return, water-intensive crop varieties will be replaced with vegetable, oil and fodder products. As part of the shift to a 'green economy' by 2030, 15% of acreage will be cultivated with water-saving technologies. Experimental agrarian and innovational clusters will be established and drought-resistant genetically modified crops developed.

In his speech of January 2014, the president said that highways were currently under construction to link Kazakh cities and turn Kazakhstan into a logistics hub linking Europe and Asia. 'The Western Europe–Western China corridor is nearly completed and a railway line is being built to Turkmenistan and Iran to gain access for goods to ports in the Gulf,' the president said. 'This should increase the capacity of Kazakhstan's port in Aktau and simplify export-import procedures. Upon completion, the 1 200 km-long Zhezkazgan–Shalkar–Beineu railway will connect the east and west of the country, providing access to the Caspian and Caucasus regions in the west and to the Chinese port of Lianyungang on the Pacific coast in the east.'

The traditional energy sector is also to be developed. Existing thermal power stations, many of which already use energy-saving technologies, will be equipped with clean energy technologies. A research centre on future energy and the green economy is to be established by the time Expo 2017 takes place. Environmentally friendly fuel and electric vehicles are to be introduced in public transportation. A new refinery will also be established to produce gas, diesel and aviation fuels. Endowed with the world's biggest uranium reserves, Kazakhstan also plans to set up nuclear power plants[10] to satisfy the country's growing energy needs.

In February 2014, the National Agency for Technological Development[11] signed an agreement with the Islamic Corporation for the Development of the Private Sector and a private investor for the establishment of the Central Asia Renewable Energy Fund. Over the next 8–10 years, the fund will invest in Kazakh projects for renewable and alternative energy sources, with an initial endowment of US$ 50–100 million, two-thirds of which is to come from private and foreign investment (Oilnews, 2014).

## KYRGYZSTAN

### A technologically dependent country

The Kyrgyz economy is oriented primarily towards agricultural production, mineral extraction, textiles and the service industry. There is little incentive to create knowledge- and technology-based industries. The insufficient rate of capital accumulation also hampers structural changes designed to boost innovation and technology-intensive industries. Every key economic sector is technologically dependent on other countries. In the energy sector, for instance, all technological equipment is imported from abroad and many of its assets are in foreign[12] hands.

**10**. Kazakhstan's sole nuclear power plant was decommissioned in 1999 after 26 years of service. According to the IAEA, a joint venture with the Russian Atomstroyexport envisages developing and marketing innovative small and medium-sized reactors, starting with a 300 MWe Russian design as a baseline for Kazakh units.

**11**. This agency is a joint stock company, like many state bodies.

**12**. If we take the example of the Russian Federation, three partly state-owned companies have recently invested in Krygzystan's hydropower, oil and gas industries. In 2013, RusHydro began building the first of a series of hydroelectric dams that it will manage. In February 2014, Rosneft signed a framework agreement to buy 100% of Bishkek Oil and a 50% stake in the sole aviation fuel provider at the country's second-biggest airport, Osh International. The same year, Gazprom came closer to acquiring 100% of Kyrgyzgaz, which operates the country's natural gas network. In return for a symbolic investment of US$ 1, Gazprom will assume US$ 40 million in debt and invest 20 billion rubles (*circa* US$ 551 million) in modernizing Kyrgyz gas pipelines over the next five years. Gazprom already provides most of the country's aviation fuel and has a 70% share in the retail gasoline market (Satke, 2014).

Kyrgyzstan needs to invest heavily in priority sectors like energy to improve its competitiveness and drive socio-economic development. However, the low level of investment in R&D, both in terms of finance (Figure 14.3) and human resources, is a major handicap. In the 1990s, Kyrgyzstan lost many of the scientists it had trained during the Soviet era. Brain drain remains an acute problem and, to compound matters, many of those who remain are approaching retirement age. Although the number of researchers has remained relatively stable over the past decade (Table 14.2), research makes little impact and tends to have little application in the economy. R&D is concentrated in the Academy of Sciences, suggesting that universities urgently need to recover their status as research bodies. Moreover, society does not consider science a crucial driver of economic development or a prestigious career choice.

