European Commission

Background Report

Specific Support to Armenia

Horizon 2020 Policy Support Facility

Research and Innovation

Background Report – Specific Support to Armenia

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Unit A4 – Analysis and monitoring of national research and innovation policies

Contact (H2020 PSF Specific Support to Armenia):

Eugenija PUČIŪTĖ, Policy Officer, Eugenija.PUCIUTE@ec.europa.eu

Contact (H2020 PSF coordination team):

Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu

Stéphane VANKALCK, PSF Head of Sector, Unit A4 - Stéphane.VANKALCK@ec.europa.eu

Marta TRUCO CALBET, PSF Team Leader, Unit A4 – Marta.TRUCO-CALBET@ec.europa.eu

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EUROPEAN COMMISSION

Background Report

Specific Support to Armenia

Prepared by the independent expert:

Sevak Hovhannisyan

2019 Directorate-General for Research and Innovation EN

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1 SOCIAL AND ECONOMIC SITUATION IN ARMEINA

Fast facts	
Full name:	The Republic of Armenia
Population:	2 .97 million
Capital:	Yerevan
Area:	29,743 sq. km (11,500 sq. miles)
Major languages:	Armenian (native), Russian, English
Major religion:	Christianity
Life expectancy:	71.3 years (men), 77.6 years (women)
Monetary unit:	Armenian dram (AMD)
Exchange rate:	Average for 2018: 570.56 AMD/EUR[1]
System of law:	Continental. Foreign law governed contracts can be enforced through New York Convention on Recognition and Enforcement of Arbitral Awards.
GDP, current USD/EUR:	USD 12.4 billion / EUR 10.5 billion (2018)
GDP per capita, PPP:	USD 9,647 (2017)

Sovereign Country Ratings	
Moody's	B1, positive (9 March 2018)
Fitch (long-term IDRs)	B+, positive (15 June 2018)

Armenia's stand in international rankings	
Ease of Doing Business (The World Bank):	41 (Rank, May 2018, out of 190 countries)
Index of Economic Freedom (Heritage Foundation):	47 (Rank, 2019, out of 180 countries)
Human Capital Index (World Economic Forum):	49 (Rank, 2017, out of 130 countries)
Global Competitiveness Index (World Economic Forum):	73 (Rank, 2017-2018, out of 137 countries)
Global Innovation Index (Cornell, INSEAD, WIPO)	68 (2018, out of 126 countries)

[1] In this report the AMD/EUR average exchange rate for 2018 has been for calculation purposes.

1.1 General Information

The Republic of Armenia is located at the crossroads of Europe and Asia in the northeast of Asia Minor (Armenian Plateau), bordering Azerbaijan, Iran, Turkey and Georgia. With an area of 29,800 square kilometres, the country is about the size of Belgium.

The capital city, Yerevan, lies on the Hrazdan River, and is home to some 1.1 million people. Yerevan is one of the world's oldest, continually inhabited cities in existence to this day. The next three largest cities are Gyumri (pop. 118,000), Vanadzor (pop. 82,800) and Echmiadzin (pop. 46,800).

The majority of Armenia is mountainous (about 2,000 metres above sea level). One-third of the territory is pastureland. Forest and woodland cover 12% of the country, arid land some 18 percent, and permanent crops cover 3%. The highest elevation is 4,095 metres (Mt. Aragats) and the lowest point is 400 metres above sea level (Debed River). One of the largest mountain lakes in the world, Lake Sevan, is about 2,000 metres above sea level.

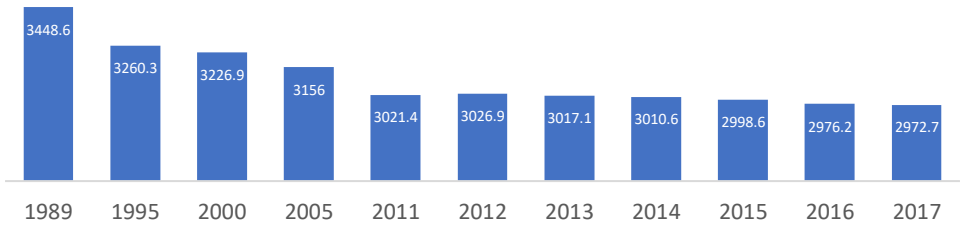
The climate in Armenia is continental, with lower temperatures and more precipitation in higher elevations. In the central plateau, temperature varies widely with cold winters and hot summers. Armenian mountains are rich in iron, molybdenum, gold, lead, silver, clay, limestone, as well as semi-precious and ornamental stones. Armenia possesses strategic deposits of molybdenum.

Armenia is a land-locked country with a population of 2.97 million people (47% men and 53% women). The country has a population density of 101 people per square kilometre (263/square mile). Armenia is the second-most densely populated of the former Soviet republics. Armenia's urbanisation rate is 0.5%.

Ethnically, Armenia is a homogeneous country with 98% Armenians while the rest are primarily Yazidis, with some Russian ethnicity present. Religious devotion in Armenia is traditionally Christian. Armenia was the first country to adopt Christianity as a national religion, and antiquity shows this occurred around 301 A.D. Over 93% of the current populous claims to be part of the Armenian Apostolic Church. Catholicism exists in Armenia, as well as Sunni Islam, both practiced by a small fraction of Armenian residents. After the collapse of Soviet Union, many Armenians left the country.

Since Armenia's independence, the population trend has been continually downward, decreasing by some 49,000 during the period 2011-2017 as more and more Armenians migrated. After the Velvet Revolution in the spring of 2018, emigration declined due to more positive expectations in the country.

Figure 1: Armenia's population, thousand people



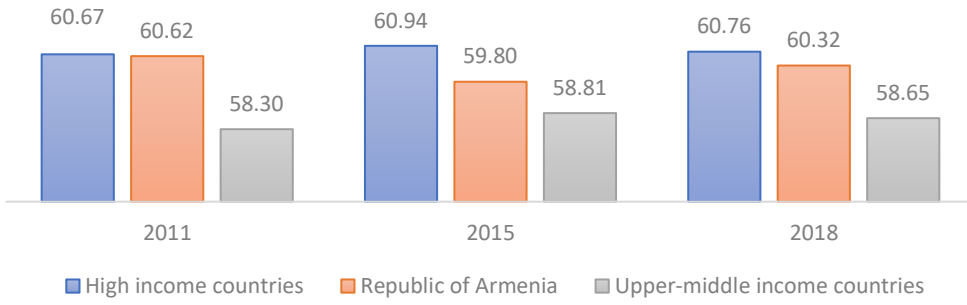
Source: Statistical Committee of the Republic of Armenia

Labour force

In parallel with the reduced labour force (2011-2017) the level of economic activity also decreased from 63% to 60.9%.[2] This was mainly due to the slow economic growth, continued migration, reduced foreign direct investment, and some other negative macroeconomic factors.

Although in the group of upper-middle income countries, Armenia's rate of economic activity is closer to the average of high-income countries.[3]

Figure 2: Economic activity rate, %



Source: World Bank Database, Labour Force Participation Rate, 2018

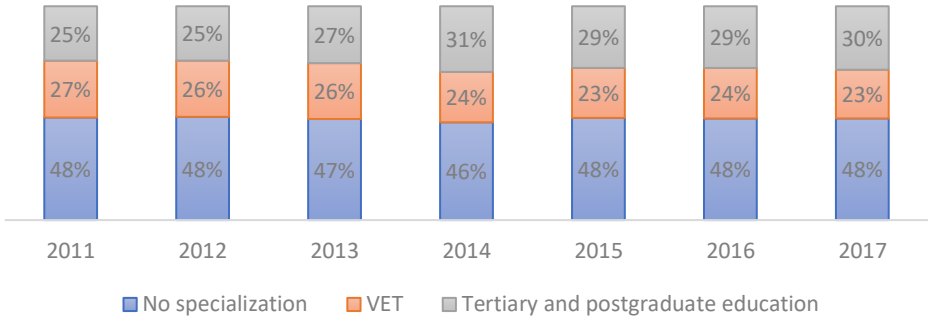
In the same six-year period, the share of people with a tertiary and postgraduate education in the economically active population increased primarily due to the reduction of the VET[4] education share. Meanwhile, the share of those without any professional education maintained a high share (about 50%).

[2] Labour force analysis methods used by the Statistical Committee of the Republic of Armenia and the World Bank are different due to the fact that the former takes into consideration population aged 15-75 while the latter population higher than 15.

[3] World Bank Database, Labour Force Participation Rate, 2018

[4] VET includes graduates of preliminary and upper-secondary professional education.

Figure 3: Economically active population by educational level



Source: The NSS database

Migration to Russia for work is significant. According to the State migration service it accounts for about 230,000 people or about 20% of the working age population.

Between 2011 and 2017, the unemployment rate decreased by only 0.6 percentage points down to 17.8% in 2017. This slim reduction was due to the decline of economically active population rather than increased employment. The majority of unemployed people (46%) with a general education (no special skills) face difficulties meeting today's labour market requirements.

To compound the problem, many female tertiary graduates drop out of the labour market, implying a significant waste of scarce public resources. Only about half of the female population and just over a third of youth aged 15 to 24 are engaged in the labour market, thus contributing too little in terms of economic activity and government revenues – insufficient to compensate for the declining population.[5]

Diaspora

The Armenian Diaspora, estimated at around 10 million people, is spread over 85 countries with a major concentration in Russia (2.5 million), United Sates (1.5 million), France (0.45 million) and Georgia (0.25 million). In the beginning of the 1990s, the Armenian Diaspora played a crucial role in the process of rebuilding the homeland after the collapse of the Soviet Union, transportation blockade, power shortages and conflict with Azerbaijan. Beyond the humanitarian, development work and political support, the Diaspora played an active role in attracting foreign investments through leveraging its potential to attract global companies such as HSBC, Coca-Cola, Marriott, Hyatt, KPMG, National Instruments, and Synopsis. Since the 2000s, the Diaspora investment has led to many businesses being founded/co-founded in different sectors. Russia, USA, Argentina and Iran are the leading source countries for Diaspora investments.

[5] World Bank 'Reducing Poverty and Improving Shared Prosperity Through Better Jobs, Skills, and Education' 24 May 2017; https://openknowledge.worldbank.org/handle/10986/28328

1.2 Geopolitical And Political Landscape

Located in the Caucasus region, Armenia is situated on the transcontinental land bridge between Europe and Asia. A landlocked country with Turkey to the west, Georgia to the north, and Azerbaijan to the east, Armenia boasts a history longer than most countries in the world.

For much of Armenia's history, part or all of the country has been controlled by each of its neighbours. Russia, which controlled Armenia most recently during the Soviet period, remains the most influential external power in the country.

The post-Soviet transformation also catalysed the reinterpretation of the historical past and memory. Ethnopolitical conflicts in the South Caucasus region were decisive in the creation of new dividing lines and animosity; xenophobic rhetoric became rampant. This was the greatest political challenge for Armenia in the post-Soviet period, as the Nagorno-Karabakh conflict strongly influenced the political and economic transformation of the country.

In Armenia, the development of the State was very slow in terms of institutionalising democratic structures and tackling endemic corruption. A semi-presidential system was formally established in 2005 based on an amendment to the 1995 constitution.

A constitutional referendum was held in Armenia in December 2015. The amendments have radically changed the country's political system, shifting from a semi-presidential to a parliamentary republic. Under the new system, the prime minister was granted extended executive powers, including supreme command of the armed forces during war, whereas the president became a ceremonial figure.

In April 2018, a peaceful movement opposed Serzh Sargsyan being elected Prime Minister according to the new Constitution which was meant to finalise the transformation of the political system to a full parliamentary republic. The movement was led by Nikol Pashinyan, the leader of Civil Contract political party (member of 'Way Out Alliance' with nine seats in the Parliament). This movement, later to be called the Velvet Revolution, led to the resignation of Serzh Sargsyan and the Republican majority of the Parliament voted in favour of Nikol Pashinyan to become the new Prime Minister of Armenia in May 2018. The new government was formed in coalition with two other parties, its programme envisaged holding new parliamentary elections within a year.

In the current Parliament, the following parties are represented:

- My Step Alliance – 88 seats in the Parliament,
- Prosperous Armenia – 26 seats in the Parliament,
- Bright Armenia – 18 seats in the Parliament.

The new PM initiated a large-scale campaign against corruption, privileges for special groups and wasteful public spending. These initiatives are generally

expected to create a level playing field for businesses in the country and substantially improve the business climate.

The Armenian government included the following key priorities in its programme to achieve this goal:[6]

- Protection of external and internal security, guarantee of Artsakh's security and its maintenance,
- Competitiveness of the economy: improvement of the creative potential, fair competition, export markets, tourism, high technologies, digitalisation etc.,
- Protection of human rights,
- Democracy and the rule of law,
- Consolidation of human, economic, financial, intellectual potential of all Armenians to promote development,
- Government accountability and transparency and the rejection of corruption,
- Separation of political and business sectors,
- Encouraging education and healthy living,
- Poverty reduction through labour and education.

Geopolitical situation

The geopolitical situation around Armenia is greatly influenced by the interplay of different interests of large global players. Russia, the United States, as well as European Union (EU) actively work to maintain and increase their influence in the region. In recent years, Armenia has also been increasing ties with Russia, especially in military and energy, while maintaining good relations both with the US and the EU.

An inseparable part of Armenia's history is the Nagorno-Karabakh conflict which began in 1988. It is a territorial and ethnic conflict between Armenia and Azerbaijan over the Armenian populated region of Nagorno-Karabakh.

Armenia has good relations with Iran and Georgia, and economic cooperation with these countries are developing. With the other two neighbours, Turkey and Azerbaijan, relations are strained. The Turkish State denies the genocide of about 1.5 million Armenians committed by Ottoman Turkey between 1915 and 1923. Currently, there are still no diplomatic relations with Turkey and the border is closed.

[6] Programme of the Government of the Republic of Armenia 2019

There are no diplomatic and trade relations with Azerbaijan either. The so-called Minsk Group of OSCE, represented by the US, Russia and French diplomats is mediating between the two countries towards resolving the Nagorno-Karabagh conflict.

In January 2015, Armenia officially joined the Eurasian Economic Union (EEU) formed by Russia, Kazakhstan and Belarus. Kirgizstan is the 5th member which joined the EEU after Armenia. For Armenia, this means free-flowing commodities, services, labour and capital within the EEU area.

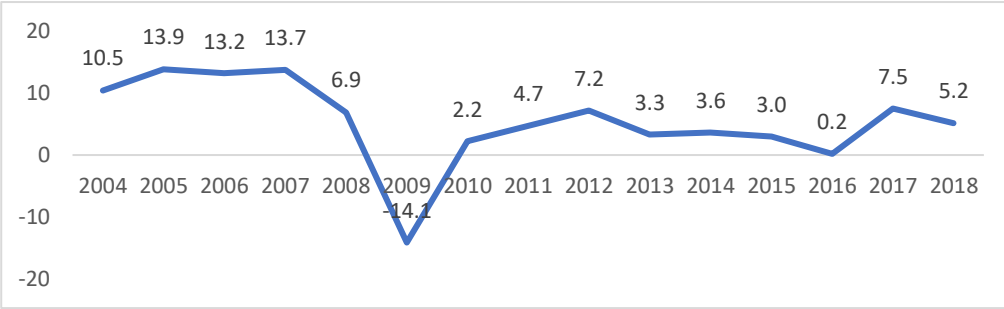
Prior to the Trump administration, Armenia was one of the largest recipients of US assistance on a per capita basis.

Armenia and the EU officially signed a Comprehensive and Enhanced Partnership Agreement (CEPA) in November 2017. For Armenia, this marks a substantial step toward developing western democratic reforms and closer ties with the EU.

1.3 Overview Of Armenia's Macroeconomic Performance

Armenia's national income in GDP fell significantly in the years following independence, as the country suffered from economic hardships in the aftermath of the Soviet Union's collapse. Throughout the 1990s, the military conflict with Azerbaijan and closed borders with Turkey, the loss of traditional export markets of former Soviet Republics, and the collapse of industry and agriculture, large-scale emigration, and unemployment all led to the country's economic deterioration. In the past three years, GDP has fluctuated between EUR 9-10.5 billion during, ranking Armenia in the 140s range in the world.

Figure 4: Armenia GDP annual growth %, 2004-2018



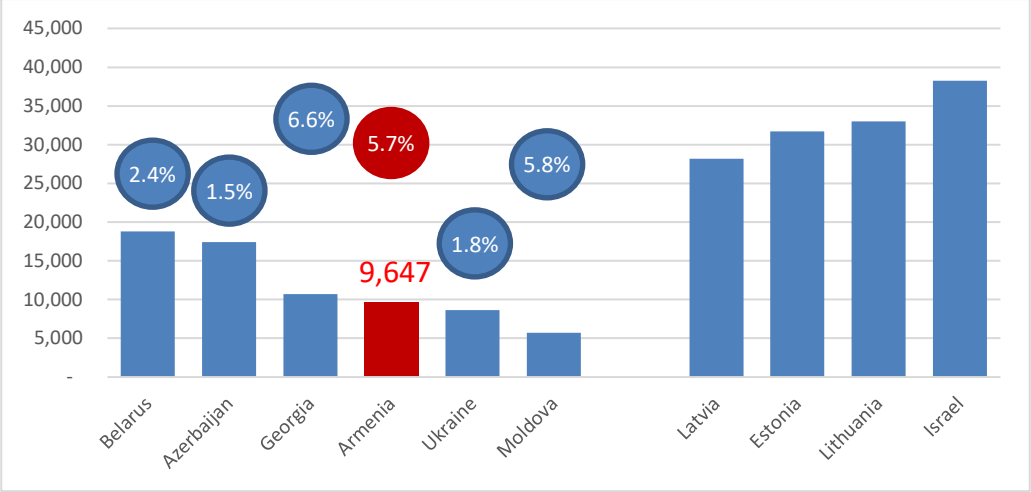
Source: Statistical Committee of the Republic of Armenia

As a result of the global economic crisis, the decline in GDP in 2009 was 14.1%, one of the steepest in the region. The economy recovered in the following year. By 2017 and 2018, Armenia had reached GDP growth rates of 7.5% and 5.2% respectively.

Armenia is about average in terms of GDP per capita (PPP) compared to other Commonwealth of Independent States (CIS), but lower than CEE countries. Based on its 2018 per capita gross national income (GNI), Armenia is classified

in the group of upper-middle income countries by the World Bank. GDP[7] grew by 33.5% from 2010-2017, while GDP per capita PPP increased by 47%. Armenia is fourth by GDP per capita in PPP indicator among Eastern Partership (EaP) countries despite record high growth during past seven years.

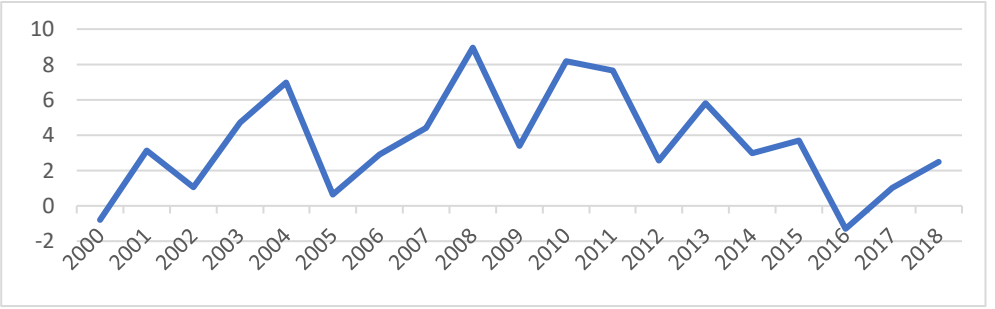
Figure 5: GDP per capita, PPP in current international USD, 2017 and CAGR 2010-17 in %



Source: Statistical Committee of the Republic of Armenia

Price stability is the main target of the Central Bank of Armenia, which consistently implements strict monetary policy. Inflation fluctuates at a low level, from 2000-2017 the average inflation rate was 3.7%. A 2.5% year-on-year inflation was recorded in Armenia in 2018.

Figure 6: Inflation, in %



Source: Statistical Committee of the Republic of Armenia

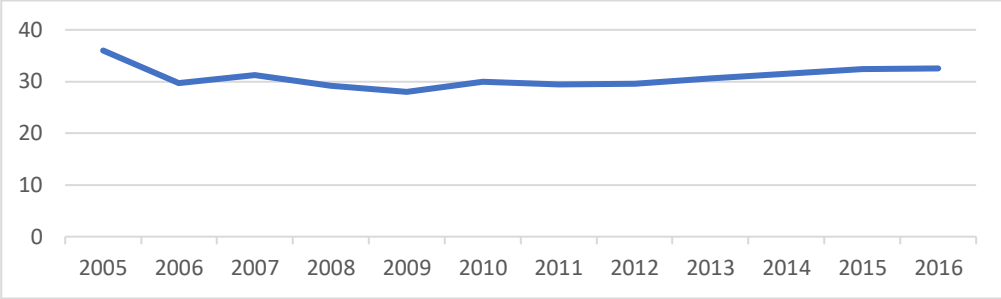
[7] Constat international USD, 2010.

Poverty and inequality

Armenia is ranked 83rd in the Human Development Index[8] and the performance increased by 16.7% during 2010-2017: from 0.647 (in 2000) to 0.755 (in 2017).

The Armenian GINI index is 32.5 (2016) which decreased by 5 percentage points compared to the 2004 figure of 37.5, indicating lower inequality in the country. The data reached an all-time high of 37.5% in 2004 and a record low of 28.0% in 2009.

Figure 7: GINI index in Armenia



Source: World Bank estimates

Economic growth over recent years has had a positive impact on the poverty level in the country. The poverty rate has decreased over the decade from 2008 to 2017. The total percentage of people below the national poverty line in 2017 was 25.7% (compared to 27.6% in 2008) – out of which 1.4% are categorised as extremely poor.[9]

Considering the Gender Equality Index, Armenia ranked 98 by 0.678 out of 159 countries in 2018.[10] Female participation in the labour market was 46.6% in 2018.

Economy structure

In the Armenian economy, agriculture (17% of GVA in 2017) plays a relatively important role. Manufacturing contributes about 11% of GVA, significantly lower than in more advanced economies (e.g. EU28).[11] As manufacturing firms tend to invest more in R&D than other sectors, the relatively limited scale of the sector is likely to lead to lower (compared to more advanced economies) technological innovation rates. In turn, this impacts on productivity, which is also relatively

[8] See: http://hdr.undp.org/en/data

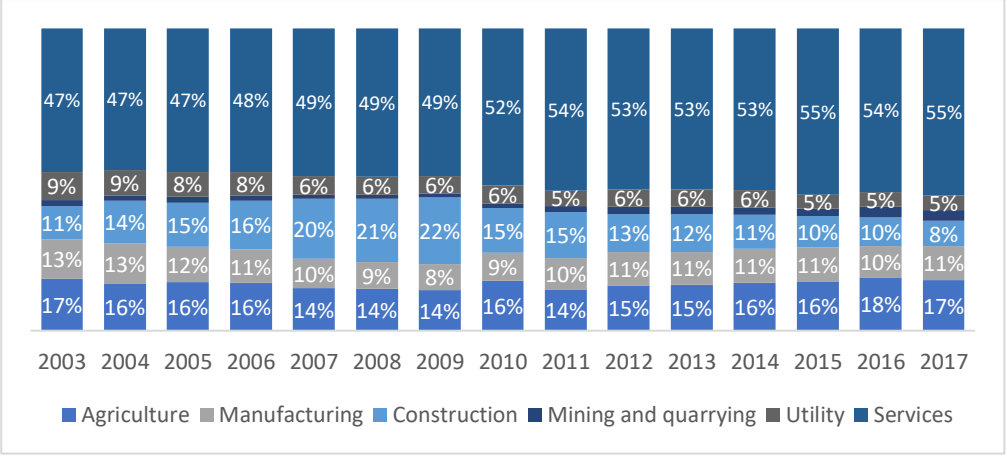
[9] Report 'Poverty in Armenia 2008-2017', SCRA, p. 40-41

[10] See: http://www3.weforum.org/docs/WEF_GGGR_2018.pdf

[11] See: http://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacturing_statistics_-_NACE_Rev._2#Country_analysis

low, due in part to the share of employment (31.34%) in agriculture. During the past 10 years, the Armenian economy has become more diversified, with significant growth in the share of the service sector in GVA, by almost 8 percentage points during the period 2003-2017.

Figure 8: GVA structure in Armenia, % share



Source: Statistical Committee of the Republic of Armenia

International cooperation

On 2 January 2015, Armenia became a member of the Russian-led Eurasian Economic Union (EAEU). This membership provides Armenian products direct access to the Russian, Belarussian, Kazakh, and Kirgiz markets. As a WTO member since 2003, Armenia has the most liberal investment regime among EAEU countries, making it an attractive location from which to base international and regional operations focused on EAEU markets. The country has Generalised Scheme of Preferences (GSP) access to the US, EU, and Japan, and a Free Trade Agreement with neighbouring Georgia which remains in force even after Armenia's accession to the EAEU.

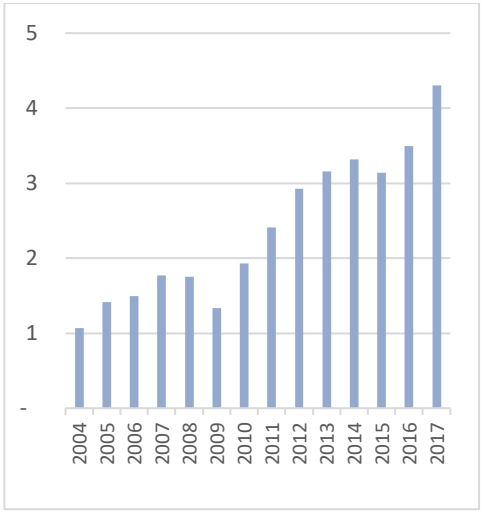
In November 2017, the EU and Armenia signed the Comprehensive and Enhanced Partnership Agreement (CEPA) aimed at significantly deepening their relations. The new agreement is expected to improve the investment climate, stimulating growth and jobs and creating a better regulatory environment for businesses to grow.

The United States and the Armenian Government signed a Trade and Investment Framework Agreement (TIFA) in May 2015, which provides a strategic framework and principles for dialogue on trade and investment. The Agreement provides high-level government engagement to meet and discuss issues of mutual interest, opportunities for trade and investment cooperation, and to ways protect business interests in both countries.

Armenian exports are quite concentrated in a few product groups: base metals (copper, molybdenum, gold) and cut diamonds, food and beverages (canned and

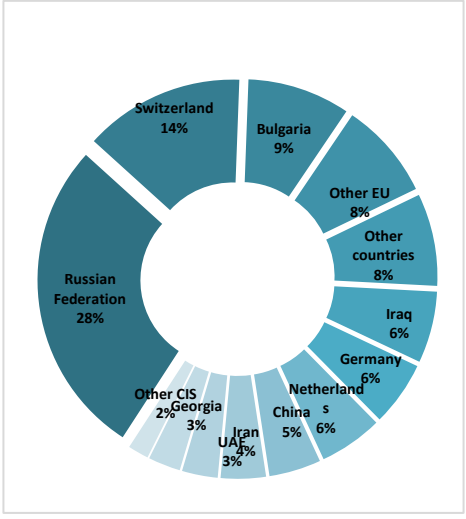
fresh food, brandy), and tobacco. Mining products, textiles, tobacco, fresh fruits and vegetables, IT and tourism services are the most dynamic and growing segments. Exports have become more diversified geographically and by product structure. Armenia's exports in goods tripled during the period 2004-2017.

Figure 9: Exports of goods and services, bln USD, 2004-2017



Source: SCRA

Figure 10: Merchandise export structure by geography, 2018

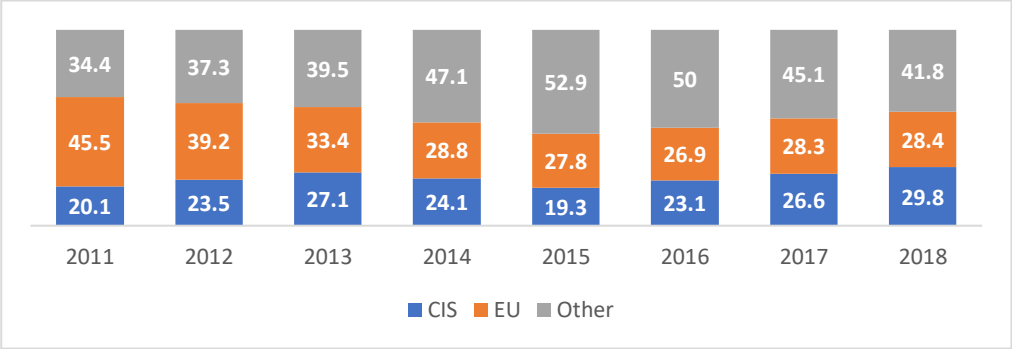


Source: SCRA

The top 10 importers of Armenian goods and services are Russia, the EU, Georgia, Iraq, China, Iran, Switzerland, USA and the UAE. Exports to CIS countries increased by almost 10 percent point in the period 2011-2018 (from 20.1% in

2011 to 29.8% in 2018), while exports to the EU decreased by 17 persent point during the same period, from 45.5% to 28.4%.

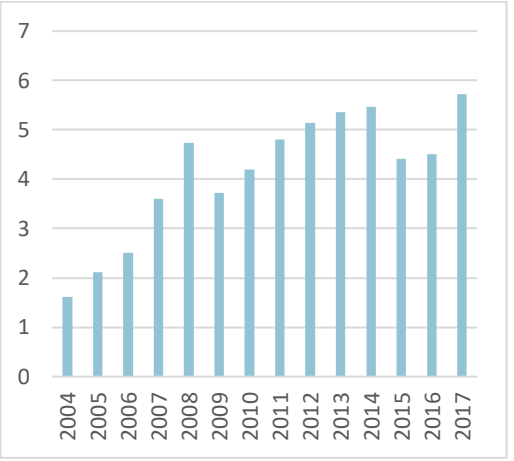
Figure 11: Shares of CIS and EU countries in Armenia's exports, 2011-2018



Source: SCRA

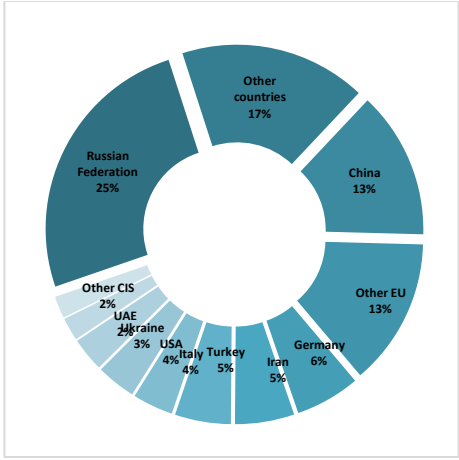
Armenian main import commodities are natural gas, petroleum, mining products, machinery and equipment, chemical products, foodstuffs, pharmaceutical products, precious, semi-precious stones. The share of equipment, machinery and technologies, pharmaceutical products, precious and semi-precious stones are increasing. In 2015 imports decreased in incredible rate -15.1%. This significant decline of imports of goods and services in 2015 is due to depreciation of Armenian Dram and reduced flow of personal transfers from Russia.

Figure 12: Import of goods and services, billion USD, 2004-2017



Source: SCRA

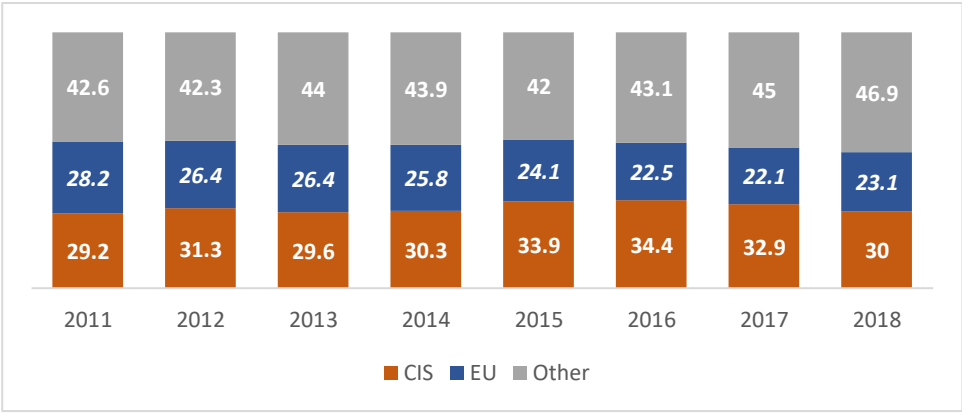
Figure 13: Import structure by geography, 2018



Source: SCRA

Share if imports from CIS countries fluctuated between 29% and 34% with certain ups and downs during 2011-2018, while the imports from EU countries decreased 18%.

Figure 14: Shares of CIS and EU countries in Armenia's imports, 2011-2018



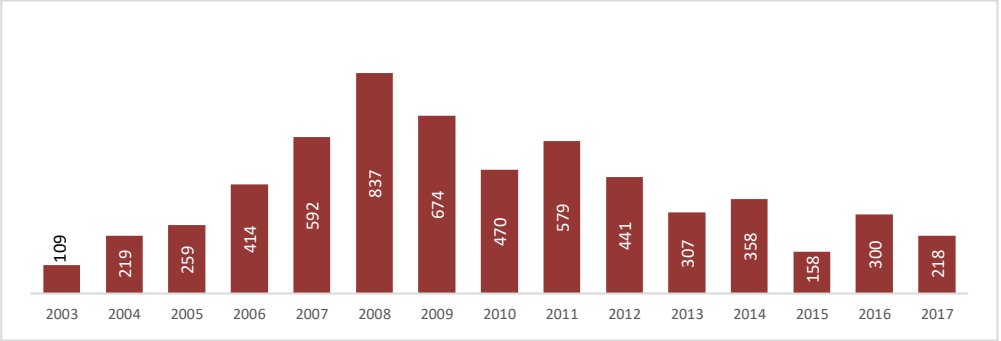
Source: SCRA

Foreign investment

Up to 2008, FDI inflows to Armenia were consistently growing. Increasing volumes of FDI, which peaked in 2008, were driven by large privatisation deals in mining, investment in telecom and airport infrastructure. After a sharp decline driven by the crisis, FDI net inflows have been more volatile. Currently, the main investment targets in Armenia are mining and quarrying, agriculture and food processing, IT and R&D, tourism, and energy generation and distribution. In 2017, Russia, Argentina, France and Cyprus accounted for the biggest direct

investments into the Armenia's real economy. FDIs' high volumes through Cyprus are associated with the benefits that Cyprus offers to offshore companies.

Figure 15: FDI net inflow, in million EUR (2017)

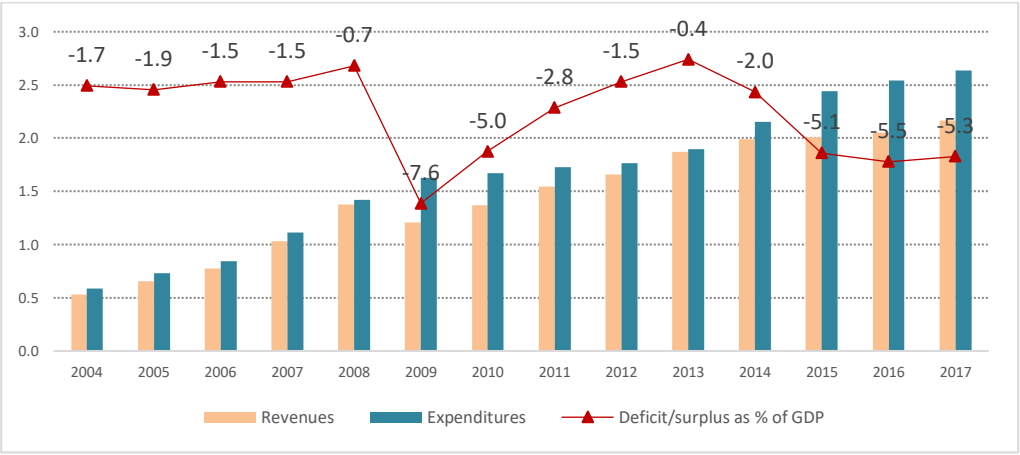


Source: CBA, Balance of Payment

Public finance and external debt

From the beginning of the 2000s, Armenia's public spending on defence and economic affairs recorded a significant increase, while education, environmental and general public services only benefited from a moderate increase.

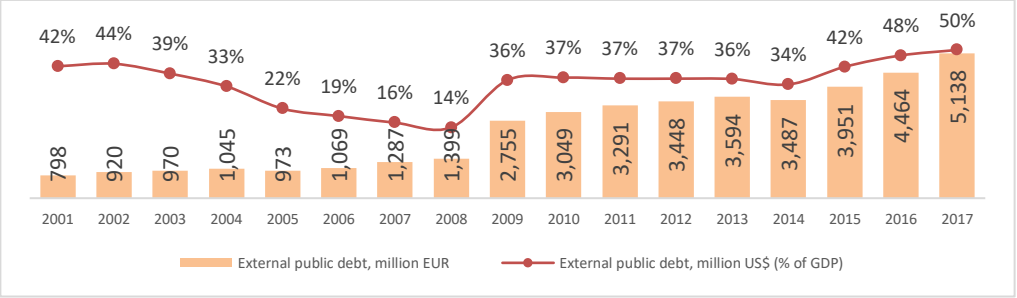
Figure 16: Public finance, in billion EUR



Source: Statistical Committee of the Republic of Armenia

External public debt increased almost 6.5 times in the period 2001-2017. Moreover, the share in GDP also increased from 42% to 50%. Despite this significant increase, the absolute volume and the share of external debt in GDP is still within a manageable range, but approaches the cap defined by law (60%). The majority of new loans went to new large-scale infrastructure projects: roads, energy, as well as to agriculture, tourism infrastructure, export promotion, education, etc. A significant share of the debt is lending by multi- and bilateral donors under privileged conditions.

Figure 17: External public debt, in million EUR



Source: Statistical Committee of the Republic of Armenia

1.4 Key Challenges

In summary, Armenia faces multiple challenges connected with the low level of social and economic development, high levels of poverty often correlated with poor education, a shrinking labour force and increasing dependency on the government which faces budget constraints.

To ensure further development, Armenia needs to:

- encourage domestic and foreign investment into the economy through continuous improvement of the country's business environment, rule of law and level playing field for all;
- streamline and increase the efficiency of public administration and combat corruption;
- increase private-sector competitiveness through efficient and targeted structural economic policies including SME and innovation support;
- investment in human capital with a better alignment of quality, relevance and flexibility which is critical for boosting competitiveness, efficiency and higher value-added production.

2 GOVERNANCE OF THE NATIONAL R&I SYSTEM

2.1 Institutional Framework: Policy Making And Execution

Armenia's institutional set-up places innovation and science into two separate policy domains with clearly distinguished roles and responsibilities.

Currently, two main policy documents exist that should provide a strategic framework for research and innovation policies in Armenia:

- **Strategic Programme for the Development of Science Sector (SPDSS), 2017-20; and**
- **Initial strategy of the formation of innovation economy (ISFIE).**

The **SPDSS** is under the auspices of the Ministry of Education and Science (MES), whereas innovation and industrial strategy is under the remit of the **Ministry of Trade and Economic Development** (now the Ministry of Economic Development and Investments(MEDI)).

Science

The **State Committee of Science** (SCS)[12] of the Ministry of Education and Science is in charge of designing and implementing science policy. According to the statute of the SCS, the main goals are: (i) ensuring the normal operation of the science sector and its progressive development; (ii) preservation and development of science and the scientific-technical potential of the country, including its educational system of scientific personnel; and (iii) supporting the integration of science, education and industry. The oversight of the Committee is executed by the Minister of Education and Science who approves the statute, defines the priorities for the Committee operations, and approves the annual reports. The Committee is headed by the Chairman (appointed by the Prime Minister) who carries out both strategic and daily operations of the body. The Chairman is accountable to the Government of Armenia, the Prime Minister and the Minister of Education and Science.

The **National Academy of Science** (NAS), with 35 subordinated research institutes, operates as a self-governing scientific organisation and has a special status. It is directly subordinate to the Government, and the President of the Academy participates in Government sessions. The Academy's basic funding comes from a specific State budget line. For additional funding and projects, the NAS, or the subordinated research institutes, can participate in competitive calls organised by the SCS.

[12] http://www.scs.am/en/home

Innovation

Science and innovation were placed on the policy agenda in 2000 with the adoption of the Law on Scientific and Technological Activity, which was followed by the adoption of several governmental decrees regulating science and technology activities. The MEDI developed the Concept on Innovation Policy and the State Support Programme of Innovation Activities for 2005-2010. These were approved by the Government in 2005 and were a basis for adopting the Law on State Support on Innovation in 2006. However, these policy documents did not receive sufficient funding for the implementation of the foreseen innovation support. There are also a number of sector development strategies (export-led industrial strategy, tourism, IT, agriculture) which set specific development objectives and measures for each sector including activities targeting technological upgrading and innovation.

The MEDI has the lead for the industrial policy framework. The implementation of economic development and investment policies (covering exports, foreign investment, tourism, SME support, etc.) is supported by four main agencies: the **Enterprise Incubator Foundation**, the **Small and Medium Entrepreneurship Development Centre of Armenia** (SME DNC); and the **Development Foundation of Armenia** (under reorganisation to become the National Investment Foundation), and the **State Committee of Tourism.**

In addition, the **National Centre of Innovation and Entrepreneurship,**[13] an agency reporting to the MEDI, is expected to support the generation of innovative ideas and their incubation and eventual commercialisation, as well as to provide scientific-technical information and library services. Due to limited resources, instruments and capabilities, the agency's activities are mostly focused on organising seminars, information sessions and training.

Three other agencies under the MEDI – the **Armenian Intellectual Property Agency** (AIPA), the **National Institutes of Standards** and the **National Institute of Metrology –** also play a role in the innovation policy system.