### A need to remove controls on industry

The government's *National Strategy for Sustainable Development* (2013–2017)[13] recognizes the need to remove controls on industry in order to create jobs, increase exports and turn the country into a hub for finance, business, tourism and culture within Central Asia. With the exception of hazardous industries where government intervention is considered justified, restrictions on entrepreneurship and licensing will be lifted and the number of permits required will be halved. Inspections will be reduced to a minimum and the government will strive to interact more with the business community. The state reserves the right, however, to regulate matters relating to environmental protection and conservation of ecosystem services. By 2017, Kyrgyzstan hopes to figure in the Top 30 of the World Bank's Doing Business ranking and no lower than 40th in the global ranking for economic freedom or 60th for global enabling trade. By combining a systematic fight against corruption with legalizing the informal economy, Kyrgyzstan hopes to figure among the Top 50 least corrupt countries in Transparency International's Corruption Perceptions Index by 2017.

### Better intellectual property protection

In 2011, the government devoted just 10% of GDP to applied research, the bulk of funding going to experimental development (71%). The State Programme for the Development of Intellectual Property and Innovation (2012–2016) sets out to foster advanced technologies, in order to modernize the economy. This programme will be accompanied by measures to improve intellectual property protection and thereby enhance the country's reputation as concerns the rule of law. A system will be put in place to counter trafficking in counterfeit goods and efforts will be made to raise public awareness of the role and importance of intellectual property. During the first stage (2012–2013), specialists were trained in intellectual property rights and relevant laws were adopted. The government is also introducing measures to increase the number of bachelor's and master's degrees in S&T fields.

### Improving the quality of education

Kyrgyzstan spends more on education than most of its neighbours: 6.8% of GDP in 2011. Higher education accounts for about 15% of the total. According to the government's *Review of the Cost-Effectiveness of the Education system of Kyrgyzstan*, there were 52 institutions offering higher education in 2011.

Many universities are more interested in chasing revenue than providing quality education; they multiply the so-called 'contract' student groups who are admitted not on merit but rather for their ability to afford tuition fees, thereby saturating the labour market with skills it does not want. The professionalism of faculty is also low. In 2011, six out of ten faculty held only a bachelor's degree, 15% a master's, 20% a Candidate of Science degree, 1% a PhD and 5% a Doctor of Science (the highest degree level).

The *National Education Development Strategy* (2012–2020) prioritizes improving the quality of higher education. By 2020, the target is for all faculty to have a minimum master's qualification and for 40% to hold a Candidate of Science and 10% either a PhD or Doctor of Science degree. The quality assurance system is also to be revamped. In addition, the curriculum will be revised to align it with national priorities and strategies for the region's economic development. A teacher evaluation system will be introduced and there will be a review of existing funding mechanisms for higher education.

## TAJIKISTAN

### Strong economic growth without greater R&D intensity

Tajikistan has recorded strong growth in recent years, thanks to various economic reforms, including the development of new sectors such as hydropower and tourism and effective measures to promote macro-economic stability. GERD increased by 157% between 2007 and 2013 (to PPP$ 20.9 million, in constant 2005 PPP$) but the GERD/GDP ratio barely improved, rising from 0.07% to 0.12% over the same period (Figure 14.3).

The country has considerable assets: in addition to freshwater and diverse mineral resources, it has relatively large expanses of undeveloped land suitable for agriculture and environmentally friendly crops, a relatively inexpensive labour force and a strategic geographical position thanks to its border with China, making it a place of transit for merchandise and transportation networks.

**13**. See http://gov.kg; www.nas.aknet.kg

### Conditions not yet in place for a market economy

The country also faces several challenges, including widespread poverty; the need to develop the rule of law; the high cost of combating drug trafficking and terrorism on its border; low Internet access (16% in 2013) and a small domestic market. The government sector is not structured to meet the demands of a market economy and development plans and strategies are neither interconnected nor vertically integrated. Potential partners in the private sector and civil society are insufficiently implicated in the development process. To compound matters, the modest allocation of financial resources is frequently inadequate to reach the goals set forth in national strategic documents. The country is also plagued by inadequate statistics.