The **Enterprise Incubator Foundation** (EIF), established in 2002 within the framework of a World Bank project, supports the development of information communication technology (ICT) in Armenia through the creation of a productive environment for innovation, technological advancement and company growth. The EIF's responsibilities were widened to support innovation in high-tech sectors including ICT. Apart from its incubator and training tasks, the EIF seeks international funding for specific innovation support actions in Armenia and is the main implementing agency for large-scale development projects in the fields of high-tech development and innovation. It has established and operates the regional technology centres in Gyumri and Vanadzor.

The **Small and Medium Entrepreneurship Development Centre of Armenia** (SME DNC) focuses on micro, small and medium-sized firms in all regions of the

[13] http://www.innovcentre.am/en/

country. The main support tools are information services, training, consulting and credit guarantee schemes to ease access to finance for rural businesses. Moreover, SME DNC is one of the **Enterprise Europe Network** (EEN)[14] partners in Armenia. The EEN is an EU-financed international technology transfer and innovation network for SMEs. From an innovation policy perspective, the activities of SME DNC remain closer to those of a more general business support agency than one that is currently well placed to deliver technically more complex support or funding to business innovation projects.

The **SDG National Innovation Lab** is established in the framework of the adoption of the UN Sustainable Development Goals in Armenia and the development of the Armenian National Development Strategy 2030. This is a joint initiative of the Government of Armenia and the UN Office in Armenia, and is the first-ever SDG National Innovation Lab dedicated to SDG implementation at a national level. The Lab aims to be a space for experimentation, collaboration, analytics and world-class human resource development, to unlock Armenia's development potential and accelerate implementation of the SDGs.

Since 2017, the IT sector development became a responsibility of the **Ministry of Transport, Telecommunication and IT**. Under the new Government, a new **Ministry of High Technology Industries** is formed which will be responsible for the development and execution of high tech and innovation policies. Such developments underline the need for cross-ministerial coordination in order to structure efforts to boost technology development and dissemination in the economy and society.

In short, different functions of business development and innovation advice are distributed across many organisations, which have specific missions and beneficiaries.

Policies and strategies

Development of Armenia's science sector is guided by the 'Strategic Programme of Development of Science Sector of the Republic of Armenia in 2017-2020', which is a set of measures and key indicators for promoting excellence in scientific and scientific-technical activities, and for creating a scientific research system competent in the international arena – primarily the European Research Area.

This programme's objectives are:

- Improvement of the science and technology management system,
- Introduction of an efficient system for re-production of personnel engaged in scientific work, modernisation of science infrastructures,

[14] http://een.ec.europa.eu/

- Promoting research of a fundamental and applied nature, including knowledge used in economy and/or of dual importance,

- Establishing preconditions to form a synergistic system of education, science, technology and innovation,

- Primary development of Armenian studies,

- Development of international scientific cooperation, ensuring smart specialisation platform in ERA.

In the scope of the 'Development Programme of the Republic of Armenia's Scientific and Technical Field for 2015-2019' (decision N 54 on 25.12.14), the government prioritises the following fields:

- Armenology, aiming to protect national interests,

- Life sciences, aiming to improve the quality of life,

- Efficient and safe energy, aiming to improve energy consumption efficiency and develop the field of renewables,

- Key enabling technologies (nanotechnology, biotechnology and so on), IT and communication, aiming to raise the competitiveness of the economy in these fields,

- Space, earth and nature sciences, aiming to ensure sustainable use of natural resources and manage disasters,

- Fundamental research focused on the major problems of scientific-technical and socio-economic development, aiming to boost scientific progress, the creation of high technologies and their usage, innovation development and civil society.

At the request of the State Committee of Science the policy mix peer review of the Armenian Science and Technology[15] (S&T) system was undertaken in the frame of the IncoNet EaP, a project funded by the EU FP7 Programme(2015). The aim of this policy review was to critically examine the existing S&T policy mix in Armenia and to provide policy advice from peers in EU and Eastern European countries, thereby increasing mutual understanding and learning. Five issues were considered: overall environment for research Research, Development, Technology and Innovation (RDTI), structural, strategic and legal framework for RDTI, financing of RDTI, human resources and international cooperation.

The report states that research and teaching infrastructure was and still is a relevant part of the research environment in Armenia, but there is no strategic approach to the interfaces between the three sectors of the innovation system:

[15] S&T Policy Mix Peer Review Armenia, Inco-Net EaP, 2015

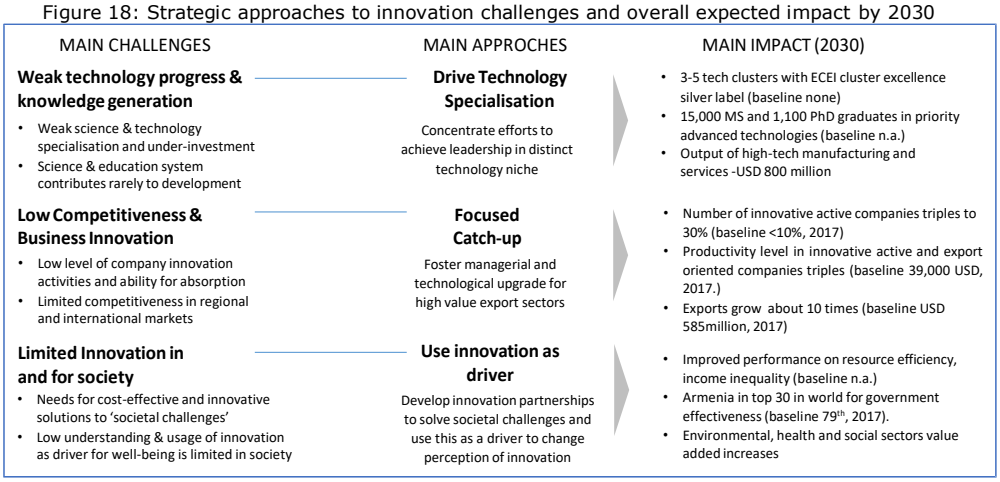
education, research and technological use. Moreover, the available data of the National Statistical Service of the Republic of Armenia(NSSRA) about the education, science and innovation landscape in Armenia is not detailed enough to serve the recent needs for evidence-based political decisions, to steer the innovation system and to benchmark and forecast governmental interventions. Thus, report indicates the importance of reliable and indicators and data, better coordination of different levels and with different goals (e.g. with the Ministry of Education, State Committee of Science, conference of university rectors, and others) and better marketing of Armenia´s intention to regain its role as a S&T power house. A lack of financial data on the the R&D, higher education and innovation sectors and insufficient monitoring of budget flows were identified as a major challenge to the wider Research, development, technology and innovation (RDTI) sector. A detailed look at the age distribution of researchers holding scientific degrees and currently involved in State programmes shows that, even without any other external influences, their numbers will be halved in the next two decades. Some initial attempts have already been made to support researchers, but key issues to make research an attractive career choice, such as a general balanced income system or career options, need to be considered more vigorously. Due to limited financial and human resources, a smart configuration of international cooperation based on Armenia's strengths seems to be an urgent requirement for strategic policy actions. However, according to this report, more international interaction is taking place, but it is not properly reported.

Innovation strategy

In line with the Government's procedures on national development strategy documents, a team of international and national experts, funded by the EU SMEDA programme, developed a concept for a national innovation strategy in March 2018.

Based on Armenia's realities and best international practices, the concept recommends having differentiated approaches to tackle the innovation challenges in Armenia. The key features of the proposed concept are illustrated in Figure 18.

Figure 18: Strategic approaches to innovation challenges and overall expected impact by 2030



Pathway 1: Technology niche leadership, which foresees a concerted and sustained effort to concentrate public-private investment on a limited number of 'high-tech' fields.

Pathway 2: Innovation for export growth, which foresees support for upgrading innovation capabilities in key export clusters in the Armenian economy.

Pathway 3: Challenge driven innovation, which foresees stimulation of broad-based innovation partnerships (partners from business, civil society/users, public sector and research institutes and, ideally, international partners), aiming to develop innovative solutions to societal challenges.

In a first 'jump start' phase, the broad outlines and priorities set in the current strategy paper will be further developed through a process of consultation and multi-stakeholder discussions that can be likened to the 'entrepreneurial discovery process' used in the EU to support the design and subsequent delivery of smart specialisation strategies for research and innovation.

According to this framework, the strategy is based on a number of high-level 'necessary conditions':

- An increase of public investment in science and innovation – the Government should set a clear medium-term target to increase the share of the budget allocated to science and innovation, as the current level of funding is sub-critical and is not sufficient to leverage additional private sector or foreign investment in favour of more innovative activities.

- Investment and activities should be targeted in all three pathways towards partnerships which can develop a strong case for prioritising their technology field, cluster or societal challenge, and which set ambitious targets to achieve within an agreed timeframe.

- The initiatives supported under each pathway should not only focus on quantified targets but also qualitative ones: innovation management, skills and capacities in the business, research, education and public sectors; as well as boosting innovation awareness in the broader society.

- Enhanced coordination of policy at inter-ministerial level means and a shift towards joint implementation actions through the adoption of medium-term programmes.

- The set of strategic initiatives proposed in this strategy are intended to help focus and structure donor activities to increase the medium-to-long run impact and sustainability of their interventions.

- Improved administrative, strategic planning and capacity for agencies supporting business development, innovation and technology transfer, exports and foreign direct investment.

The concept was intensively discussed with the Ministry of Economic Development and Investment, State Committee of Science and PM, but later the approval of the document was stalled due to the political changes in the country.

2.2 Performance Of Innovation Ecosystem (Global Innovation Index)

Armenia ranked 68th in the Global Innovation Index (GII) in 2018. Ranks for knowledge and technology outputs, institutions and creative outputs (62nd, 67th and 48th respectively) were higher than the country's overall rank. Business sophistication, infrastructure and human capital and research (88th, 93rd and 110th respectively) rank considerably lower. However, the good rankings are skewed by a few 'high-performing indicators' suggesting that NIS is characterised by a few 'pockets of excellence'; while the low performing indicators point to significant gaps in 'necessary conditions' for a well-functioning NIS.[16]

Low ICT take-up (usage, e-government, etc.), ICT service imports (ranked 92nd), and computer software spending (86th), which can be used as proxies for knowledge absorption, contrast with a strong (ranked 18th) in ICT service exports as a percentage of total trade (highlighted as a strength by the GII). This points to an ICT 'cluster' that is not linked to the rest of the economy and, thus, not reflected in broader capabilities. From an industry 4.0 (business digitalisation) perspective, the challenge is to improve ICT usage and productivity across the economy.

Table 1: Main structural and performance indicators of Armenia's NIS

	2013	2014	2015	2016	2017	2018
Global Innovation Index	**59**	**65**	**61**	**60**	**59**	**68**
Innovation Efficiency Ratio	42	28	34	15	17	15
Innovation Input Sub-index	71	81	69	80	82	94
Innovation Output Sub-index	47	55	51	43	47	50
GII Pillars						
1. Institutions	57	58	57	61	63	67
2. Human capital and research	71	99	105	104	103	110
3. Infrastructure	97	93	76	74	91	93
4. Market sophistication	48	56	36	78	46	81
5. Business sophistication	84	90	89	82	85	88
6. Knowledge and technology outputs	58	51	46	48	50	62
7. Creative outputs	53	63	55	44	44	48

Source: Global Innovation Index 2018

[16] The analysis and assessments of the innovation ecosystem performance are largely based on the Innovation Mapping Report (EU SMEDA 2018) with updates of the author.

Despite a low innovation input sub-index (94th), innovation output ranks quite high (50th) leading to a strong innovation efficiency ratio (15th). This can be explained by the rich heritage of the science system and progressive developments in the ICT sector. The innovation output scores are boosted by an overall above average knowledge creation rank (38th) including a high relative level of patenting (and other forms of intellectual property) as well as scientific and technical articles compared to GDP (PPP USD).

Again, the data on innovation outputs hints at some 'pockets of excellence' in the NIS, while other indicators suggest that knowledge impact and diffusion are weak. Rather than growing a few high-tech spin-off or start-up companies, the real challenge these indicators point to is the need for existing businesses to reinforce their productivity and product development ('value creation') position in their respective (global) value chains.

The specific Armenian weaknesses are related to 'capabilities' (skills and know-how) and cooperation linkages, expenditure on education as a percentage of GDP (107th), graduates in science and engineering (90th), innovation linkages (99th) and knowledge absorption (94th). For the latter, the suggestion that Armenian businesses import new technologies is undermined by the low level of high-tech imports (104th). Two key indicators for innovation linkages point to a poorly functioning innovation ecosystem, with university/industry research (85th) and state of cluster development (86th) much lower than average.

Table 2: Performance of Armenia versus selected benchmark countries, 2018[17]

	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and technology output	Creative outputs
Armenia	67	110	93	81	88	62	48
Belarus	81	34	73	91	53	65	122
Georgia	39	67	71	39	91	57	73
Estonia	22	36	21	35	30	29	5
Israel	34	14	25	13	3	7	15
Ireland	17	17	4	29	10	4	19
Latvia	31	53	45	24	36	51	23

[17] Numbers in red indicate the lowest rank among the benchmarking countries.

	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and technology output	Creative outputs
Lithuania	38	46	32	50	35	58	33
Ukraine	107	43	89	89	46	27	45
Azerbaijan	71	100	66	26	96	89	87

Source: Global Innovation Index 2018

Table 2 provides a benchmarking of Armenian performance using GII data against the Eastern Partnership (EaP) countries of Belarus, Georgia, Ukraine, and Azerbaijan, the Baltic States (Latvia, Lithuania and Estonia), Israel and Ireland.

As can be seen, Armenia's relative weaknesses lie in human capital and research and infrastructure. Elements of Armenian under-performance can be, in part, explained by missing or incomplete data such as intellectual property receipts as a share of trade, researchers as share of population and business expenditure on R&D.

Innovation performance and outcomes can be measured by several indicators including those collected through surveys of business innovation activity and in overall terms by growth in value added in the economy (productivity) and well-being (income per head, reduction in share of population in poverty, improved social and environmental metrics, etc.). The National Statistical Service has recently completed a pilot survey applying the EU's 'Community Innovation Survey 2014' model questionnaire.[18]

The survey results provide initial and useful insight into the extent and type of innovation activity in the Armenian business sector (in total 1489 companies replied of which 60% were based in Yerevan). Key findings of the survey include:

- Overall, 9.4% of enterprises declared themselves to be 'innovation active'; however, this figure varied significantly by sector rising as high as 24.8% of enterprises in the scientific and technical service sector, 14.6% of manufacturing firms, 14.5% of mining firms, 13% of agricultural firms, 12.5%

[18] A World Bank Enterprise survey from 2013 covering nearly 400 firms in Armenia and Georgia found much higher innovation rates for Armenia which performed relatively well when benchmarked with 10 Europe and Central Asia countries (including eight EU Member States). See chapter 4 in Kuriakose S (2013) for more details.

of financial and insurance firms and 11.4% of information and communication firms.

- Only 4.3% of firms declared to have carried out product (only) innovation, 2.8% process (only) innovation, 6% product and process innovation, 3.5% organisational innovation and 5.1% marketing innovation.

- Large and medium-sized firms tended to be more innovation active, for instance 24.5% of larger manufacturing firms, 29% of larger information and communication firms, etc. However, there were exceptions such as scientific and technical services and mining (26.8% of smaller innovation active firms) and financial services (14.3%).

- Manufacturing firms dominate in terms of product innovation (38.4% of active innovators); the same is true of process and product innovators, where manufacturing firms account for between 30% and a third of total innovation active firms. Organisational innovators are more equally spread: retail trade (19% of total), hotel and catering (15.8%), scientific and technical services (18%), and manufacturing (28%). In terms of marketing innovation, the retail trade sector (30.2%) and manufacturing (37.6%) are the most active.

Table 3: Share of innovation active firms by sector – Armenia compared with selected EU28 countries (CIS 2014)

NACE_R2	Armenia	Croatia	Estonia	Latvia	Lithuania
Innovation core activities	9.4	39.7	26.5	25.5	43.3
Mining and quarrying	14.5	22.6	25	8.6	58
Manufacturing	14.6	41.3	26.9	28.9	43.7
Accommodation and food service activities	8.5	29.1			
Construction	3.3	22.2			30.3
Electricity, gas, steam and air conditioning supply	2.8	63.5	30.2	36.4	53.5
Financial and insurance activities	12.5	50.5	40.4	40.1	42
Information and communication	11.4	59.6	39.7	41.1	63.6
Professional, scientific and technical activities	24.8	34.8		28.7	
Real estate activities	6.5	24.9			

NACE_R2	Armenia	Croatia	Estonia	Latvia	Lithuania
Transportation and storage	3.4	29.9	17.3	13.8	32.5
Water supply; sewerage, waste management and remediation activities	4.5	36.1	39.4	17.5	54.8
Wholesale and retail trade; repair of motor vehicles and motorcycles	7.9	33.5		24.7	

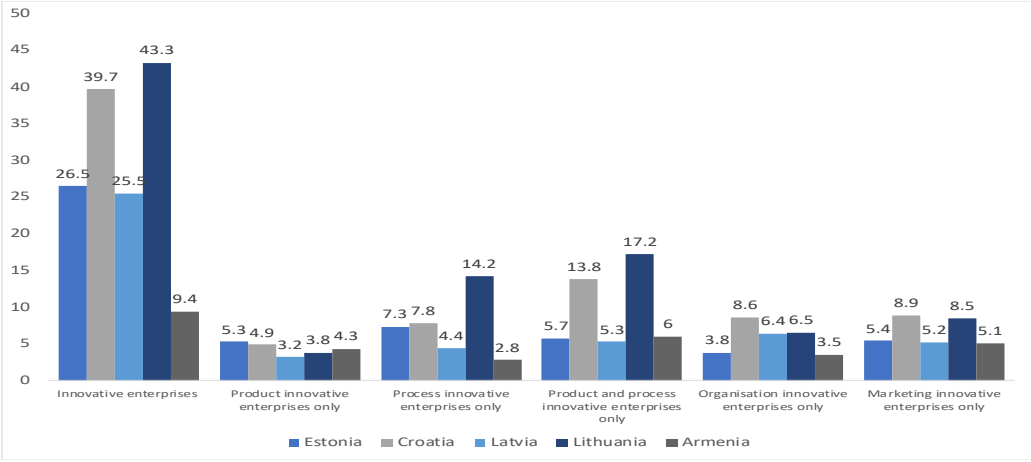
Source: NSS for Armenia; other countries: Eurostat

In order to provide a comparison, data for selected EU28 countries on rates of innovation activity for the CIS 2014 survey are provided in the table above. As can be seen, in overall terms Armenian innovation activity rates are much lower than the three Baltic States or even Croatia (the newest EU Member State). However, Armenian performance in 'professional, scientific and technical activities' sector and, to a lesser extent, in mining and manufacturing sectors are close to the average for the EU28 benchmarks. In contrast, the innovation activity rate in information and communication is far from the rates witnessed in the EU countries and the same can be said for the financial, water supply, energy and construction sectors.

While it should be kept in mind that the Armenian survey was a pilot, it does point to a significant 'innovation deficit' overall and in most sectors, however, when comparing by type of innovation, the gap is less significant – as can be seen in the following figure.[19]

[19] Armenia Innovation Mapping Report. 2018

Figure 19: Comparison of rates of innovation activity by type of innovation



Source: data for Armenia, NSS; Other countries: Eurostat

The findings offer some grounds for optimism if policy measures can target selected groups of companies (e.g. manufacturing, ICT, 'fin-tech', energy, water, etc.) where innovation rates are low. Nevertheless, a key factor dragging down Armenian innovation activity rates is the relatively low share of manufacturing in the economy. The pilot survey also provides insight into the factors hampering innovation, with lack of funds within the enterprise or group being a main factor along with uncertain demand for innovative goods or services. Surprisingly, knowledge factors such as information on markets, finding partners for innovation, qualified personnel and lack of information on technology were generally not considered a hampering factor. Only eight of 238 innovative enterprises reported receiving public financial support. A key driver of Armenian enterprises' decision to introduce innovation with environmental benefits is the high cost of energy, water and materials (46% of firms).

Considering the type of innovation expenditure, it is noteworthy that the majority of innovative firms are pursuing innovation through the acquisition of machinery, equipment and software (notably in small innovative firms); while in-house research and development on a continuous basis is only carried out by 47.6% of medium-large innovative companies and 24.5% of small innovative firms. A relatively small share of innovative companies (9.7% in total) are commissioning external R&D (e.g. from research institutes or other companies). The majority of enterprises implementing product and process innovation with a partner reported that the partner was located in Armenia (42 out of 68 companies) followed by Europe (15 companies). This points to a rather 'closed' innovation system (possibly due to cost or language constraints).