These factors affect the implementation of the *National Development Strategy* for 2005–2015, which was designed by President Emomalii Rahmon to help the country meet the Millennium Development Goals. In education, the *National Development Strategy* focuses on an institutional and economic reform of the education system and on boosting the education sector's potential to provide services. Key problems to overcome include widespread malnutrition and illness among children, leading to absenteeism; poorly qualified teaching staff; lowly paid teachers, which affects morale and encourages corruption; a shortage of up-to-date textbooks; ineffective evaluation methods; and inadequate curricula at all levels of education for meeting the demands of the modern world, including an absence of science-based curricula at some levels.

### Education increasingly dependent on aid

According to projections, the number of secondary school pupils could rise by 40% between 2005 and 2015. A recent survey revealed a lack of 600 000 places for schoolchildren, no heating or running water in one-quarter of schools and no toilets in 35%. Internet access is rare, even in schools equipped with computers, owing to frequent electricity cuts and a shortage of trained staff. In recent years, the gender gap in school attendance has increased for pupils in grades 9–11 particularly, in favour of boys.

Although state spending on education rose from 3.4% to 4.0% of GDP between 2007 and 2012, it remains well beneath 1991 levels (8.9%). Only 11% of this expenditure went to higher education in 2012, after peaking at 14% in 2008.

The education system is thus becoming increasingly dependent on 'unofficial payments' and international aid. Administrative barriers hamper the establishment of effective public–private partnerships, limiting private sector participation at pre-school and vocational and university levels, in particular. It seems unlikely that Tajikistan will reach the target ensconced in its *National Development Strategy* of privatizing 30% of these institutions by 2015.

Only time will tell whether Tajikistan can reach other key targets for 2015. These include providing all pupils with adequate textbooks, involving local communities more in problem-solving, decentralizing education funding, retraining 25% of teachers annually and founding at least 450 new schools, all of which are to be equipped with heating, water and sanitation, along with the renovated schools. At least 50% of schools are also to be given access to the internet.

### Plans to modernize the research environment

Tajikistan can still count on a fairly strong core of human resources in science but the meagre resources available for R&D are spread too thinly across a wide range of areas. Research is disconnected from problem-solving and market needs. Moreover, research institutions have weak linkages to educational institutions, making it hard to share facilities such as laboratories. The poor distribution of ICTs also hampers international scientific co-operation and information-sharing.

Conscious of these problems, the government intends to reform the science sector. There are plans to conduct an inventory and analysis of research topics at scientific institutions in order to enhance their relevance. Targeted programmes will be adopted for basic and applied research in critical areas for scientific and economic development; at least 50% of scientific projects will have some practical application. Scientists will be encouraged to apply for competitive grants proposed by the government and international organizations and foundations, and contract research will be gradually introduced for high-priority R&D in all the sciences. Related scientific facilities will be renovated and equipped, including with internet access. A scientific information database is also being set up.

Tajikistan hosted its first forum of inventors in October 2014 in Dushanbe, entitled From Invention to Innovation. Run by the National Centre for Patents and Information of the Ministry of Economic Development and Trade, in partnership with international organizations, the forum discussed the private sector's needs and fostered international ties.

### Equal on paper but not in practice

If Kazakhstan, Kyrgyzstan and Uzbekistan have all maintained a share of women researchers above 40% (even gender parity in Kazakhstan's case) since the fall of the Soviet Union, only one in three Tajik scientists (33.8%) was a woman in 2013, down from 40% in 2002. Although policies are in place[14] to give women equal rights and opportunities, these are underfunded and poorly understood by public employees at all levels of government. There is also little co-operation among the state, civil society and the business world when

**14**. A government programme identified basic directions for state policy in maintaining equal rights and opportunities for men and women over the period 2001–2010, and a March 2005 law guarantees these rights and opportunities.

it comes to implementing the national gender policy. As a result, women often find themselves excluded from public life and decision-making processes, even though they are increasingly a household breadwinner.

As part of current administrative reform within the *National Development Strategy*, gender considerations are to be taken into account in the drafting of future budgets. Existing legislation will be amended to support gender equality objectives and ensure equal access for men and women to secondary and higher education, loans, information, consulting services and, in the case of entrepreneurs, to venture capital and other resources. The policy will also focus on eliminating gender stereotypes in the public consciousness and preventing violence against women.

## TURKMENISTAN

### Social safety nets to cushion market transition

Turkmenistan has been undergoing rapid change – with little social upheaval – since the election of President Gurbanguly Berdimuhammadov in 2007 (re-elected in 2012), following the death of 'president for life' Sparamurat Niyazov. Turkmenistan has been moving towards a market economy since this policy was enshrined in the Constitution in 2008; in parallel, however, the government offers a minimum wage and continues to subsidize a wide range of commodities and services, including gas and electricity, water, wastewater disposal, telephone subscriptions, public transportation (bus, rail and local flights) and some building materials (bricks, cement, slate). Economic liberalization policies are being implemented gradually. Thus, as the standard of living has risen, some subsidies have been removed, such as those for flour and bread in 2012.

Today, Turkmenistan has one of the fastest-growing economies in the world. By introducing a fixed exchange rate of US$ 1 to 2.85 Turkmen manat in 2009, the president caused the 'black' foreign exchange market to disappear, making the economy more attractive to foreign investment. A fledgling private sector is emerging with the opening of the country's first iron and steel works and the development of a chemical industry and other light industries in construction, agro-food and petroleum products. Turkmen gas is now exported to China and the country is developing one of the largest gas fields in the world, Galkinish, with estimated reserves of 26 trillion $m^3$ of gas. Avaz on the Caspian Sea has been turned into a holiday resort, with the construction of dozens of hotels which can accommodate more than 7 000 tourists. In 2014, some 30 hotels and holiday homes were under construction.

The country has embarked on a veritable building boom, with the construction of 48 kindergartens, 36 secondary schools, 25 sports academies, 16 stadiums, 17 health centres, 8 hospitals, 7 cultural centres and 1.6 million $m^2$ of housing[15] in 2012 alone. Across the country, roads, shopping centres and industrial enterprises are all under construction. Turkmenistan's railway transport and metropolitan trains have been fully upgraded and the country is buying state-of-the-art aircraft.

At the same time, schools around the country are being renovated, 20-year old textbooks replaced and modern multimedia teaching methods introduced. All schools, universities and research institutes are being equipped with computers, broadband and digital libraries. Internet has only been available to the public since 2007, which explains why just 9.6% of the population had access to it in 2013, the lowest proportion in Central Asia.

### A better respect for the rule of law

In the political arena, President Berdimuhammadov has restored the legislative powers of the *Mejlis*, the Turkmen parliament, and made it obligatory for parliament to approve certain ministerial appointments, such as those of the ministers of justice and the interior. The first multi-party parliamentary elections took place in 2013, allowing a second party, the Party of Industrialists and Entrepreneurs, to enter the *Mejlis* for the first time.

Laws have been introduced giving greater freedom to the media and punishing torture and other criminal acts committed by state officials. Movement within the country has also become easier with the removal of identity checkpoints – at one time there were no fewer than 10 between Ashgabat and Turkmenabat. Nowadays, someone travelling abroad need only present their passport once, a development which should facilitate the mobility of scientists.

### A president keen to revive Turkmen science

The current president is far more committed to science than his predecessor. In 2009, he restored the Turkmen Academy of Sciences and its reputed Sun Institute, both dating from the Soviet era (Box 14.4). In 2010, he also determined 12 priority areas for R&D (*UNESCO Science Report 2010*, p. 245):

- Extraction and refining of oil and gas and mining of other minerals;
- Development of the electric power industry, with exploration of the potential use of alternative sources of energy: sun, wind, geothermal and biogas;
- Seismology;
- Transportation;
- The development of ICTs;

**15**. See: www.science.gov.tm/organisations/classifier/high_schools

- Automation of production;
- Conservation of the environment and, accordingly, introduction of non-polluting technologies that do not produce waste;
- Development of breeding techniques in the agricultural sector;
- Medicine and pharmaceuticals;
- Natural sciences; and
- Humanities, including the study of the country's history, culture and folklore.

Several of the academy's institutes were merged in 2014: the Institute of Botany was merged with the Institute of Medicinal Plants to become the Institute of Biology and Medicinal Plants; the Sun Institute was merged with the Institute of Physics and Mathematics to become the Institute of Solar Energy; and the Institute of Seismology merged with the State Service for Seismology to become the Institute of Seismology and Atmospheric Physics.[16]

In 2011, construction began of a technopark in the village of Bikrova near Ashgabat. It will combine research, education, industrial facilities, business incubators and exhibition centres. The technopark will house research on alternative energy sources (sun, wind) and the assimilation of nanotechnologies. The same year, the president signed a decree creating the National Space Agency[17] which will be responsible for monitoring the Earth's orbit, launching satellite communication services, conducting space research and operating an artificial satellite over Turkmenistan's territory.