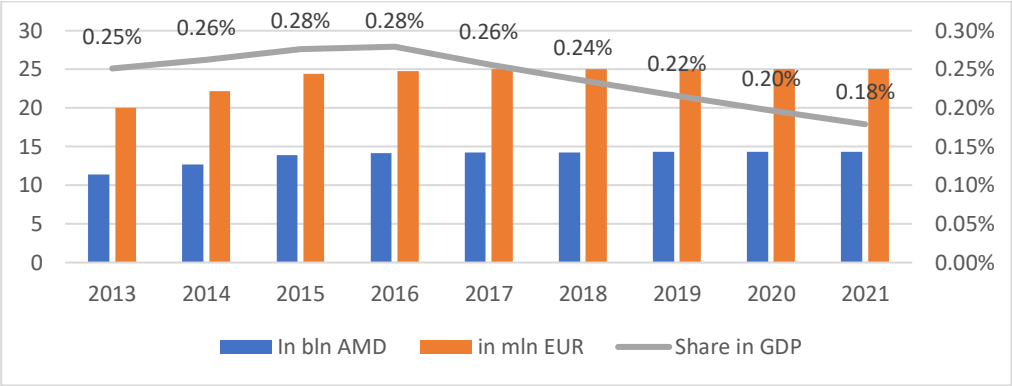
3 FINANCING OF R&D

3.1 Public Funding Of R&D

Armenia's gross expenditure on R&D (GERD), which in this case is equivalent to government and higher education expenditure as no data is collected on business R&D expenditure, has remained largely unchanged as a share of GDP in the last decade, at roughly 0.25% and rising in absolute terms to AMD 14 billion (or EUR 25.4 million) in 2018, of which 88.2% was performed in the government sector and 11.8% in higher education.[20]

In budgetary terms, Government expenditure on science grew between 2013 and 2017. According to the current medium-term expenditure framework plan (2019-2021) the annual science budget will remain at AMD 14.3 billion (or EUR 25.1 million) level for 2019 and the next two years. Considering GDP growth forecasts, science expenditure's share in GDP will decrease.

Figure 20: State expenditures for science in AMD and EUR and its share in GDP



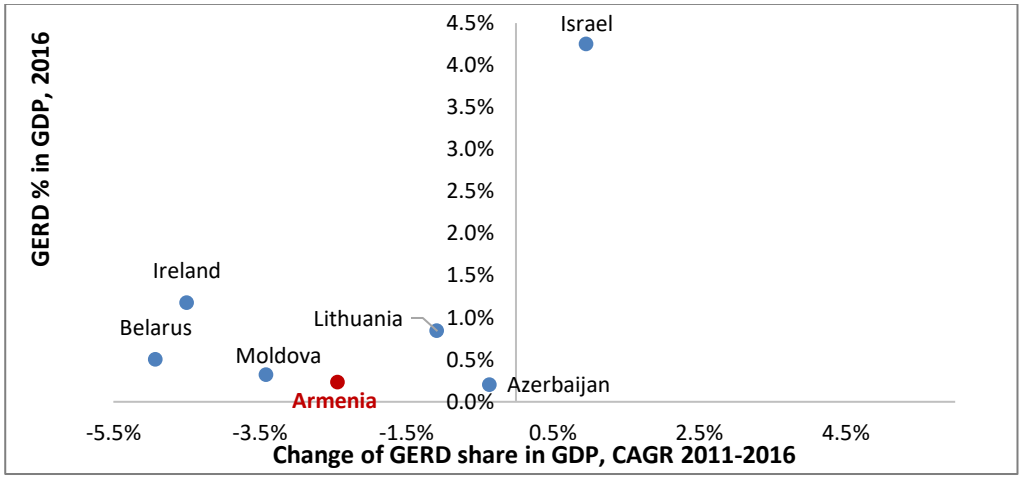
Source: Strategic Programme of Development of Science Sector of Armenia, 2017-2020, State Budget for 2018, Medium-term Expenditure Framework 2019-2021

The degree of science and technology prioritisation is vividly reflected in the level of R&D funding relative to the size of the economy. The most technologically advanced countries typically have higher levels of spending on R&D compared to GDP.[21] One of the most well-known cases is Israel, which traditionally maintains one of the highest levels of spending in the world.

[20] http://uis.unesco.org/en/country/am?theme=science-technology-and-innovation

[21] Due to missing data on business expenditures on R&D for Armenia, GERD captures only R&D expenditures of Government (GOVERD) which artificially reduces the GERD/GDP indicators for Armenia.

Figure 21: GERD to GDP, in %, 2016 vs. CAGR 2011-2016



Source: UNESCO

Note*: For Georgia, the calculations are done for the period 2014-2016

Expenditures on R&D in Armenia are in the lowest quantile in the peer group, in line with its neighbours. Moreover, the share of the GERD in GDP has decreased during the 2011-2016 period.

The distribution of State funding by types of financing of scientific and scientific-technical activities (2015-2017) indicates that the largest share of the budget (73-77%) was allocated to 'Basic funding including premiums for scientific degree'. The purpose of this is to cover operational and maintenance costs of public research institutes and ensure their functionality.

Table 4: Allocation of state funding volumes according to the types of financing of scientific and scientific-technical activities, 2015-2017

N	Type of financing	2015	2016	2017	2018	2019	2020	2021
1	Basic funding including premiums for scientific degree, million EUR	18.84	19.18	19.11	18.23	18.35	18.35	18.35
	Share in total, %	77.2%	77.3%	76.4%	72.9%	73.3%	73.3%	73.3%
2	Financing of state programs (Target funding), million EUR	3.22	3.24	3.24	4.50	4.50	4.50	4.50
	Share in total, %	13.2%	13.1%	12.9%	18.0%	18.0%	18.0%	18.0%
3	Contract based research (thematic financing) million EUR	2.34	2.38	2.67	2.29	2.17	2.17	2.17
	Share in total, %	9.6%	9.6%	10.7%	9.2%	8.7%	8.7%	8.7%
Total, million EUR		24.40	24.81	25.02	25.02	25.02	25.02	25.02

Source: Mid-term Expenditure Programme 2019-2021

Almost 180 Government-financed projects were implemented in 2015 and 2016 with the aim of boosting scientific and scientific-technical activities. The number of projects was 173 in 2017. An average of 12 applied research projects were funded annually between 2015 and 2017. Only about 9% of the budget was allocated to thematic financing.

Institutional ('Basic') funds go to support and carry out programmes that are offered by public (State) research organisations and universities. Public and private research organisations together with universities are funded by so-called 'Target' funds, while the 'Topic' funds go to research groups (max. 5 members), individual researchers and PhD students from public and private research organisations and universities.

Among the top 20 research organisations receiving Basic funding, Yerevan Physics Institute, followed by Matenadaran and Yerevan State University will get EUR 1.1-1.5 million, other 9 between EUR 400-650,000 and the rest EUR 330,000, on arevage.

Applied research with fundamental and essential significance received EUR 25,000 in annual support 2015-2017, and was carried out by 11, 8 and 10 research centres respectively.

Table 5: Distribution of science budget by expenditure direction, '000 EUR 2015-2017

Expenditure programs for scientific and scientific-technical activities	2015	2016	2017
Applied research with fundamental and essential significance	25	25	25
Infrastructure maintenance and development	15,492	15,812	15,875
Preservation of scientific objects of national value	1,517	1,536	1,575
Premiums to researchers for scientific degree	1,645	1,650	1,473
Development of scientific personal	161	161	166
Government targeted programs	3,224	3,239	3,239
Contractual (thematic) research	2,336	2,382	2,669
Total	**24,401**	**24,806**	**25,022**

Source: Mid-term Expenditure Programme 2019-2021

Government financing on infrastructure maintenance and development programmes increased by only 2% during the period 2015-2017 (from EUR 15.5 million in 2015 to EUR 15.9 million in 2017). In the scope of this expenditure programme, 72 (2015), 74 (2016) and 73 (2017) State research centres were financed. There is also a competitive grant component for research laboratories and researcher groups. The new approach for infrastructure maintenance and development programmes has been in place since 2010. The projects should include a scientific research component which ensures that investments are closely related to the research outcomes.

Among the competitive grants' sub-programmes, the following programmes were financed by the government:

- Competitive grants programme for obtaining modern scientific equipment and technology;
- Competitive grants programme for international bilateral scientific collaboration;
- Competitive grants programme for the creation of two research laboratories and one group together with the French National Centre for Scientific Research (CNRS);
- Membership of International Scientific Institutions;
- Participation in international scientific collaborations, in particular the three core experiments A Large Ion Collider Experiment(ALICE), A Toroidal LHC

Apparatus(ATLAS) and Compact Muon Solenoid(CMS) of the European Organisation for Nuclear Research (CERN);

- Programme ensuring free access to leading international scientific information databases to State scientific organisations and higher education institutions;
- Financial assistance programme for organising conferences;
- Support programme for organising schools for young scientists;
- Fellowships for participating in conferences and other scientific events abroad.

Aiming to strengthen young professionals in the science field, the following initiatives are being implemented:

- Two-year research assistance programme for young scientists (under 35 years' old);
- Annual programme for encouraging PhD (under 35s) research;
- Annual programme for encouraging young scientists (under 35s) working in State scientific programmes.

A new evaluation scheme was introduced in 2013 according to which each scientific application has to be examined by two independent experts. Some 85% of the score is based on the average of the experts' scores and the remaining 15% is the professional assessment of the head of the research group and performers.

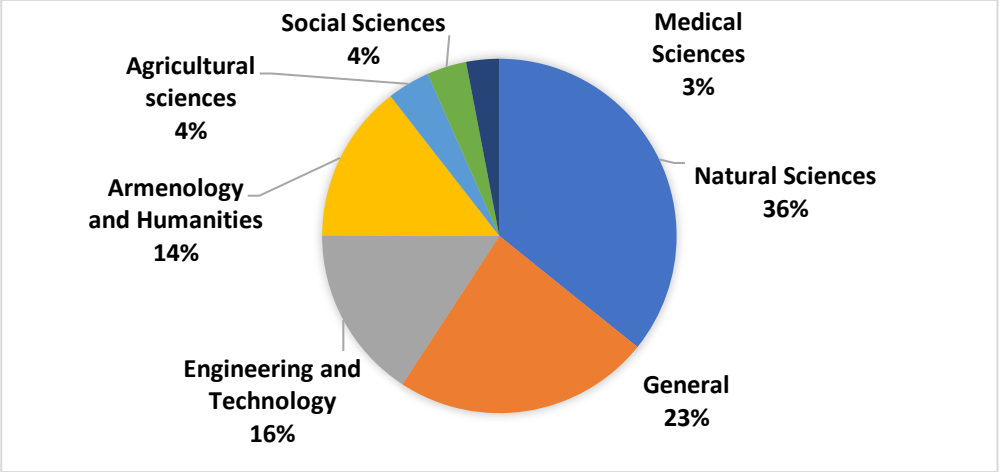
About 1,714 scholars were involved in a scientifically independent system of expertise in December 2015, out of which 518 were scholars from abroad.

While Topic funding's decision making relies on both the board expertise and independent experts, institutional funding depends only on the decision of board expertise. Target funding decision is being made not only based on the board expertise but also government resolution.

Budget allocation by field of science

In terms of scientific specialisation, data on the broad distribution of the State science budget by scientific field is presented below. The total budget in 2017 was EUR 25.1 million with three fields (natural sciences, engineering and technology, Armenology and humanities) absorbing 65% in total.

Figure 22: Armenian science budget (2017) by field of science



Source: SCS

While the data is not entirely comparable, it is instructive to compare government budgets[22] (see Table 6). Different patterns emerge across countries (this can be partly due to different classification methods but also reflects priorities). For instance, Estonia allocates 8% to transport and telecommunications R&D (digital agenda); 14% to health, 7% to environment (both in line with smart specialisation priorities) and close to 5% to 'culture' (Estonian language and culture studies being given a high priority.

Ireland has a relatively high share allocated to industrial production and technology and agriculture (reflecting the dual nature of the economy driven in part by FDI manufacturing operations and by agro-food production). Lithuania's distribution is less marked, but double the EU28 average is invested in agricultural research, energy (a national priority also receives a relatively high share) while cultural R&D is double the EU28 average.

[22] Innovation Mapping Report, EU SMEDA, 2018

Table 6: GBAORD by socio-economic objective (2015) selected EU countries

NABS07/GEO	EU28	Estonia	Ireland	Lithuania
Exploration and exploitation of the earth	2.2%	1.4%	0.4%	3.1%
Environment	2.7%	7.7%	1.0%	2.1%
Exploration and exploitation of space	5.0%	1.4%	2.3%	0.0%
Transport, telecommunication and other infrastructures	2.8%	8.1%	0.5%	0.0%
Energy	4.1%	2.3%	1.0%	5.2%
Industrial production and technology	8.9%	4.0%	20.8%	7.8%
Health	9.5%	13.8%	5.7%	2.0%
Agriculture	3.3%	6.1%	12.4%	6.3%
Education	1.4%	3.6%	2.6%	1.0%
Culture, recreation, religion and mass media	1.0%	**4.7%**	0.0%	2.3%
Political and social systems, structures and processes	2.7%	4.3%	1.2%	1.7%
General advancement of knowledge: R&D financed from General University Funds (GUF)	34.4%	0.0%	18.2%	53.6%
General advancement of knowledge: R&D financed from other sources than GUF	17.3%	41.1%	34.1%	14.8%
Defence	4.8%	1.5%	0.0%	0.1%
Total civil R&D appropriations	95.2%	98.5%	100.0%	99.9%
Total R&D appropriations	100.0%	100.0%	100.0%	100.0%

Source: Eurostat [gba_nabsfin07]

Armenia's budget reflects the importance of 'Armenology' (similar to Estonia's emphasis on language and cultural preservation) and has a relatively high share (like Ireland) allocated to engineering and technology. In contrast, medical sciences seem to receive a relatively lower share (only Lithuania allocates less). A more detailed breakdown of the Armenian science budget would possibly clarify the share of, say, engineering and technology science funding that is allocated to specific technologies or defence-related R&D (presumably relatively important given Armenia's geopolitical situation).[23]

3.2 Private And International Funding Of R&D

Investment funds and private development foundations are an important backer of innovation in Armenia. Innovative SMEs in the country can currently apply to two Armenian venture capital firms: Granatus Ventures and Smartgate. Granatus ventures was established in 2013, with the help of the Armenian diaspora and World Bank. The fund focuses on later-stage companies. Smartgate is a fully private fund which focuses on smaller-scale companies, providing up to EUR 85,000 in financing.

Since late 2014, a total of USD 87.6 million in venture capital and grant financing has been infused into Armenian start-ups; USD 2.1 million in grants came from the World Bank and EU/GIZ via the Enterprise Incubator Foundation (55 deals with 50 companies), USD 20.5 million seed investments (39 deals with 24 companies), USD 45 million series A deals (6 deals with 5 companies) and USD 20 million series B deals of PicsArt company.

[23] Ideally, it would be instructive to have more detailed data such as the distribution of budget by type of expense (research funding, maintenance, rewards, laboratory upgrade); distribution by type of recipient organisation (R&D institutions, academies, universities, etc.) and distribution by scientific sub-categories.

3.3 Main R&D And Innovation Funding Initiatives And Support Infrastructures

Business R&D tax and financial incentives

There are no special tax credits, custom exemptions, or incentives for R&D. There are no financial support schemes such as R&D subsidies or grants. Only one tax incentive supporting tech entrepreneurship has been introduced; namely a 0% income tax, 10% flat payroll tax for tech start-ups. The support scheme ended in December 2017, but is reported to have created about 700 new IT and high-tech start-ups over four years.

R&D funding mechanisms

State funding for research (managed by the SCS) is channelled through the science budget via four main financing mechanisms:

- Financing the maintenance and development of science infrastructure (about 60% of total budget) which is allocated to State-owned research institutes;
- Special purpose R&D, such as defence-related projects (about 11%);
- Thematic funding based on calls for proposals from the research community (about 7%);
- A small portion for collaborative and applied research (less than 1.5%).

The portfolio of projects indicates that there is low engagement by the private sector in this instrument.

Idea and innovation matching grants

To foster business innovation, European Investment Fund (EIF) manages two types of grant competitions financed by the State and donors (U.S. Civilian Research & Development Foundation (CRDF Global), World Bank and European Union):

- Science & Technology Entrepreneurship Programme (STEP) – supported by CRDF and co-financed by the State provides five 'idea' grants annually to engineers, researchers, and scientists aimed at helping them take their innovative products to market, create new ventures, and to encourage effective partnerships with established companies (annual budget up to USD 75,000);
- Innovation matching grants (in the frame of the World Bank's EIC project) with the total disbursed amount of USD 1 million (33 grantees which later attracted external investments of USD 13 million);
- Innovation matching grants (supported by the EU-funded SMEDA project) with a total budget of EUR 750,000 (30 grantees in the first round of competition);
- Innovation matching grants (supported by World Bank and SMEDA project).

As can be seen, the implementation of such grant schemes largely depends on the availability of donor funding.

4 R&D PERFORMERS

4.1 Higher Education Institutions

Armenia has a well-established system of tertiary education that encompasses 22 state universities, 37 private universities, four universities established under intergovernmental agreements and nine branches of foreign universities. Universities in Armenia have a high degree of autonomy in formulating curricula and setting tuition fees. With only a few exceptions, universities tend to focus almost exclusively on teaching and do not engage in, or encourage, research by staff.

In the 2016/2017 academic year, the total number of faculties in State universities comprised 17,517 – out of which 945 (5% of the total) have a doctoral decree. There are no statistics on their engagement in research activities.

The Government established the Competitive Innovation Fund (CIF) to modernise and enhance the financial system through integrating effective principles and mechanisms for funding the various institutions. The CIF acts as a policy mechanism triggering innovation and advances in higher education through competitively issued grants. During the period 2013-2018, 15 universities implemented 22 grant projects worth a total budget of EUR 7.6 million. Half of the projects were collaborations with private local companies. The last round of the grant allocation is planned in 2019. The activities on mainstreaming the CIF will be continued under the framework of the World Bank's new Education Improvement Project, however, after 2019, the future operations of the CIF remain unclear.

Out of Armenia's universities, Yerevan State University topped the list of organisations involved in State science programmes in 2017 (5.8% of budget) followed by Armenian National Agrarian University (about 2%). State Medical University, National University of Architecture and Construction, and National Polytechnic University are in the second tier, receiving about 1% of the State budget each year.

4.2 Public Research Institutes

Over the last three decades, research activity has fallen significantly. It is estimated that the number of scientists dropped from 25,344 in 1991 to about 5,000-6,000[24] currently, while the number of research institutes fell from 124 to 83 over the same period. The National Academy of Science (NAS) has 35 research institutes and scientific centres in five main disciplines: mathematical and technical sciences; physics and astrophysics; natural sciences; chemistry and earth sciences; and Armenology and social sciences. Aside from the NAS system, 47 institutes come under the the remit of the State, and the rest are private.

[24] The range: SCS data and official statistics.

Table 7: Distribution of scientific institutions engaged in State programmes by fields of science and type of institutions as of January 2017

Filed/Type of Institutions	NAS	Private	State	HEI	*Grand Total*
Chemistry and earth sciences	5	1	6	-	12
Mathematical and technical sciences	4	4	1	-	9
Natural Sciences	8	2	3	-	13
Physics and astrophysics	5	-	3	-	8
Social sciences	12	3	19	-	34
Multidisciplinary	-	-	-	15	15
Grand Total	34	10	32	15	91

Source: Science Committee of the Republic of Armenia

Note:
NAS: Nation Academy of Science
HEI: Higher Education Institutions

The NAS is the best research performer, receiving about 40% of the State science budget. Another 30% is allocated to the State Committee of Science (15.5%), the Ministry of Defence (11.5%), and other research institutes under ministry responsibility. Private research institutes and scientific agencies absorb about 18% of the science budget.

4.3 Business Enterprise Sector

There are no official statistics on business expenditure on R&D. However, expert opinion tends to conclude that most business R&D is done by foreign companies (MNCs) along with a few larger domestic firms (e.g. in mining, IT or precision engineering).

A group of successful Armenian start-ups have emerged in the IT industry, such as Picsart which attracted USD 35 million in capital (including from Sequoia). Betconstruct is another start-up with Armenian origins takin gon global markets with its award-winning technology and services for online and land-based gaming. Large-scale acquisitions in the industry include that by Monitis (acquired by GFI Software in 2011), VMWare (acquired Integrien for around USD 100 million), and Oracle (acquired LiveLook aimed at becoming a regional R&D hub). The industry has attracted certain global brands such as Synopsis, which located a considerable part of its R&D functions in Armenia. Foreign enterprises comprise 35% of all of the company's operation in the field of ICT, leading to a high degree of internationalisation and significant exports.

Along with the IT industry, engineering and especially the precision engineering industry has seen strong progress in recent years. The industry is still nascent (about USD 25 million in 2015) compared to the IT industry, but the presence and successful operations of global firms, such as National Instruments and IBM, indicate the positive growth prospects, encouraged by the State's forward-looking

development strategy for the industry (part of Armenia's 'Export-led Industrial Strategy') aimed towards attracting MNC production and R&D units and positioning Armenia as a R&D centre.