International co-operation with major scientific and educational centres abroad is being encouraged, including long-term scientific collaboration. International scientific meetings have been held in Turkmenistan regularly since 2009 to foster joint research and the sharing of information and experience.

The Turkmen State Institute of Oil and Gas was founded in 2012 before being transformed into the International Oil and Gas University a year later. Built on a 30-hectare site which includes a Centre for Information Technology, it can accommodate 3 000 students. This brings the number of training institutes and universities in the country to 16, including one private institution.

The government has also introduced a series of measures to encourage young people to pursue a career in science or engineering. These include a monthly allowance throughout their degree course for students enrolled in S&T fields and a special fund targeting the research of young scientists in priority areas for the government, namely: the introduction of innovative technologies in agriculture; ecology and the rational use of natural resources; energy and fuel savings; chemical technology and the creation of new competitive products; construction; architecture; seismology; medicine and drug production; ICTs; economics; and the humanities. It is hard to gauge the impact of government measures in favour of R&D, though, since Turkmenistan does not make data available on higher education, R&D expenditure or researchers.

**16**. See: www.turkmenistan.ru/en/articles/17733.html

**17**. See: http://en.trend.az/news/society/1913089.html

## Box 14.4: **Turkmenistan's Sun Institute**

Although Turkmenistan is blessed with abundant oil and gas reserves and produces enough electric power for its own needs, it is difficult to lay power lines in the Kopet Dag mountains or arid parts of the country: about 86% of Turkmenistan is desert. Local generation of wind and solar energy gets around this problem and creates jobs.

Scientists at the Sun Institute are implementing a number of long-term projects, such as the design of mini-solar accumulators, solar batteries, wind and solar photovoltaic plants and autonomous industrial mini-biodiesel units. These units will be used to develop arid areas and the territory around the Turkmen Lake, as well as to foster tourism in Avaz on the Caspian seashore.

In isolated parts of the country, 'sun' scientists are working on schemes to pump water from wells and boreholes, recycle household and industrial wastes, produce biodiesel and organic fertilizers and raise 'waste-free' cattle. Their achievements include solar drying and desalination units, the cultivation of algae in solar photobioreactors, a 'solar' furnace for high-temperature tests, solar greenhouses and a biogas production unit. A wind and energy unit has been installed on Gyzylsu Island in the Caspian Sea to supply water to the local school.

Within the Tempus project, 'sun' scientists have been trained (or retrained) since 2009 at the Technical University Mountain Academy of Freiberg (Germany). 'Sun' scientists are also studying the possibility of producing silicon from the Karakum sands for photovoltaic converters, thanks to a grant from the Islamic Development Bank.

*Source:* www.science.gov.tm/en/news/20091223news_alt_ener/

One of the first laws adopted under Berdimuhammadov's presidency offered a state guarantee of equality for women, in December 2007. Some 16% of parliamentarians are women but there are no data on women researchers. A group of women scientists have formed a club to encourage women to choose a career in science and increase the participation of women in state S&T programmes and in decision-making circles. The current chair is Edzhegul Hodzhamadova, Senior Researcher at the Institute of History of the Academy of Sciences. Club members meet with students, deliver lectures and give interviews to the media. The club is endorsed by the Women's Union of Turkmenistan, which has organized an annual meeting of more than 100 women scientists on National Science Day (12 June) ever since the day was instituted in 2009.

## UZBEKISTAN

### A fledgling innovation system

The anti-crisis package covering 2009–2012 helped Uzbekistan weather the financial crisis by injecting funds into strategic economic sectors. As specified by presidential decree in December 2010, these sectors were, for 2011–2015: energy, oil and gas; the chemical, textile and automobile industries; non-ferrous metals; engineering; pharmaceuticals; high-quality processing of agricultural products ; and construction materials. These sectors tend to involve large companies equipped with design bureaux and laboratories. There are, however, also specialized state institutions which actively promote innovation. These include the: the Agency for Technology Transfer (since 2008), focusing on technology transfer to the regions; the Scientific and Technical Information State Unitary Enterprise, placed under the Committee for the Co-ordination of Science and Technology Development (since 2009); and the Intellectual Property Agency of Uzbekistan (since 2011).