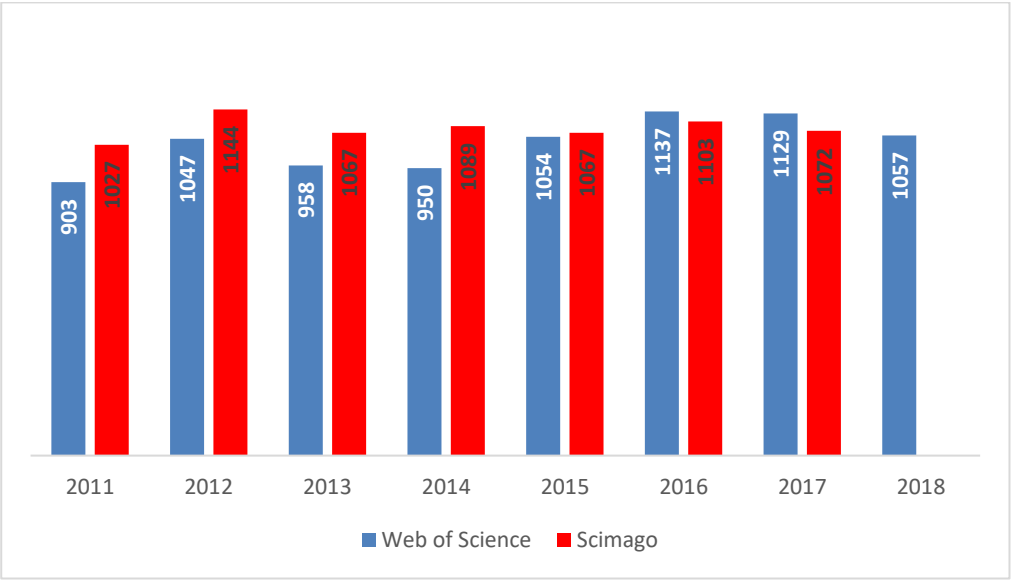
5 QUALITY OF THE SCIENCE BASE

5.1 Positioning Armenian Scientific Excellence Along Bibliometric Indicators

This section represents Armenia's bibliometric profile which includes the total number of published documents, citable documents, citations and citations per document.

Figure 23 represents the total number of published documents according to the Web of Science and Scimago databases (2011-2018).[25] Armenia's total number of published documents increased by 17% during this period with slight ups and downs according to Web of Science, while it increased only by 4% (2011-2017), according to Scimago. The growth trend of publications is flattering.

Figure 23: Number of publications, 2011-2018

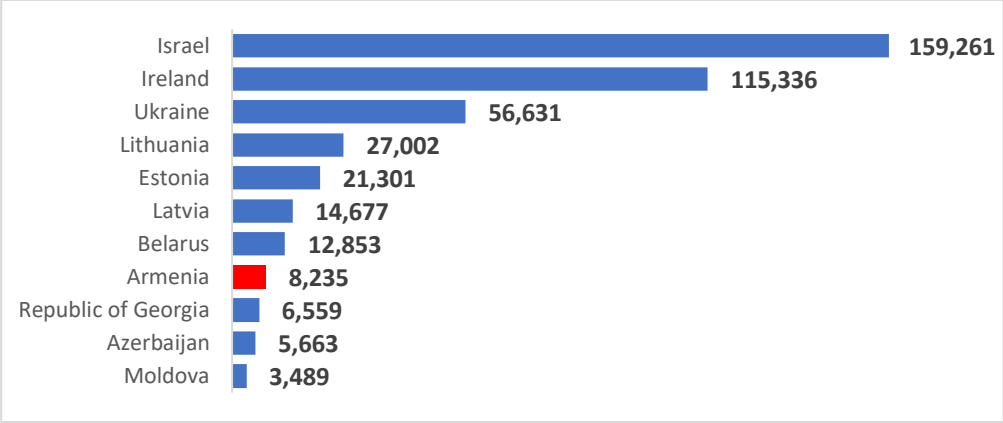


Source: Web of Science, Scimago; last accessed on 3 April 2019

The next figure indicates the comparison of total published documents (2011-2018) by different countries. Benchmarks for this exercise include the Eastern Partnership countries, Baltic States, Israel and Ireland. Compared with these countries, Armenia has a quite high output (8,235 publications) when taking into account its size and population. While comparing with only Eastern Partnership countries, Armenia is in the 3rd place following Ukraine (56,631 publications) and Belarus (12,853 publications).

[25] No data available for 2018 in Scimago

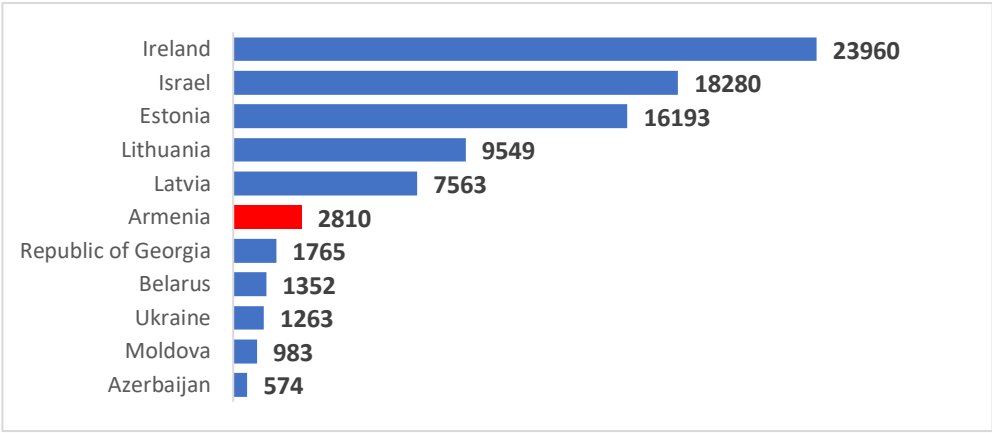
Figure 24: Cumulative publications of Armenia, Israel, Ireland, EP and Baltic countries, 2011-2018



Source: Web of Science, last accessed on 3 April 2019

Again taking into account the size of the country, Armenia performs well with 2,810 publications per million people, followed by Georgia with 1,765 publications per million.

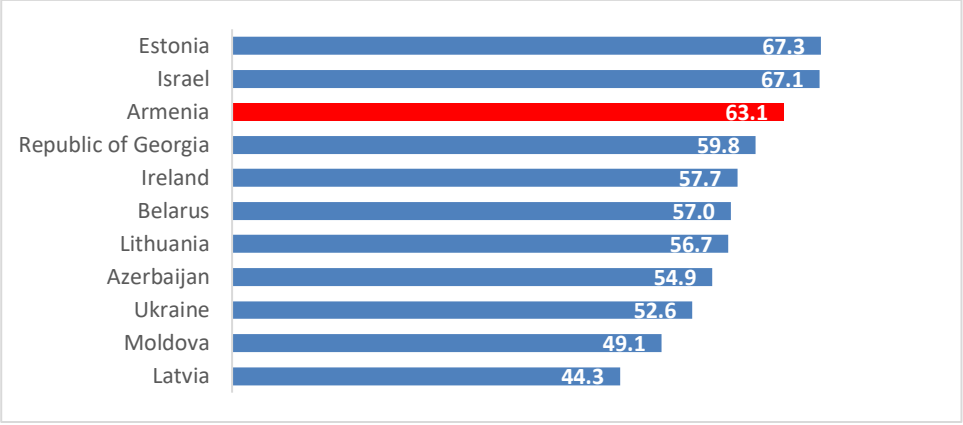
Figure 25: Cumulative publications of Armenia, EP and Baltic countries by per million population, 2011-2018



Source: Web of Science, last accessed on 3 April 2019

According to the Web of Science database (2016), 63.1% of Armenian publications were cited. When comparing again with the same countries (Figure 26) Armenia leads not only the EP countries, but also Ireland (57.7%), Lithuania (56.7%) and Latvia (44.3%). Armenia trails only Estonia and Israel with 67.3% and 67.1% respectively.

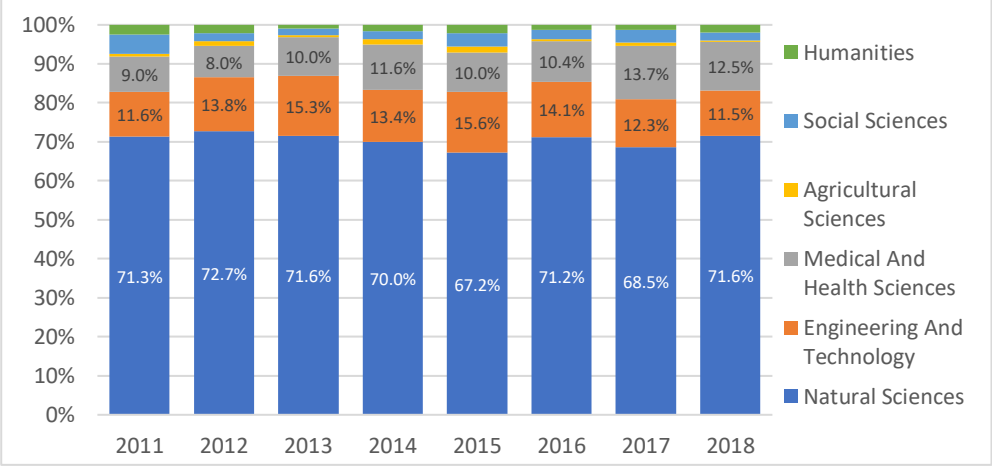
Figure 26: Share of cited documents in total publications %, 2016



Source: Web of Science, last accessed on 3 April 2019

Figure 27 shows the changing pattern of the Armenia's publications (2011-2018) in six research areas: natural sciences, engineering and technology, medical and health sciences, agricultural sciences, social sciences and humanities. Almost 72% of publications were in the field of natural sciences, followed by engineering and technology (11.5%). In 2011, 9% of publications were in the field of medical and health sciences, while in 2018 this indicator increased by 3 percentage points. The share of publications in agricultural sciences (0.9 % on average), social sciences (2.76% on average) and humanities (1.72% on average) were low and slightly decreased during this period.

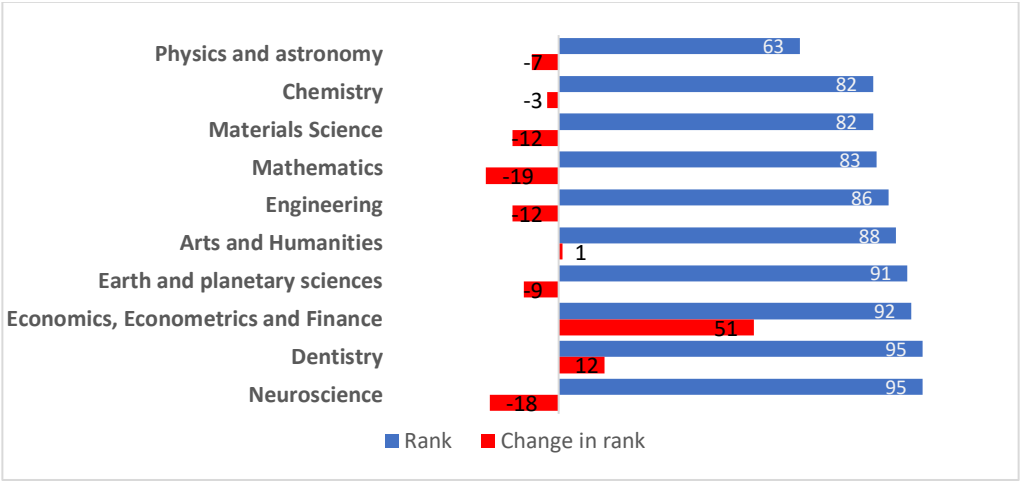
Figure 27: Publications from 2011-2018 by research area



Source: Web of Science, last accessed on 3 April 2019

Figure 28 shows the changes of the ranks of top 10 subject areas, which have the highest ranking in 2017. According to Scimago database, physics and astronomy have the highest ranking (63) – down seven positions compared to 2011. Armenia ranked 92nd in the field of economics, econometrics and finance but it significantly increased its ranking by 51 places compared to 2011.

Figure 28: Ranking of different subject areas in 2017 and their changes, 2011-2017



Source: Scimago database, last accessed on 8 April 2019

Table 8 shows Armenia's top subject areas with the highest share of cited documents in the period 2011-2018. The table includes only those fields where Armenia had more than 100 published documents. Some 74% (3,365 documents) of physical sciences and astronomy – a leading subject in the field of science of Armenia – were cited during this period.

Table 8: Subject areas with highest percentage of citations, 2011-2018 (more than 100 published documents)

Subject area	Published documents	Share of cited documents in total, %
1.03 Physical sciences and astronomy	4547	74
1.05 Earth and related environmental sciences	205	64
2.05 Materials engineering	261	62
1.04 Chemical sciences	682	61
2.11 Other engineering and technologies	283	61
2.07 Environmental engineering	112	56
1.06 Biological sciences	626	54

Subject area	Published documents	Share of cited documents in total, %
2.1 Nano-technology	166	54
1.01 Mathematics	606	52
3.01 Basic medical research	380	44
2.03 Mechanical engineering	241	43
3.03 Health sciences	175	38
2.02 Electrical eng, electronic eng	359	30
3.02 Clinical medicine	614	29
6.01 History and archaeology	109	26
1.02 Computer and information sciences	189	24

Source: Web of Science, last accessed on 3 April 2019

Table 9 shows the cumulative publications by subject areas of benchmark countries (EP and Baltic States) and the rank of Armenia among them. In the field of physics and astronomy, Armenia is in 3rd place after Ukraine and Belarus. Armenia has a relatively high rank (4th) also in history and archaeology followed by Estonia, Ukraine and Lithuania.

Table 9: Cumulative publications of benchmark countries by subject areas, 2011-2018

Name	Armenia	zerbaijan	Belarus	Georgia	Moldova	Ukraine	Latvia	Lithuania	Estonia	Armenia's rank among EP and Baltic Countries	Israel
1.03 Physical sciences and astronomy	4,547	1,888	4,866	2,436	947	18,774	1,726	4,067	2,737	3	**20,532**
1.04 Chemical sciences	682	867	1,670	272	596	8,371	1,285	2,449	1,640	7	**10,448**
1.06 Biological sciences	626	267	922	653	188	3,718	1,207	2,525	4,065	7	**24,915**
3.02 Clinical medicine	614	397	1,797	1,104	700	5,039	1,679	3,712	2,437	8	**43,522**
1.01 Mathematics	606	773	777	659	170	4,438	289	1,076	523	6	**9,419**
3.01 Basic medical research	380	169	684	591	276	2,587	653	1,385	1,445	7	**17,318**
2.02 Electrical eng., electronic eng.	359	364	801	204	315	7,598	1,235	1,869	1,499	7	**9,556**
2.11 Other engineering and technologies	283	221	1,114	126	94	2,185	894	953	756	6	**3,939**
2.05 Materials engineering	261	474	1,604	142	491	9,043	1,432	2,064	1,110	8	**6,087**
2.03 Mechanical engineering	241	257	593	119	79	2,615	511	1,439	462	7	**3,037**
1.05 Earth and related environmental sciences	205	206	241	377	142	1,821	940	1,865	2,094	8	**5,856**
1.02 Computer and information sciences	189	403	312	139	139	2,168	991	1,166	1,163	7	**9,947**
3.03 Health sciences	175	61	277	310	121	990	481	1,203	1,036	7	**8,512**
2.1 Nano-technology	166	57	451	60	289	2,212	308	431	202	7	**2,631**
2.07 Environmental engineering	112	194	224	54	99	1,417	1,039	1,171	1,013	7	**2,301**
6.01 History and archaeology	109	59	31	33	26	167	72	130	639	4	**3,183**

Source: Web of Science, last accessed on 3 April 2019

Table 10 shows international collaborations (2011-2019) by research areas. On average, 63% (519 publications) of the publications in the natural Sciences were done through international collaborations. Over half (51%) of the published documents in engineering and technology, and 46% in medical and health sciences involved international collaboration.

Table 10: International collaborations, 2011-2018

Subject areas	Average number of documents published	Average number of international collaborations	Share of international collaborations
Natural sciences	823	519	**63%**
Engineering and technology	158	80	**51%**
Medical and health sciences	125	58	**46%**
Agricultural sciences	10	6	**60%**
Social sciences	32	14	**44%**
Humanities	20	4	**20%**

Source: Web of Science, last accessed on 3 April 2019

The share of industry collaboration in subject areas is generally quite low in the period 2011-2018, but in 2018 the share of medical and health sciences in industry collaborations was 7.4%.

According to Scimago, Armenia's institutions performs well compared to the institutions from EP countries with A.Alikhanyan National Laboratory coming second place behind Ukraine's National Academy of Sciences in Ukraine which is ranked 488th in the world.

Table 11: Institutions rankings, 2018: EP countries

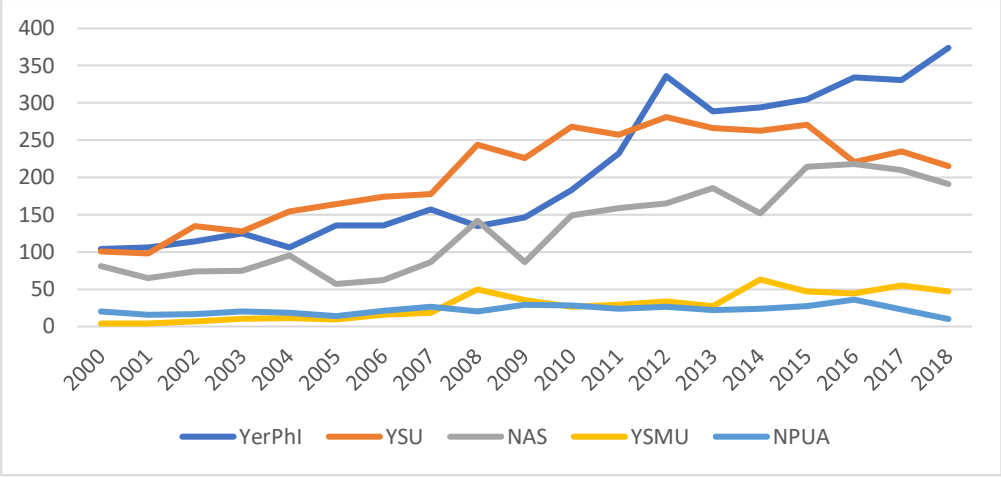
EP Rank	Global Rank	Country	Name of Organisation
1	488	UKR	National Academy of Sciences
2	**637**	**ARM**	**A.Alikhanyan National Laboratory** (Yerevan Physics Institute, YerPhI)
3	658	BLR	Belarusian State University
4	686	UKR	Taras Shevchenko National University of Kyiv
5	705	BLR	National Academy of Sciences
6	706	UKR	Institute of Physics National Academy of Sciences
7	718	UKR	Lviv Polytechnic National University

EP Rank	Global Rank	Country	Name of Organisation
8	719	UKR	G. V. Kurdyumov Institute for Metal Physics National Academy of Sciences
9	720	GEO	Ilia State University
10	725	UKR	National Technical University of Ukraine - Kyiv Polytechnic Institute
11	730	GEO	Ivane Javakhishvili Tbilisi State University
12	731	UKR	Ivan Franko National University of Lviv
13	734	UKR	Odessa National I.I. Mechnikov University
14	735	BLR	Belarusian National Technical University
15	737	UKR	V.N. Karazin Kharkiv National University
16	739	UKR	Institute for Scintillation Materials National Academy of Sciences
17	740	UKR	Sumy State University
18-19	**741**	**ARM**	**Yerevan State University**
18-19	741	UKR	National Technical University - Kharkiv Polytechnic Institute
20	742	MDA	Academy of Sciences
21-22	743	UKR	V. Ye. Lashkaryov Institute of Semiconductor Physics National Academy of Sciences
21-22	743	UKR	Kharkov National University of Radio Electronics
23	745	BLR	Belarusian State University of Informatics and Radioelectronics
24	746	UKR	Kiev International University of Civil Aviation
25-26	747	AZE	National Academy of Sciences
25-26	747	UKR	Chernivtsi National University
27	748	UKR	National Science Center Kharkov Institute of Physics and Technology National Academy of Sciences
28-29	751	UKR	Institute for Single Crystals National Academy of Science
28-29	751	UKR	Bogolyubov Institute for Theoretical Physics National Academy of Sciences
30	752	UKR	Donetsk O. O. Galkin Institute of Physics and Engineering National Academy of Sciences
31	754	GEO	Georgian Technical University
32-33	**755**	**ARM**	**National Academy of Sciences**
32-33	755	UKR	Frantsevich Institute for Problems of Materials Science National Academy of Sciences
34	757	UKR	O. Ya. Usikov Institute for Radio Physics and Electronics National Academy of Sciences
35	762	GEO	National Academy of Sciences
36	764	UKR	B.Verkin Institute for Low Temperature Physics and Engineering National Academy of Sciences
37	766	UKR	H. V. Karpenko Physico-Mechanical Institute National Academy of Sciences
38	768	UKR	Institute of Nuclear Research National Academy of Sciences
39	769	AZE	Baku State University

Source: Scimago database, last accessed on 8 April 2019

The top ranked research institution in Armenia in terms of research outputs in 2018 was the Yerevan Physics Institute (YerPhI). Over the 2000-2018 period, it vied with Yerevan State University (YSU) for the leading position. YerPhI's research outputs have increased 3.5 times since 2000.