The government has also decreed free industrial zones (FIZ) to foster the modernization of all economic sectors. The Navoi region became the first FIZ in December 2008. It was followed by Angren in the Tashkent region in April 2012 and Djizak in the Sirdary region in March 2013. The enterprises established in these FIZ have already produced some inventions and are involved in public–private partnerships through which they co-finance projects in innovation with the Fund for the Reconstruction and Development of Uzbekistan, set up in May 2006. The national innovation system in Uzbekistan is still in its formative years, however. There is at best a tenuous relationship between science and industry and almost no commercialization of research results.

In 2012, the Committee for the Co-ordination of Science and Technology Development formulated eight priorities for R&D to 2020, based on the needs of industry (CCSTD, 2013):

- Constructing an innovative economy by strengthening the rule of law;
- Energy and resource savings;
- Development of renewable energy use;
- Development of ICTs;
- Agriculture, biotechnology, ecology and environmental protection;
- Medicine and pharmacology;
- Chemical technologies and nanotechnologies; and
- Earth sciences: geology, geophysics, seismology and raw mineral processing.

The first of the eight R&D priorities merits greater explanation. The ultimate goal of the ongoing legal reform in Uzbekistan is to harness innovation to solving socio-economic problems and enhancing economic competitiveness. Innovation is perceived as a means of democratizing society. The contours of the draft law on innovation and innovative activity were first outlined in the presidential decree of January 2011 devoted to deepening democratic reforms, including by strengthening the status of local representatives. This draft bill also sets out to create an effective mechanism for the testing, deployment and commercial development of promising scientific work. It outlines additional incentives and rewards for enterprises developing innovative projects, especially in high-tech industries. In 2014, the draft law was subjected to public scrutiny to encourage debate.

In Uzbekistan, state support (financial, material and technical) for innovation is provided directly to specific programmes and projects, rather than to the individual research institutions and hierarchical structures. One of the most effective elements of this scheme is the principle of equity financing, which allows for a flexible combination of budgetary funds with funding from industry and the regions. This ensures that there is a demand for the research being undertaken and that the results will lead to products and processes. It also creates bridges between the public research sector and industrial enterprises. Researchers and industrialists can also discuss ideas at the country's annual innovation fairs (see photo, p. 364). Between 2008 and 2014:

- 26% of the proposals vetted concerned biotechnologies, 19% new materials, 16% medicine, 15% oil and gas, 12% chemical technologies and 13% energy and metallurgy;
- more than 2 300 agreements were signed for experimental development for more than 85 billion Uzbek soms (UZS), equivalent to US$ 37 million;
- based on these contracts, 60 new technologies were introduced and 22 product types went into production;

Table 14.4: **Uzbekistan's most active research organizations, 2014**

| Physics and Astronomy | Energy |
|---|---|
| Institute of Nuclear Physics | Institute of Energy and Automation |
| RT-70 Observatory | Tashkent State Technical University |
| SPU Physical–Technical Institute (Physics–Sun) | Fergana Polytechnic Institute |
| Institute of Polymers, Chemistry and Physics | Karshi Engineering Economic Institute |
| Institute of Applied Physics, National University of Uzbekistan | Biochemistry, genetics and molecular biology |
| **Chemical Sciences** | **Biochemistry, Genetics and Molecular Biology** |
| Institute of Bio-organic Chemistry *(named after Academician Sadykov)* | Centre of Genomics and Bioinformatics |
| Institute of General and Inorganic Chemistry | Institute of Plant and Animal Genofund |
| Institute of Chemistry and Plant Substances | Institute of Genetics and Plant Experimental Biology |
| Institute of Polymers, Chemistry and Physics | Institute of Microbiology |

*Source:* compiled by author

- the new products generated UZS 680 billion (almost US$ 300 million), providing US$ 7.8 million in import substitution.