Figure 29: Research outputs by top 5 research institutions



Source: Science Committee of Armenia

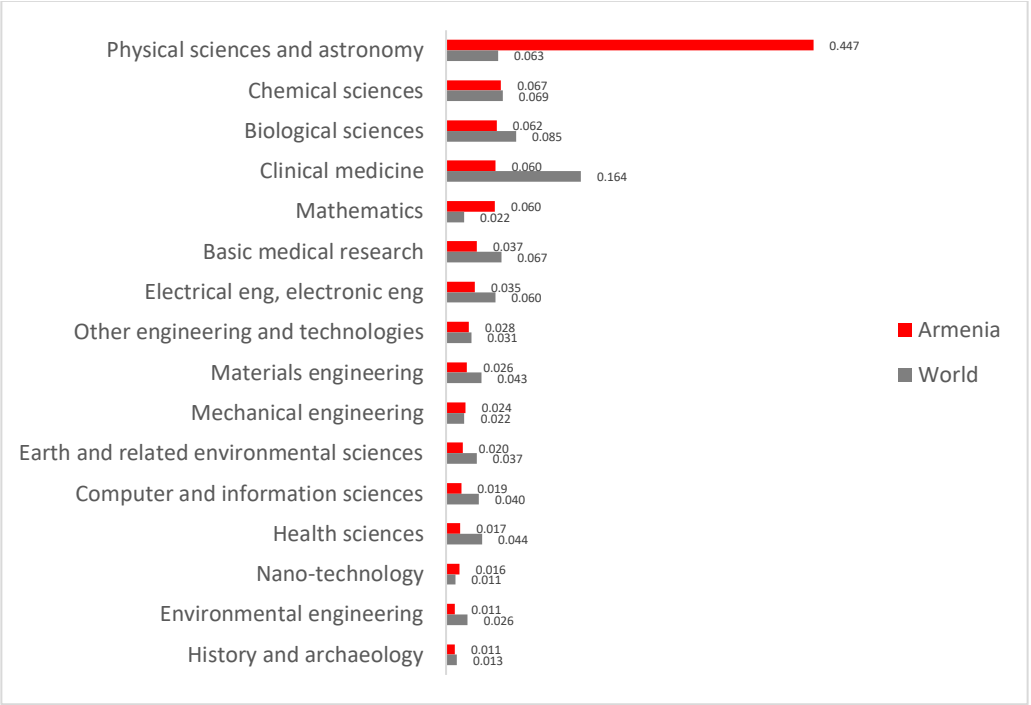
The Armenian National Academy of Sciences (NAS) came in 3rd during this period, followed by Yerevan State Medical University (YSMU) and the National Polytechnic University of Armenia (NPUA). The NAS increased its research output by 2.5 times, reaching 191 publications yearly.

5.2 Results Of The Bibliometric Benchmarking

Figure 30 compares Armenia's and World's coverage or share of subject areas in total publications[26] to assess the level of scientific specialisation in Armenia. The share of physical science and astronomy in total publications is seven times more in Armenia than in the World. Armenia demonstrates its strengths also in mathematics and mechanical engineering.

[26] The share is calculated by dividing a certain subject area's publications with total publications. The higher the share above the world average indicates the strength of the 'specialisation' in that field.

Figure 30: Comparison of Armenia's and world's share of subject areas, 2011-2018

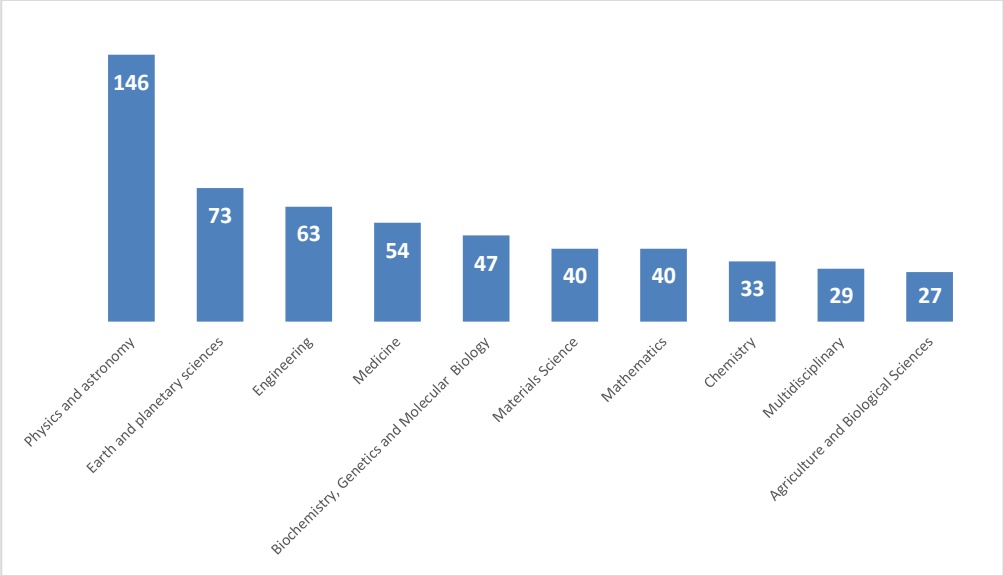


Source: Web of Science, last accessed on 3 April 2019

5.3 H-Index

As shown in Figure 31, other research impact metrics, such as the H-index of publications and citations, also show that Armenia's best-performing field of science is physics and astronomy (H-index of 146). This is partly explained by historical legacy. However, Armenians publish much fewer scientific publications in computer science (H-index of 15). This can be explained by the fact that the best human resources in computer science are deployed in industry due to a significant wage differential. Since career opportunities in the software industry are very attractive, the academic field of computer science has suffered as a result.

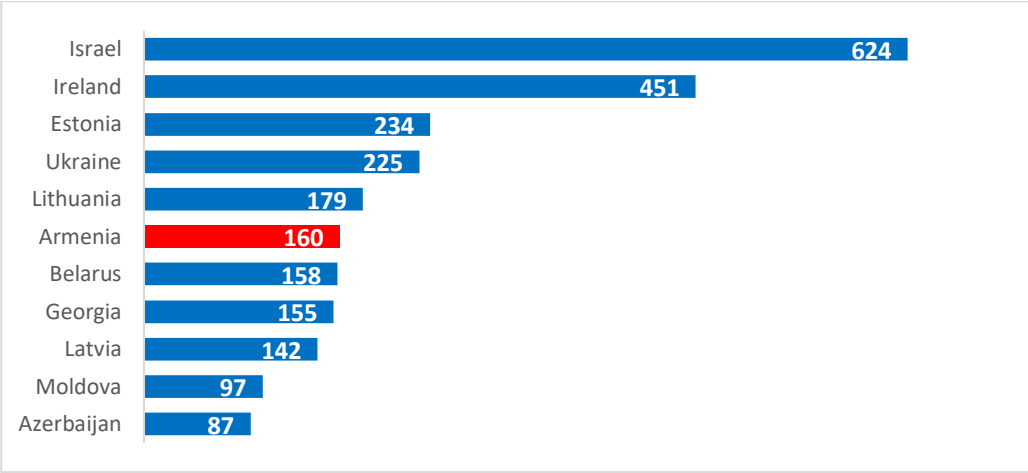
Figure 31: Subject areas with the highest H-index



Source: Scimago database, last accessed on 8 April 2019

Again, when comparing with the benchmark countries, Armenia's H-index is quite high. Armenia is 2nd among EP countries, trailing only Ukraine.

Figure 32: H-indexes of benchmark countries, 2017

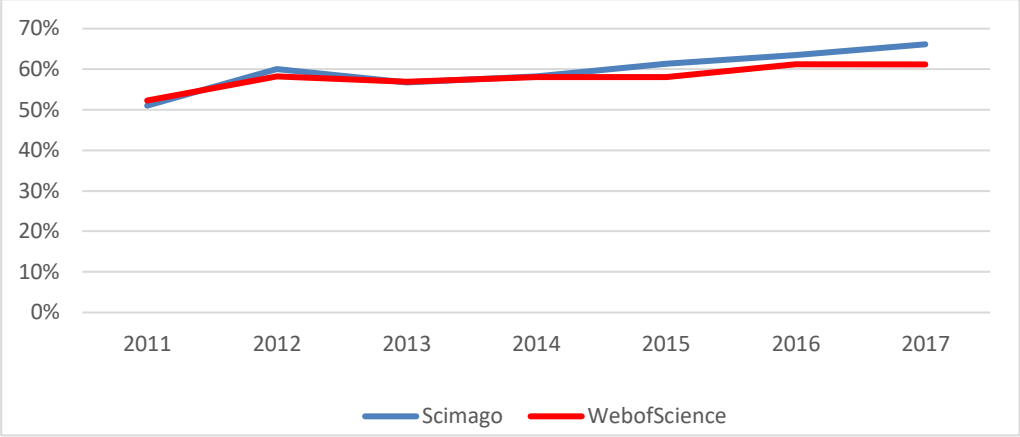


Source: Scimago database, last accessed on April 8, 2019

5.4 International Co-Publications

One factor that favouring Armenian scientific impact is its scientists' relatively high rate of international collaboration, thanks in part to diaspora links. Figure 33 illustrates the growing pattern of the share of Armenia's international co-publications (2011-2017) according to Scimago and Web of Science databases. From the beginning of the time period this share increased from 51.6% to 63.7%.

Figure 33: Share of international collaborations, 2011-2017



Source: Web of Science, Scimago; last accessed on 3 April 2019

Armenia´s specialisation in the area of Physics & Astronomy is confirmed with 65% in total collaborations in 2017. The number of the international publications in this subject area increased by almost 77% from the beginning of this decade: from 265 in 2010 to 470 in 2017. The subject area of engineering is the 2nd among the international collaborations with 17% in total collaborations and increased by 85% compared with 2000. The third most important field for Armenia is Medicine with 11% of all publications followed by material science and mathematics 8% each.

Over the period 2003-2013, the highest co-publication rate with the EU/AC (Associate Countries) was in Moldova (42%), followed by Armenia and Georgia (33%). In terms of impact, Armenia had the most citations on average per publication (7.94), followed by Georgia (6.31), Moldova (5.94), Ukraine (3.72), Azerbaijan (3.07) and Belarus (3.4). The highest scientific impact factor in Armenia was for 'General science and rechnology' (33.07).[27]

Armenia's co-publications are notably with partners from the US, Germany, Russia, France and Italy. Looking at the co-publication shares, Armenia´s co-publication rate in physics and astronomy of 65% is exceptionally high and more

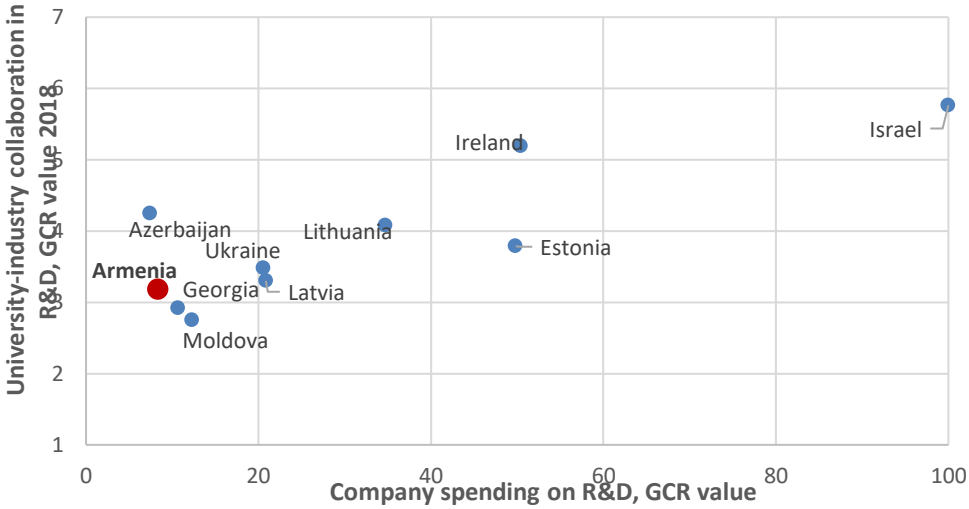
[27] Black Sea Horizon report, part 1

than three-quarters of the co-publications involve EU/AC. Another strong co-publication field with the EU/AC is clinical medicine.

Collaboration with industry

Armenia ranks only 86th on R&D expenditure indicator and lags behind many of its competitor countries.

Figure 34: Company spending on R&D vs. university-industry collaboration on R&D, 2018



Source: World Economic Forum, Competitiveness Rankings 2018

Another critical challenge to Armenia's scientific landscape is the poor connection between scientific pursuit and the real needs and problems faced by businesses in domestic and global economies. Conservative research agendas based on the personal scientific interests of institutional heads, lack of cutting-edge topics, and lack of vision for solving business problems are major hurdles to progress.

However, positive trends can be observed in the software, microelectronics, and engineering solutions sector in the form of intensifying R&D activities and capabilities in newly developing technologies. A group of companies – branches of multinationals – performs deep science-based R&D and develops corresponding capabilities. For example, Synopsis spends about 10% of the company's total spend on R&D through their Armenian subsidiary, has mentored 42 PhD students so far, and filed many patents based on research by Armenian engineers. Other Armenian IT and engineering companies show significant dynamism in the usage of disruptive or deep technologies. Below is a summary of estimates on companies and engineers engaged in selected disruptive technologies.[28]

[28] ACR 2017

Table 12: Number of companies and employed engineers in selected disruptive technologies in Armenia

Technologies	Number of engineers (upper bound estimates)	Number of companies
Machine learning/AI	100	14
Robotics and drones	40	5
Internet of things	50	6
Blockchain	30	2
Big data and cloud computing	200	12
3D printing	25	4
Augmented and virtual reality	25	4
Cybersecurity	40	6

Source: ACR 2017

While the numbers are not huge and the application of these technologies is still experimental in most of the companies, they are ramping up their capabilities aggressively. Many of the group of companies are start-ups developing their own products, which indicates Armenian companies are tuned in to global trends. Generally, such dynamism provides a sound basis for the sector to move faster towards a competitive ecosystem.

6 HUMAN RESOURCES

6.1 Education Overview Of The Armenian Population

The education level in Armenia is comparatively high. Primary school enrolment covers all children, and this ensures a literacy rate of 100%. Gross enrolment to tertiary education was 52.2% in 2017 (UNESCO data).[29] However, the vocational training system is not well developed and the transition from school to employment represents a challenge for school graduates. International donors are currently implementing actions to foster vocational education and training in order to overcome this weakness.

Education in general – and higher education in particular – is well perceived by families and society. The higher education system (university education) in Armenia still profits from the scientific and technical heritage of the Soviet period.

However, various studies[30] report an erosion of the technical basis in higher education. More people are studying softer subjects and the standard of teaching in the natural sciences is deteriorating. Both the quality and the number of technical scientists is at risk, which will ultimately have an impact on Armenia's innovation potential. The Government has prioritised education as a major development challenge and a reform of the education system is thus high on the policy agenda.

A number of initiatives exist to promote scientific and technical education. The ICT sector is a good example. Since 2008, the Union of Information Technologies Enterprises in Armenia[31] has been running the Armrobotics Programme. Armrobotics organises after-school activities in secondary schools, including modules such as design and testing of robots, research and learning projects.[32]

Funding of education

Armenia's higher education system struggles with efficiency and quality due to weak governance and problems with the funding system.

Armenia's government expenditure on education was 2.3% of GDP in 2017 (AMD 128 billion) and only 0.22% was spent on higher education. The new Armenian government is planning to spend AMD 139 billion on education in 2019.[33]

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[29] World Bank's WDI Online Database

[30] EU SMEDA, ACR 2010, 2017

[31] See: http://uite.org/index.php?lang=en

[32](Ministry of Education and Science of the Republic of Armenia, 2015), p.12

[33] Government budget of RA 2019

Table 13: Government expenditures on education of benchmark countries

Country	Expenditure on education % of GDP	Expenditure on higher education % of GDP	Year
Armenia	2.3	0.22	2017
Azerbaijan	2.9	0.5	2016
Belarus	4.8	0.79	2017
Georgia	3.8	0.39	2017
Estonia	5.2	1.41	2015
Israel	5.9	0.95	2015
Ireland	3.8	0.88	2015
Latvia	5.3	1.18	2015
Lithuania	5.2	1.18	2015
Moldova	6.7	0.99	2016
Ukraine	5	1.53	2016
EU	**5.1**	**-**	**2015**

Source: WDI online database, UNESCO

After graduating from basic school, teenagers may choose either high school, or preliminary or middle vocational education institutions. On average, a fifth of basic school graduates carry on to a middle vocational education institution, 8% chooses preliminary education. The majority of basic school graduates continue education in high school, while only 13% of them drop out. From 2018 onward, the law states that all basic school graduates have to continue their education either in high school, preliminary or middle vocational institutions.

The enrolment rate in degree courses (Bachelor's) in Armenia is quite high. According to the National Statistic Service of the Republic of Armenia, about three quarters of high school graduates go to higher educational institutions.

6.2 Tertiary Education

Tertiary education is delivered by 63 higher education institutions and 12 branches.[34] Meanwhile, only 27 institutions are accredited (institutional) and one is in the process of reaccreditation according to the official register of the the National Centre for Professional Education Quality Assurance Foundation (ANQA). Some 22 of the them are State-run universities.

A comparison of the number of students with the quantity of higher educational institutions indicates a degree of fragmentation and below par performance by many educational institutions, especially privately-run establishments. In total, there were 81,600 (2016/2017) students enrolled (88% in State universities and only 11% in private ones). More than half (53.8%) of the enrolled students were women.

On average, about 330 PhDs are prepared annually in Armenia.

Table 14: Number of students enrolled/graduated in different degree levels

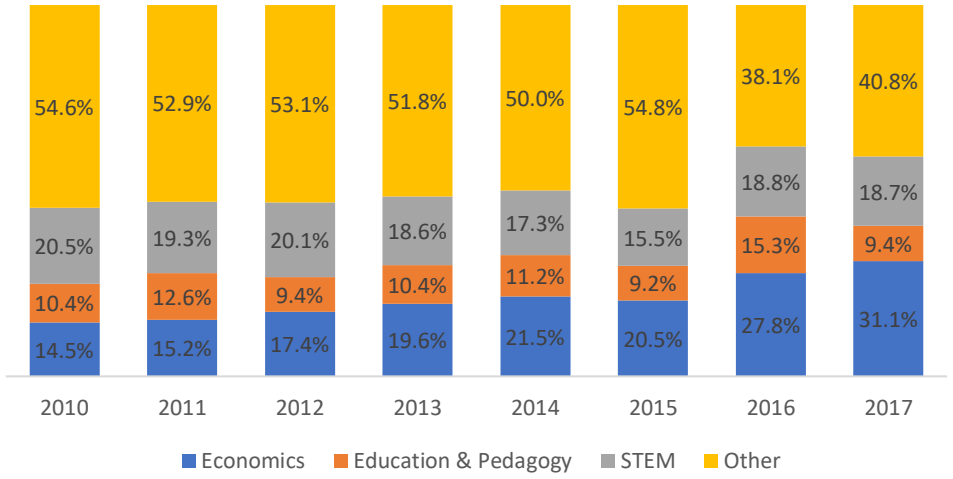
	2012	2013	2014	2015	2016	2017
Bachelor's degree						
Enrolled	21,342	19,034	17,473	18,061	17,649	15,538
Graduated	24,597	21,944	19,702	12,666	19,036	17,787
Master's degree						
Enrolled	7,125	7,541	7,373	5,807	6,401	6,192
Graduated	5,175	7,125	7,522	6,484	6,507	4,613
PhDs						
Enrolled	373	395	321	353	396	265
Graduated	368	239	314	324	334	348
Doctorate studies						
Enrolled	11	12	20	13	13	15
Graduated	9	8	12	13	14	16

Source: SCRA

[34] https://www.armstat.am/file/article/sv_03_17a_5190.pdf

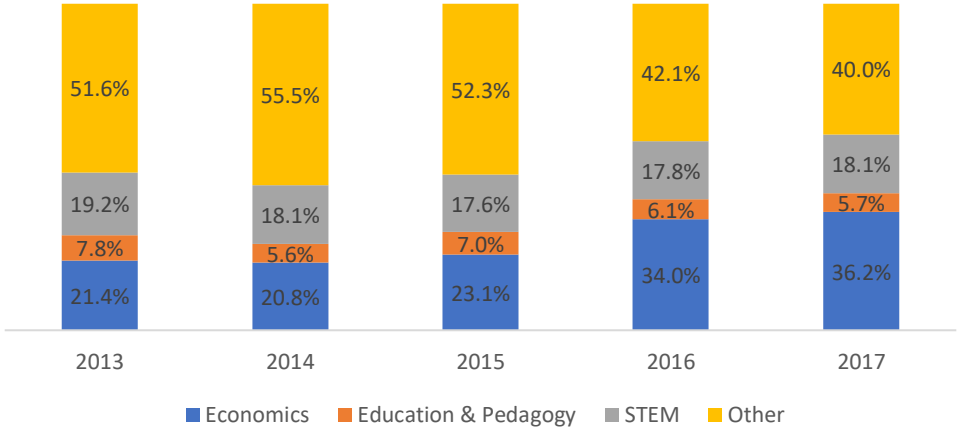
The following two figures show the distribution of graduates by specialisation in Bachelor's and Master's degrees between 2010 and 2017. The fastest-growing specialisation was economics; Bachelor's enrolments increased from 14.5% to 31.1%, while the Master's rose from 21.4% to 36.2%. The science, technology, engineering and mathematics (STEM) field showed a slight decrease in types of degree, as too enrolments in education and pedagogy.