## Securing a new generation of researchers

In 2011, three-quarters of Uzbek researchers were employed in higher education and just 6% in the business enterprise sector (Figure 14.5). With most university researchers nearing retirement, this imbalance imperils Uzbekistan's research future. Almost all holders of a Candidate of Science, Doctor of Science or PhD are more than 40 years old and half are aged over 60; nearly one in four researchers (38.4%) holds a PhD degree, or its equivalent, the remainder holding a bachelor's or master's degree (60.2%).

In July 2012, a presidential decree abolished the system of Candidate of Science and Doctor of Science degrees inherited from the Soviet system,[18] replacing it with the three-tier degree system comprised of bachelor's, master's and PhD degrees. Whereas those with a bachelor's degree used to be barred from postgraduate studies in the old system, they will now be able apply for a course leading to a master's degree. This should incite young people to study science.

In December 2012, a second presidential decree focused on improving proficiency in foreign languages, beginning with the 2013/2014 academic year. English teaching, in particular, will be introduced into secondary schools and certain university courses will be taught in English, especially engineering and specialized areas, such as law and finance, in order to foster international information exchange and scientific co-operation. Students from remote rural areas will be able to specialize in foreign language teaching at university on the recommendation of local public authorities. Television and radio programmes designed to teach children and teenagers foreign languages will be broadcast widely. Universities will be given greater access to international multimedia resources, specialized literature, newspapers and magazines.

Inha University in Tashkent opened its doors to students in October 2014. Specializing in ICTs, this new university is the result of collaboration with Inha University in the Republic of Korea and will adopt similar academic programmes. Initially, 70 students are being selected for the Department of Information and Communication Engineering and a further 80 for the Department of Computer Science and Engineering. All lectures are given in English.

In order to improve training, the first cross-sectorial youth laboratories were created by the Academy of Sciences in 2010, in promising fields such as genetics and biotechnology; advanced materials; alternative energy and sustainable energy; modern information technology; drug design; and technology, equipment and product design for the oil and gas and chemical industries. These fields were chosen by the academy to reflect the strengths of Uzbek science (Figure 14.6 and Tables 14.2 and 14.4). The Academy of Sciences has also revived the Council of Young Scientists.

## More problem-solving research

In order to re-orient academic research towards problem-solving and ensure continuity between basic and applied research, the Cabinet of Ministers issued a decree in February 2012 re-organizing more than 10 institutions of the Academy of Sciences. For example, the Mathematics and Information Technology Research Institute was subsumed under the National University of Uzbekistan and the Institute for Comprehensive Research on Regional Problems of Samarkand was transformed into a problem-solving laboratory on environmental issues within Samarkand State University. Some have remained attached to the Academy of Sciences, such as the Centre of Genomics and Bioinformatics (Table 14.4 and Box 14.5).

**18**. For an explanation of the Soviet system of higher education, see Figure 14.3 on p. 220 of the *UNESCO Science Report* 2010.

### Box 14.5: **Uzbek and US scientists add economic value to cotton fibre**

A recent study could potentially have a multibillion-dollar impact on the global cotton industry and help cotton farmers fend off increasing competition from synthetic fibres.

Published in January 2014 in *Nature Communications*, the study is the result of collaboration between biologists at the Uzbek Centre of Genomics and Bioinformatics, the Texas A&M University (USA) and the US Department of Agriculture's Office of International Research Programs, which provided most of the funding.

'Sustainability and biosecurity of cotton production are pivotal for the Uzbek economy because agriculture accounts for [19%] of the country's GDP', says lead author Prof. Ibrokhim Abdurakhmonov, who received his master's degree in plant breeding from Texas A&M University in 2001 and is now director of the Centre of Genomics and Bioinformatics at the Academy of Sciences in his native Uzbekistan.

The overwhelming majority of cotton harvested worldwide is upland cotton *(Gossypium hirsutum)*. A cotton called *Gossypium barbadense* is more desirable because of its longer fibres and greater strength but it is late-maturing, low-yielding and more difficult to grow because it requires a dry climate and is less resistant to pathogens and pests.

'For a long time, cotton breeders have been trying to develop upland cotton with the fibre qualities of *G. barbadense* cotton,' says Alan Pepper, an associate professor in the Texas A&M Department of Biology and a co-author of the paper. 'Globally, everybody is trying to do it. Economically, it is a huge deal because every millimetre you add to fibre length adds that much to the price of cotton when the farmer sells it.'