Figure 35: Bachelor's degree, distribution of graduates by group of specialisations



Source: Statistical Committee of the Republic of Armenia

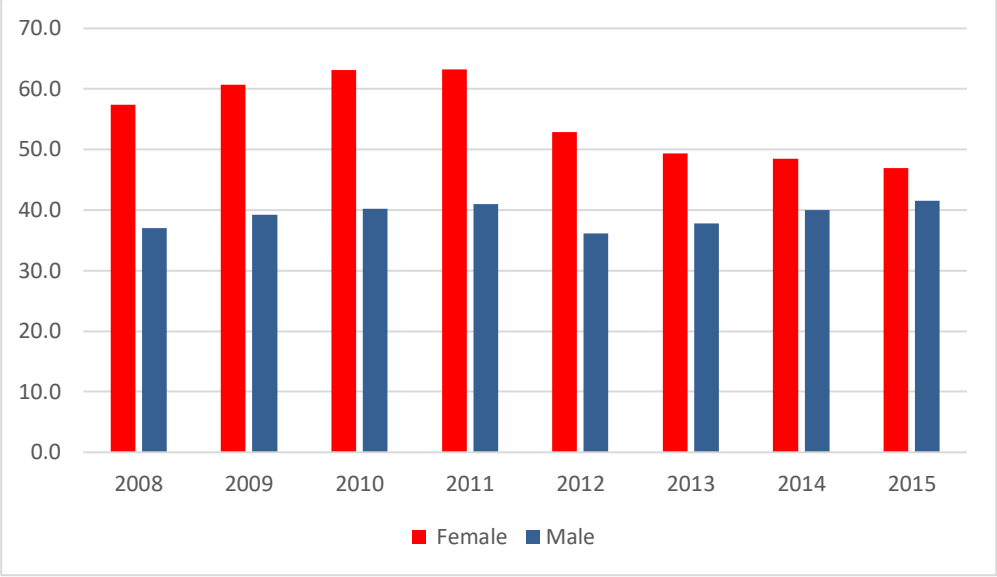
Figure 36: Master's degree, distribution of graduates by group of specialisation



Source: Statistical Committee of the Republic of Armenia

Gender balance in education reflect the situation of women and men in economic, social and political spheres throughout Armenian society. Women have higher rates of tertiary education enrolments than men. Despite this fact, the labour market still faces lower participation among women.

Figure 37: Tertiary school enrolment, % gross



Source: WDI

6.3 The Situation Of Researchers In Armenia

Demographic trends, emigration and under-investment mean that the number of researchers employed in the public sector is in decline, falling between 2010 and 2017 by almost 12% (from 5460 to 4822), and the average age is over 50.

In terms of staff working in 'R&D institutions', a total of nearly 4,133 people were employed in R&D in 2017, and 85% were classified as research-specialists with a higher education degree (495 'Doctors of Science' and 1,553 'Candidates of Science' which is equivalent to a PhD). In comparison, Estonia had 5,636 research personnel in the higher education and government sectors in 2015, of which 4,187 were researchers (1,788 with doctoral degrees).

Table 15: Number of R&D staff by education level, 2017

Education level	Higher education			Vocational education	Other	Total
	Total	Doctor of Science	PhD			
Research-specialists	3,544	495	1,553	25	19	*3,588*
Technicians	98	-	-	93	28	*219*
Support staff	208	1	2	207	112	*527*
Other	283	-	1	44	161	*488*
Total	**4,133**	**496**	**1,556**	**369**	**320**	**4,822**

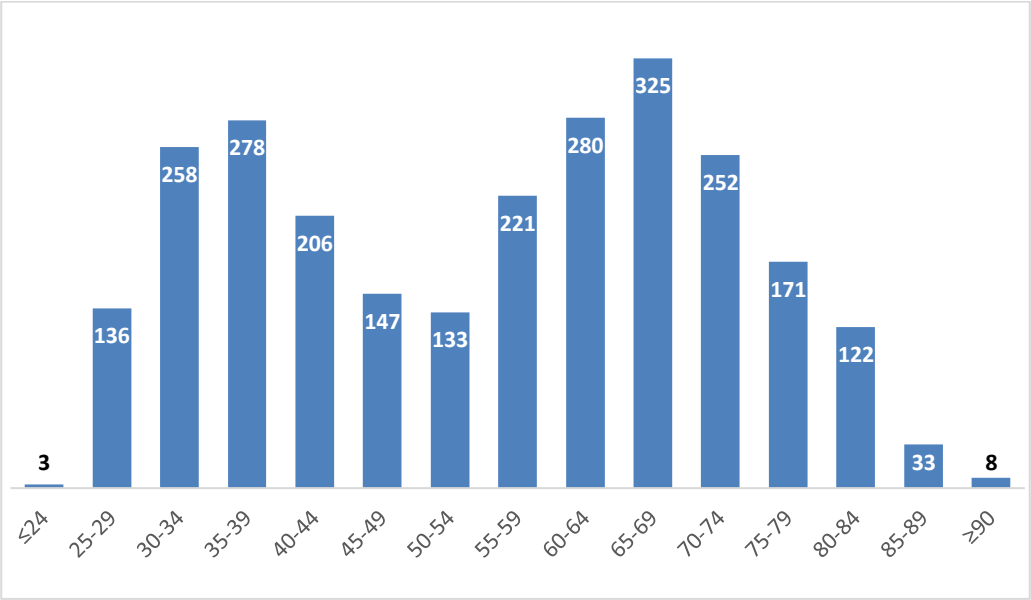
Source: Statistical Committee of the Republic of Armenia

According to Armenia's Science Committee, the number of people working in the field of science was 6,057, out of which 3,951 were researchers and 2,573 have a science degree.

Similar to many other post-Soviet countries, Armenia has seen a significant drop in the number of people with a Doctorate among younger groups: 30-39 year-olds (105 PhDs); 45-49 year-olds (78 PhDs); and 65-69 year-olds (211 PhDs). This demographic hole in the scientific community is a result of the transition period in the 1990s when the Soviet 'science system' collapsed and the amount of resources committed to science and technology sharply decreased. The once-prestigious professions of scientist and engineer became marginalised as both career opportunities and remuneration diminished. Many scientists emigrated, while others changed professions to pursue careers in commercially more attractive areas. Thriving scientific institutions became ghost buildings or were used for commercial purposes. As a result, entire scientific schools, knowledge, and technologies were lost.

However, as new technologies gradually proliferated and globalisation brought new opportunities, scientific and engineering knowledge became in demand once again. International collaborative projects started to provide more attractive professional opportunities for young researchers. This launched a gradual, positive trend in the interest in science and technologies, leading to a trickle of new blood into the system.

Figure 38: Researchers with academic degrees by age group (scientists engaged in State programmes), 2018



Source: State Committee of Science of the Republic of Armenia

Grand doctor (Doctor of Science) is a higher doctoral degree which may be earned after the Candidate of Science (the latter is informally regarded in Russia and many other post-Soviet States as equivalent to the PhD obtained in countries in which the PhD is not the highest academic degree).

The breakdown of researchers by field of science provides further insight into scientific specialisation, with natural sciences dominating (54.2% of total, with biology and psychology alone accounting for 16.5% of total researchers and technical sciences with 15.4% of total researchers), followed by humanities (including presumably Armenology) with 14.3%. In contrast, a relatively low share of researchers works in agriculture (2.4% despite the importance of this sector in the economy); while medical sciences and social sciences account for 6.3% and 7.3% respectively.

Table 16: Research-specialists by field of science and scientific degree, 2017

	Total	Grand doctor	PhD	Other
Natural sciences	**1946**	**273**	**903**	**770**
of which:				
Mathematics and mechanics	417	74	168	175
Physics, astrology	357	77	164	116
Chemistry, p	369	37	172	160
Biology, psychology	592	64	330	198
Geology	199	21	65	113
Geography	12	0	4	8
Technical sciences	553	36	103	414
Medical sciences	227	52	89	86
Agricultural sciences	86	9	25	52
Social sciences	**263**	**44**	**133**	**86**
of which:				
Economics	75	9	37	29
Law	23	3	11	9
Pedagogics	38	7	25	6
Psychology	30	5	19	6
Sociological sciences	17	4	8	5
Political sciences	5	1	2	2
Other	75	15	31	29
Humanities	**513**	**81**	**300**	**132**
of which:				0
Historical sciences	167	27	95	45
Philosophy	16	7	7	2
Philology	241	31	158	52
Art, architecture theory and history	89	16	40	33
Total	**3,588**	**495**	**1,553**	**1,540**

Source: National Statistical Service

These numbers are broadly in line with the split of science budget by science field suggesting that the main cost in each science budget is staffing. The share of researchers in agricultural sciences, medical and social sciences deviate somewhat from the respective share in the science budget. The differences may be due to relative staff costs (e.g. respective share of PhD holders) although it is not possible to be sure based on the available data.

Student and (post)graduate numbers by scientific field[35] also provide insight into current priorities and future potential for specialisation in certain technologies and sectors. Bachelor's and Master's level studies are dominated by social sciences (close to 80% of Bachelor's and 70% of Master's level graduates in 2016). At PhD level, technical and natural sciences account for a higher share (about 38.2% in total) of PhD entrants in 2016, while only 1.4% of PhD entrants were studying agricultural sciences.

Table 17: Summary overview of science system by science field

Science field	Science budget 2017	Researchers 2016	PhD entrants 2016
Technical	20%	14.5%	15.4%
Natural sciences	30%	54.6%	22.6%
Agriculture/veterinary	5%	1.8%	1.4%
Medical sciences	3%	5.9%	2.8%
Social sciences	3%	5.9%	38.7%
Humanities	15%	17.3%	19.1%
General	24%	n.a.	n.a.

Source: Innovation Mapping Report 2018

A specific characteristic of the Armenian scientific landscape is the diverse range of scientific institutes (more than 90 institutes and centres) in a breadth of disciplines (a third of which are in the social sciences). The quality and availability of scientific (research) infrastructure is equally diverse with, on the one hand, buildings and research equipment that need to be renovated to meet modern requirements; and, on the other hand, facilities that operate at an internationally comparable level. The **Armenian National Engineering Laboratory's** (ANEL) infrastructural endowment and equipment, for example, seems to be sufficient for the tasks at hand. In addition, the accelerator project CANDLE (Centre for the Advancement of Natural Discoveries using Light Emission) at the Synchrotron Research Institute is an example of an ambition to upgrade Armenia's research infrastructure to be at the 'technological frontier'.

[35] Source: NSS, www.armstat.am

6.4 International R&D Cooperation And Mobility

Armenia has cooperated with the **Joint Institute for Nuclear Research** (JINR) since 1992. JINR's principal directions of theoretical and experimental studies focus on particle physics, nuclear physics and the physics of concentrated environments. As a JINR member, a coordinating committee was established in Armenia, headed by the chairman of the State Committee of Science of the Ministry of Education and Science of the Republic of Armenia.

Armenia joined the **International Scientific and Technical Centre** (ISTC) on 14 September 1994. Almost 400 projects involving 75 research institutes have been financed by ISTC so far, from which 154 projects received USD 36.5 million funding in total.

Promoting joint collaborative programmes, creation joint labs and research centres are preconditions for networking towards EU programmes. Armenia's Science Committee has bilateral programmes with several countries around the world.

Table 18: Bilateral programmes, Science Committee of the Republic of Armenia

Centre National de la Recherche Scientifique (CNRS)	From 2009: 2 Joint Labs, 1 Joint Group, 20 Ann. Grants	France
Foundation for Fundamental Research (FFR)	From 2011: 30-34 Two Years Grants	Belarus
Russian Foundation for Humanities (RFH)	From 2011: 10-12 Two Years Grants	Russia
Russian Foundation for Basic Research (RFBR)	From 2013: 40-42 Two Years Grants	Russia
Federal Ministry of Education and Research (BMBF)	From 2013: 10 Two Years Grants	Russia
State Science and Technology Committee (SSTC)	From 2015: 4 Two Years Grants	Belarus
National Science Fund (BNSF)	From 2020	Bulgaria
National Research Council (CNR)	From 2020	Italy

Source: Science Committee of the Republic of Armenia

6.5 Cooperation With The EU

R&D cooperation with the EU has significant importance for Armenia. International cooperation and integration into the European Research Area (ERA) are prioritised by all national policy documents. The Strategy of STI Development for 2011-20 and Action Plan for 2017-20 set ambitious targets for the R&D sector: to support development of the knowledge-based economy in Armenia and be competitive in ERA through smart specialisation.

One of the major programmes helping to boost Armenia's research sector is Horizon 2020. Armenian researchers could apply for Horizon 2020 funding for their research projects. During the period 2014-2016, some 91 applications were made, out of which 12 were approved.

Table 19: Armenia's participation in Horizon 2020, 2014-2016

	2014	2015	2016	Total
Applications	27	42	22	91
Participations	2	4	6	12

Source: Science Committee of the Republic of Armenia

Starting from May 2016, Armenia became an Associated Country to the EU's Horizon 2020 programme. From that date, Armenian researchers and innovators had full access to this funding programme. So far, 25 projects have been implemented jointly. They include several of Armenia's science and technology development priorities.

Table 20: Armenia's participations in the H2020 projects

Legal name	H2020 Participation
National Academy of Sciences of the Republic of Armenia	7
Institute for Informatics and Automation Problems of the National Academy of Sciences of the Republic of Armenia	4
Small and Medium Entrepreneurship Development National Centre of Armenia Fund	3
Information Society Technologies Centre	2
Yerevan State University	2
Yerevan State Medical University after Mkhitar Heratsi	1
Centre for Ecological-Noosphere Studies National Academy of Sciences of the Republic Armenia	1
Caucasus Consulting Group-am	1
ACBA leasing credit organization closed joint stock company	1
Grovf LLC	1
Educational and Cultural Bridges	1

Legal name	H2020 Participation
Centre of Medical Genetics and Primary Health Care	1
'Matenadaran' M.Mashtots Institute of Ancient Manuscripts	1
Scientific and Production Centre Armbiotechnology NAS Republic of Armenia	1
Institute for Physical Research of the National Academy of Sciences of Armenia	1
A.I. Alikhanyan National Science Laboratory	1

Source: State Committee of Science of the Republic of Armenia

On 7 March 2019, the official launch of the EU-funded **EU4Digital regional initiative** took place in Yerevan. Participants had the opportunity to learn about EU-Armenia partnerships in e-governance, the scope and objectives of the EU4Digital initiative, and the outcomes of the ongoing EU4Armenia: e-Gov actions project. The project lasts three years with the total budget of EUR 12 million distributed among the six EP countries according to the quality of the proposed projects.[36]

Armenia also cooperates with the EU within the **EU4 Innovation in Armenia** project (2017-2020), which aims to develop STEM fields in Armenia. The project invests in human capital to meet the requirements of the local labour market. The estimated total cost of the project is EUR 26,125,000 (EUR 23,000,000 by the EU).

6.6 Cooperation With Other Countries And Regions

UNESCO's 'Education for Sustainable Development' Chair was established in Armenia by the UNITWIN/UNESCO Chairs Programme, which has been operating in the **Centre for Ecological-Noosphere Research in Republic of Armenia** since 2011. The Chair's activity areas are:

- Implementation of scientific research and educational programs;
- Training and retraining of specialists;
- Development of educational-methodological infrastructure,
- Organisation of conferences, meetings, seminars, festivals,
- Ensuring international cooperation in sustainable development;

[36] https://eeas.europa.eu/delegations/armenia/60474/eu4digital-regional-initiative-was-launched-yerevan_en

- Implementation of international joint scientific and educational programmes at regional and global levels including UNITWIN Networks, Copernicus Alliance, ENSI, Info CENN, GAPS, and more.

Armenia participated in the **Black Sea Interconnection** (BSI) project, which was being implemented under EU's Seventh Framework Programme (FP7). Launched in March 2008, it was the largest regional research network project launched and aimed to provide a sharp increase in the internet capabilities of research networks. It was based on the NATO's project 'The Virtual Silk Highway'. BSI aimed to build a proper regional research and education network among South Caucasus and connect it to GÉANT2, integrating South Caucasus scientific potential to Europe and fostering collaboration between homogenous scientific communities.[37]

The **Institute for Physical Research of National Academy of Sciences of Armenia** has been actively involved in over 40 international grant programmes within the last five years, including FP7, ISTC, INTAS, CRDF, NFSAT, Volkswagen, ANSEF and SCOPES. Currently, they have bilateral collaborations with France, Germany, USA, Italy, UK, Russia, Latvia, Bulgaria, Poland, Japan, Spain, Australia, Switzerland, Croatia, Canada, Taiwan, Greece and others. In particular, the **CNRS LIA** (French-Armenian International Associated Laboratory) has proved an especially fruitful international collaboration for Armenia (20 January 2009). Within the framework of the project, the target areas were particularly physics, chemistry, mathematics, humanities and social sciences.[38]

Armenia actively cooperates with Russia. On 25 March 2005, Armenia's Science Committee and the Russian Foundation for Fundamental Research signed a collaboration agreement. Armenia also has some joint laboratories with Russia, such as a joint laboratory 'X-rays optics' between the Institute of Applied Problems of Physics and Tomsk Polytechnic University, a joint lab between the Institute of Applied Problems of Physics and Kurchatov Institute (Moscow), and an international laboratory 'Optics of photons and elemental particles' between the Republic of Armenia and Belgorod State National Research University. On 28 March 2018, during the meeting between Armenia's Science Committee and the Russian Foundation for Fundamental Research, another programme promoting cooperation between young researchers and scientists was planned.

The Russian-Armenian University plays a major role in collaborations between the two countries, signing agreements with leading Russian universities, such as Moscow State University, Peoples' Friendship University of Russia, and Moscow State Institute of International Relations etc.).[39]

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[37] Source: asnet.am

[38] Source: ipr.sci.am

[39] For more info.: http://www.rau.am/eng

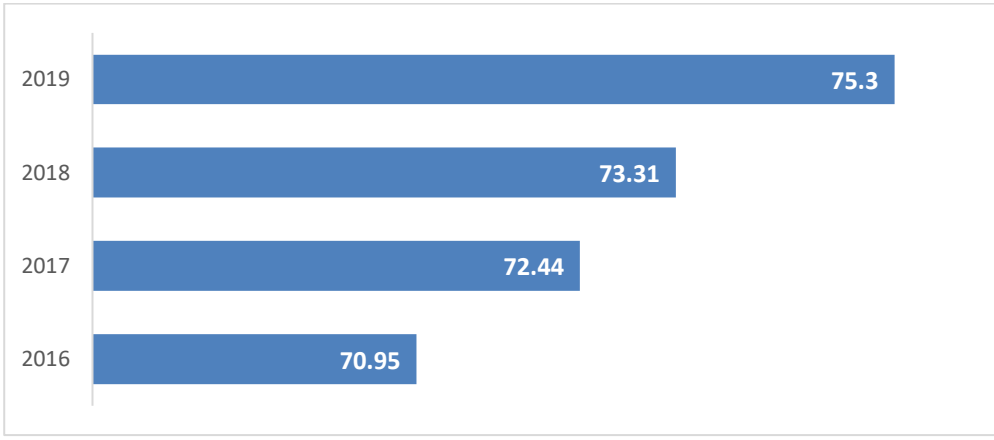
7 FRAMEWORK CONDITIONS FOR R&I

7.1 General Policy Environment For Business

Innovation can be hampered by barriers to entrepreneurial activity, access to finance or gaps in infrastructure (transport, logistics, digital networks, energy supply, etc.).

Armenia has made progress in improving its business environment, but remains well below neighbouring Georgia in the World Bank's doing business (DB) survey.[40] Armenia's DB rank is 41st among 190 countries with the ease of DB score 75.37, while Georgia ranked 6th with 83.28 score. Armenia stands a bit above compared to the regional average of Europe and Central Asia at 72.34. Armenia's ease of DB score increased by 6.1% during the past four years, which indicates that the business environment has a developing pattern.

Figure 39: Ease of doing business score, 2016-2019

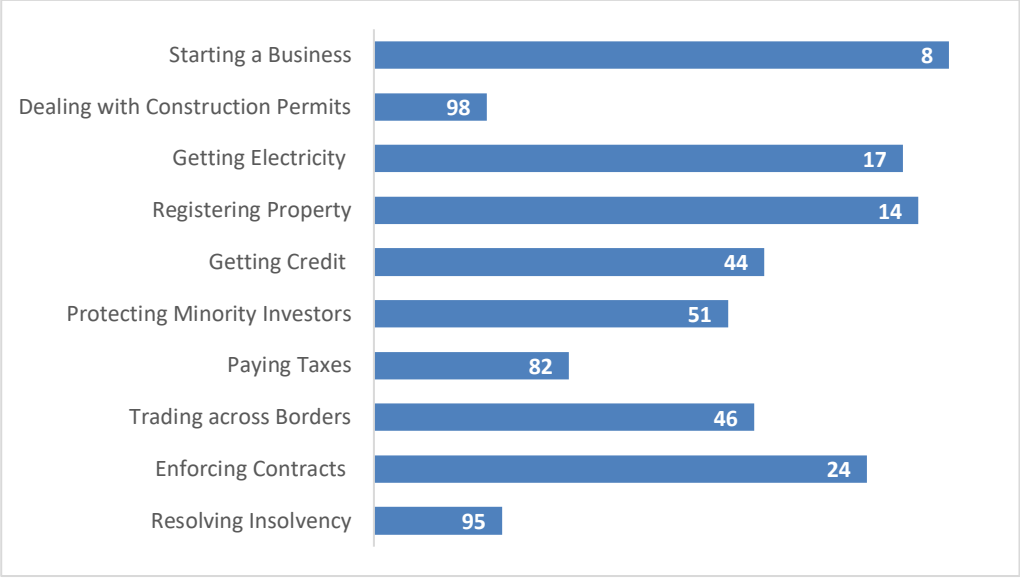


Source: Doing Business, World Bank 2019

Armenia's rank is quite high in terms of how easy it is to start a business (8th with a score of 96.21) and in the region trails only Georgia (ranked 2nd with the score of 99.34).