The researchers' method increased the length of the fibre by at least 5 mm, or 17%, compared to the control plants in their experiment. 'This was pure basic science – kind of a shot-in-the-dark experiment,' says Pepper.

He acknowledges that the results of the research are, technically, genetically modified organisms (GMOs). But he makes a key distinction. A major criticism of GMOs, Pepper notes, focuses on cases where genes from other species – even bacterial ones – have been added to an organism to achieve a desired trait. 'What we are doing is a little different. We are not actually adding a gene from another species. We are just taking the genes that are there and we are knocking down the effect of one of those genes that is already in the plant.'

'The increased value of longer and stronger lint would be at least US$ 100 per acre more income,' says Abdurakhmonov. 'Our anticipation of possible improvement of resistance to abiotic stresses [such as high winds or drought] further adds to its commercial potential.'

In December 2013, Prof. Abdurakhmonov was named 'researcher of the year' by the International Cotton Advisory Committee for this 'gene knockout technology,' which is being patented in Uzbekistan, the USA and elsewhere. Research is being conducted in order to apply this technology to other crops.

Uzbekistan accounts for about 10% of global cotton fibre exports, behind the USA, India, China and Brazil. It is currently using revenue from cotton-growing to diversify its economy.

*Source:* www.bio.tamu.edu (press release); see also http://genomics.uz

In March 2013, two research institutes were created by presidential decree to foster the development of alternative energy sources, with funding from the Asian Development Bank and other institutions: the SPU Physical–Technical Institute (Physics Sun Institute) and the International Solar Energy Institute.

## CONCLUSION

### Progress hampered by low investment in R&D

Most of the Central Asian republics have managed to maintain stable economic growth throughout the global financial crisis and even some of the highest annual growth rates in the world. They are still in the process of transition to a market economy, however. Progress is being hampered by the low level of investment in R&D and, in Kyrgyzstan and Turkmenistan in particular, by very low levels of internet access.

The republics are all adopting structural and administrative reforms to reinforce the rule of law, modernize traditional sectors of the economy, introduce new technologies, strengthen related skills and create an environment more conducive to innovation, such as by strengthening intellectual property protection and providing incentives for innovative enterprises. Increasingly, government policies are opting for a more sustainable development path, including for extractive industries.

In order to attain the objectives outlined in their respective development plans, governments in Central Asia need to:

- strengthen co-operation – which is vital for sharing R&D results – by developing a common regional network for scientific and technical information, and creating a database in priority research areas: renewable energy, biotechnology, new materials, etc.;

- establish a support centre for STI using a common methodological approach to ensure unified legislative frameworks and the development of standard tools to assess STI policy implementation;
- provide one another with foreign direct investment, in order to diversify sources of R&D funding and foster intraregional co-operation in areas of common interest, including renewable energy, biotechnology, biodiversity conservation and medicine;
- develop more infrastructure to foster innovation: science and technology parks, special industrial zones, business incubators for start-ups and spin-offs, etc.; and
- co-operate in training highly qualified specialists for the knowledge economy: managers and engineers for innovative projects; intellectual property lawyers, including as concerns international law, patent marketers and so on.

### *KEY TARGETS FOR CENTRAL ASIA*

- Raise Kazahkstan's GERD/GDP ratio to 1% by 2015;
- Raise the share of innovative activity in Kazakh enterprises to 10% by 2015 and 20% by 2020;
- Carry the weight of the Kazakh manufacturing sector to 12.5% of GDP by 2020;
- Reduce the share of the Kazakh population living below the poverty line to 8% by 2020;
- Cultivate 15% of the acreage in Kazakhstan with water-saving technologies and develop drought-resistant genetically modified crops by 2030;
- Place Kyrgyzstan among the top 30 countries for doing business by 2017 and the 50 least corrupt by 2017;
- Ensure that all Kyrgyz faculty members hold at least a master's degree and 10% a PhD or Doctor of Science degree by 2020;
- Privatize 30% of Tajik pre-schools, vocational schools and universities by 2015;
- Equip 50% of Tajik schools with internet access by 2015;
- Ensure that 50% of Tajik scientific projects are in applied fields by 2015.

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