[40] Doing Business, World Bank 2019

Figure 40: Armenia's rankings on doing business topics



Source: Doing Business, World Bank 2019

Weaker points appear to be the insolvency procedures, dealing with construction permits and protecting minority investors.

Although improvements have been made to key infrastructure in recent years, there remain gaps in rural roads, water supply and sewage in rural areas as well as in energy supply. Further development and upgrading of the infrastructure is hampered by public budget constraints as well as by the need to maintain high defence expenditure. Although these basic infrastructures are not directly connected to the innovation support system, incomplete or inefficient transport, energy, water, etc. infrastructure impedes businesses from implementing an effective innovation process.

In this respect, Armenia performs poorly on internationally comparable resource efficiency indicators,[41] suggesting a need for greater attention to 'eco-innovation'[42], including measures to ensure businesses are applying relevant waste minimising, energy and water efficient technologies[43].

[41] See for instance : https://epi.envirocenter.yale.edu/epi-country-report/ARM

[42] Defined as any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development. This can be achieved either by reducing the environmental impact or achieving more efficient and responsible use of resources.

See also: https://ec.europa.eu/environment/ecoap/

[43] See for instance https://www.oecd.org/env/outreach/SME-greening-country-pilot-report-Armenia-en.pdf

In terms of transport and logistics, however, the new international airport at Yerevan meets modern requirements, yet international connections and schedules are not optimal (from either a business or tourism perspective). Rail (passenger and freight) networks are sub-optimal and investment is required in both upgrading the network and management of services.[44] The connectivity factor is of utmost importance for a land-locked country with the added complication of several 'closed borders' with neighbours. The result is a poor relative logistics performance that hampers both existing businesses and technology start-ups in developing exports and strategic partnerships.

Access to high quality (and affordable) digital infrastructure and services is an increasingly important pre-condition for doing business and for supporting the emergence and uptake of digital technologies. Armenia's position in international rankings on key digital economy indicators, while broadly acceptable (ACR 2017), could be improved[45] – particularly given the emphasis on an innovative ICT sector underpinning the related digital strategy.

On a number of levels, Armenia can be considered as the regional leader in terms of banking regulation and finance. The central bank has worked to put in place a relatively modern and efficient banking sector. However, Armenia's banking sector remains relatively fragmented and high interest rates and weak corporate transparency hold back private investment in the economy (ACR 2014). This situation will certainly constrain investment in technology upgrading, which depends on access to bank credits. In terms of risk-capital financing aimed at 'high-potential' companies, despite the establishment of the first Armenian venture capital fund (Granatus Ventures) in 2013 and several investment initiatives for start-up companies, pre-seed funding remains limited and Armenia ranks 79th in the world. There have been efforts to kick start a 'Fintech' ecosystem in Armenia, such as a 'hackathon' organised in 2016 by Microsoft Armenia in cooperation with Central Bank of Armenia and NASDAQ OMX Armenia.

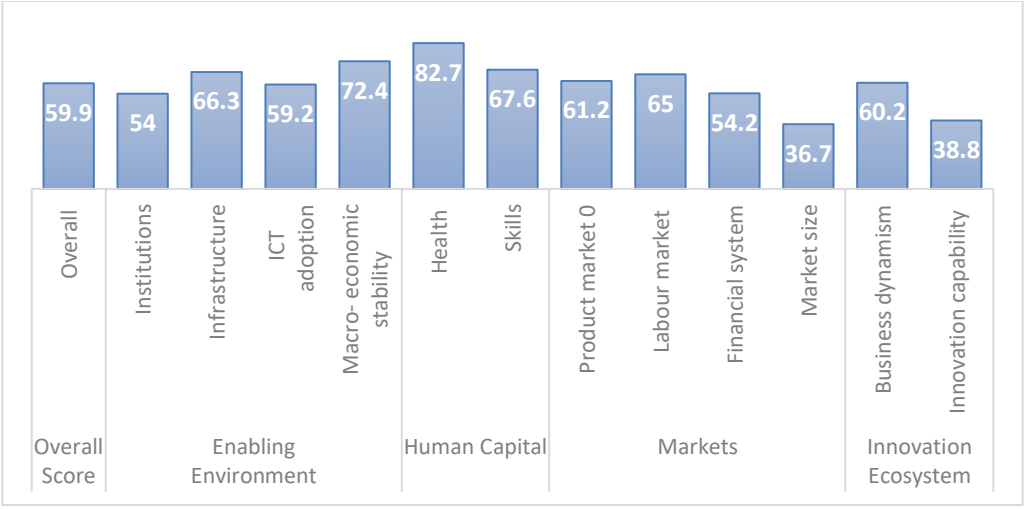
In terms of competitiveness, Armenia ranked 70th in 2018 with a score of 59.9 (out of maximum 100), a slight improvement on 2017's score (58.9)[46] and ranking (72nd).

[44] See: https://www.adb.org/sites/default/files/publication/28298/armenia-transport-outlook.pdf

[45] See for instance: https://www.internetsociety.org/map/global-internet-report/

[46] The Global Competitiveness Report, WEF, 2018

Figure 41: Armenia's performance overview 2018, GCR



Source: GCR

Armenia enjoys strong performances on health (score 82.7), macro-economic stability (pillar 4,72.4), and education and skills (pillar 6, 67.6). To secure a stronger competitiveness position, Armenia should diversify its economy and work to build upon these strengths to increase its presence in segments higher up the value chain. This will require enlargement of the market size, improvement of financial systems, and upgrading of capabilities for innovation – the three main common areas of weakness in the country.

7.2 Enabling Platforms And Intermediaries (VC, Accelerators)

In recent years, an embryonic innovation support infrastructure in the form of free economic zone, technoparks, innovation centres, educational labs and other enabling platforms have been developed, supported by a mix of private, State and donor funding.

Business incubators and accelerators

Two technoparks have been created and operate as 'regional technological hubs' targeted to support regional economic development.

- **Gyumri Technology Centre (GTC)** (in Shirak region) has been established by the Enterprise Incubator Foundation, the Armenian Government and the World Bank. The goals of the Centre include development of technical and business skills, promotion of technological entrepreneurship, commercialisation of innovative research undertakings, creation of new technology companies, attracting foreign investment and others

- **Vanadzor Technology Centre (VTC)** (in Lori region) has also been established by the Government on the site of the State Engineering University of Armenia. Building on the experience gained at Gyumri, the Enterprise

Incubator Foundation will be responsible for operational coordination of this project.

In Yerevan, there are also two private technoparks providing infrastructure and respective services to start-ups and international ICT enterprises.

Viasphere Technopark is a commercial technopark operational since 2000. It includes several US-based subsidiaries developing information and communications technologies, while providing infrastructure for local ICT start-ups. It provides not just the physical premises, but also services from incubation through growth and management of technology companies, management and training, and international linkages.

Free Economic Zones (FEZs) are another instrument to support the development of more innovative businesses, in a general sense. They aim to encourage FDI, develop new and advanced technologies, export promotion, employment creation and economic growth. Armenia's first FEZ opened in July 2013, as a joint initiative of the Yerevan Computer Research and Development Institute (YCRDI) (27,000 square metres of office space in the centre of Yerevan, suitable for R&D centres and laboratories); and the Mars manufacturing company (56,000 square metres of space for manufacturing and 11,000 for office space). Sitronics Armenia has invested USD 6 million in FEZ infrastructures notably the 'Alliance' FEZ specialised in innovative technologies in electronics, precision engineering, and IT. The 'Meridian' FEZ focuses on diamond cutting, watch and jewellery making.

The Tumo Centre for Creative Technology is a free innovative after-school learning initiative for teenagers aged 12-18. The objective is to enhance youngsters' horizons and make available the necessary resources to realise their creative potential by helping unleash talents and gain competitive skills. Students advance their knowledge and skills in four main areas: animation, game development, web development and digital media. At the end of the two-year course, students undertake a challenging project in one of the focus areas.

Microsoft Innovation Centre was launched in 2011, by the combined efforts of USAID, Microsoft Corporation and Enterprise Incubator Foundation. This was originally established in an attempt to improve skills and training in the workforce, and to train and certify local companies. However, it has become one of the most successful of Microsoft's centres in Central and Eastern Europe, already with around 10 start-ups, and a high level of Armenian participation in Microsoft's Imagine Cup, which is a student technology competition bringing together young technology specialists from around the world to generate solutions to key global challenges.

IBM Innovative Solutions and Technologies Centre (ISTC), is a solid example of oublic-private partnership (PPP) in ICT innovation as a joint project between IBM, the Armenian Government and USAID (as resource partners) with the Enterprise Incubator Foundation as implementation partner. The aim of the Centre is to develop the educational capacity of Armenian HEIs in IT/high-tech, enhance their research potential, while creating a favorable environment for business formation. The ISTC is located at Yerevan State University. However, all

the resources are available for the faculty members and students of all Armenian universities and the private sector. ISTC focuses on two main activities:

- *Enhancement of IT education and R&D*, which includes upgrading the curricula of Armenian HEIs, collaboration between local and US tech universities and R&D promotion and commercialisation.

- *Business aggregator*, which involves helping Armenia's technical and managerial workforce to form viable teams by providing mentorship and access to financing, development and provision of customised software solutions for SMEs, and promotion of local technology products in global markets.

The Engineering City, now under construction with a total budget of USD 20 million, is located on a 3 hectare area in Jrvezh, which will work with support from the Armenian Ministry of Economy, Enterprise Incubator Foundation Director, and National Instruments Armenia. The Engineering City will have exclusive laboratories with equipment worth several hundred thousand dollars. The equipment will be used by several companies. Around 30-35 companies will have individual buildings and nearly 50 will be able to develop their activities.

The Convergence Centre for Engineering and Applied Science is a proposed PPP between a donor organisation, Armenian educational institutions and IT companies. It is aimed at significantly increasing the number and quality of Armenian engineers and technology professionals, and raising the quality of technology education in universities. The Convergence Centre is made up of: (1) a Shared Hub offering hands-on workshops, project-based instruction and applied research facilities, surrounded by (2) academic modules run by partner universities and companies, offering instruction in specific IT disciplines with coordinated access to the Shared Hub, and closely coupled with (3) small offices and incubator facilities offering low-cost space and venture acceleration services to start-ups and small technology companies. The Centre also has cafes, a gym, etc. that will allow it to become a functioning ecosystem. The lead initiator of the project is the TUMO Centre for Creative Technologies.

Diaspora led networks

The Foundation for Armenian Science and Technology (FAST), launched in 2016, aims at building an ecosystem that drives technological innovation and scientific advancement in Armenia and beyond. FAST intends to mobilise the scientific, technological, and financial resources of Armenian and international communities. FAST initiated the Science and Technology Angels Network (STAN) which started operating in February 2018. This initiative unites 18 investors and entrepreneurs of Armenian descent and from other countries who will not only provide Armenian start-ups financing and consulting, but also mentor them and help them establish business ties.

ArmTech is a non-profit global network and recurring event officially adopted by the Republic of Armenia as its global high-tech industry platform. Conceived under the theme of 'learning from the past and inventing the future', it is

dedicated to further the success of Armenia's high-tech industry in a dynamic global free-market economy. Every year, the ArmTech Congress attracts industry professionals, high-level executives and interested parties from all over the world who get together to improve communications and cooperation with and within the Armenian high-tech industry. ArmTech Congress provides an opportunity to obtain business and professional information, and to connect with top industry representatives, government officials, major players in the financial and services sectors, and leading academics from Armenia, the US, Russia, European Union, CIS countries, the MENA region, and South-East Asia to strengthen cooperation and identify new partnership and investment opportunities.

ARPA Institute is a non-profit tax-exempt organisation established in 1992 in Los Angeles, California. The principal objective of ARPA is to promote international cooperation and understanding within the world community through the provision of consulting, analysis, research and planning services in education, economics, policy, health and technology between the Republic of Armenia and the USA.

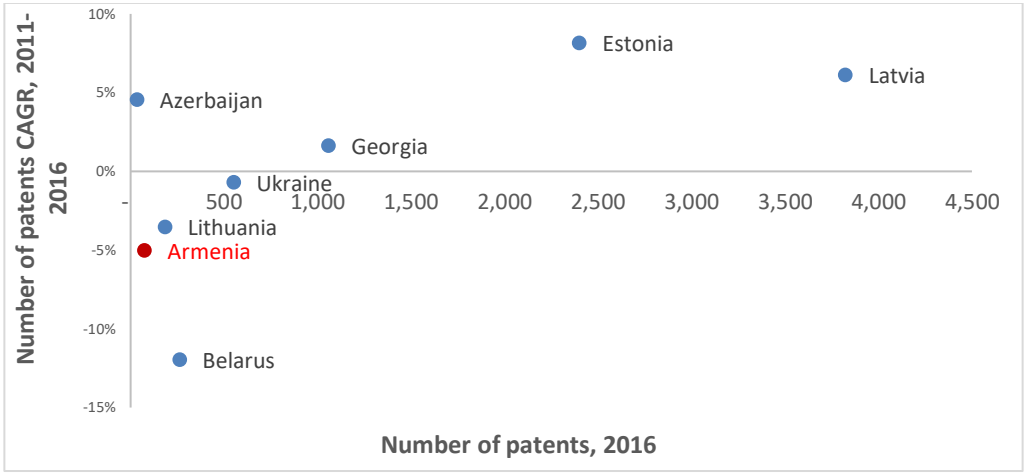
The Armenian Engineers and Scientists of America, Inc. (AESA) is a non-partisan and non-sectarian philanthropic organisation focused primarily on addressing the professional, technical and scientific needs of fellow Armenians throughout the world.

7.3 Knowledge Markets And Science-Business Relations

Patenting activity

Figure 42 compares Armenia with benchmark countries in terms of the numbers of patents and growth dynamics in the period 2012-2016. Data from WDI indicates that Armenian researchers are less active in patenting. Negative CAGR shows that patenting has a decreasing tendency during that period. Among the reasons could be a low patentability of the majority of research, indicating its more fundamental nature rather than applied or technological nature. Another reason might be the lack of practice, incentives and culture of patenting.

Figure 42: Patents in force per million inhabitants, 2016 vs. CAGR 2012-2016

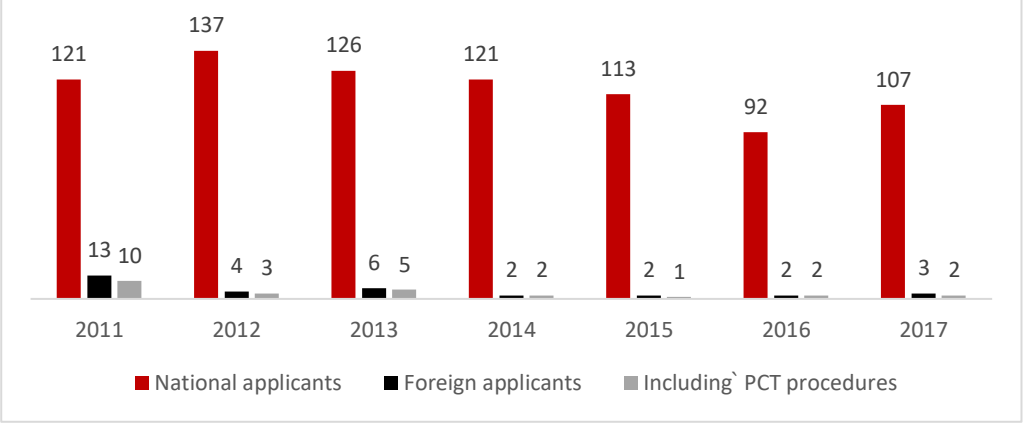


Sources: WDI, WIPO

Note*: For Azerbaijan, the calculations are done from 2012 to 2016

According to the Intellectual Property Agency, the majority of patent applications are submitted by national applicants. From 2011 to 2017 the total number of invention applications decreased by 22% (from 143 to 112).

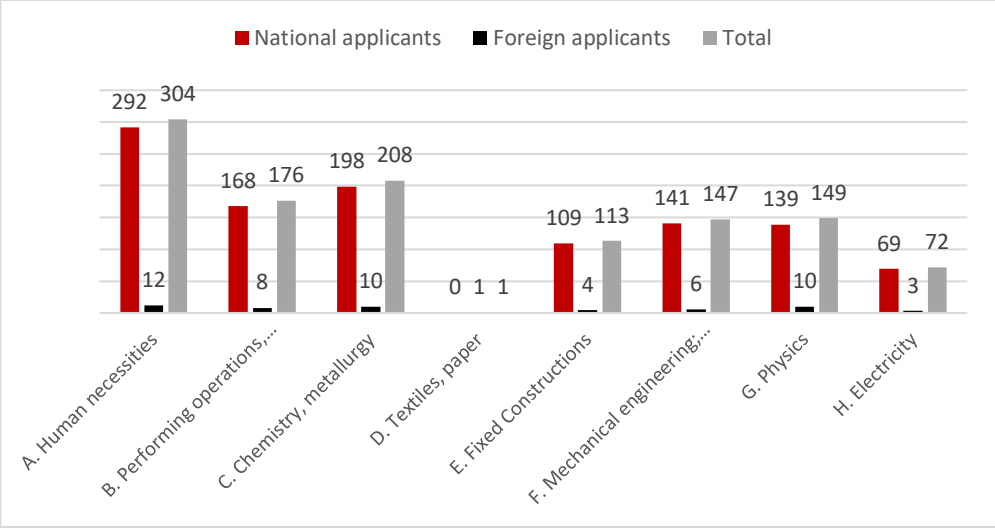
Figure 43: Number of invention patent applications in Armenia, 2011-2017



Source: Intellectual Property Agency, www.aipa.am

The leading field of patent applications in the timeframe was 'human necessities' both for national and foreign applications. The subject area of chemistry and metallurgy was in 2nd place, followed by the category 'performing operations and transporting'. Physics is not on the list of top subject areas with only 149 applications in total during the period 2011-2017. This goes against Armenia's higher scientific performance in that discipline.

Figure 44: Number of patent applications in Armenia by the field of technology, 2011-2017



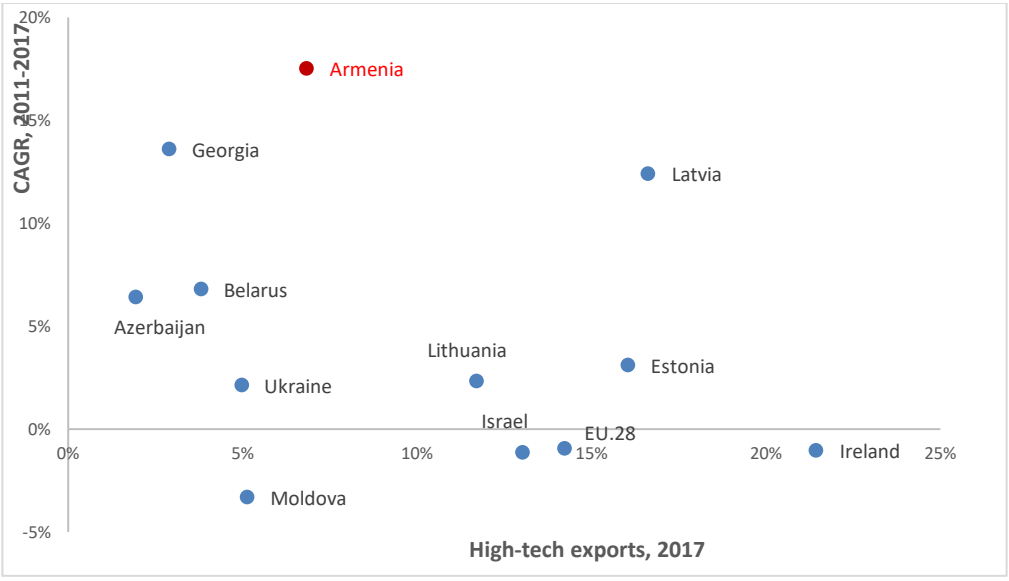
Source: Intellectual Property Agency, www.aipa.am

Commercialisation of knowledge products

The results of innovation activities are materialised either in commercial or scientific/research outputs. The strength of any ecosystem depends on the intensity of both types of outputs which are closely related. In the context of this report's framework, commercial output includes products and services based on the application of advanced technologies as well as fees and royalties received due to technology transfer.

One of the key measures of the level of **commercial output** produced by a country is the share of high-tech exports in total merchandise export.

Figure 45: High-tech exports (in percentage to total manufactured exports) in 2017 vs. CAGR 2011-2017



Source: WDI

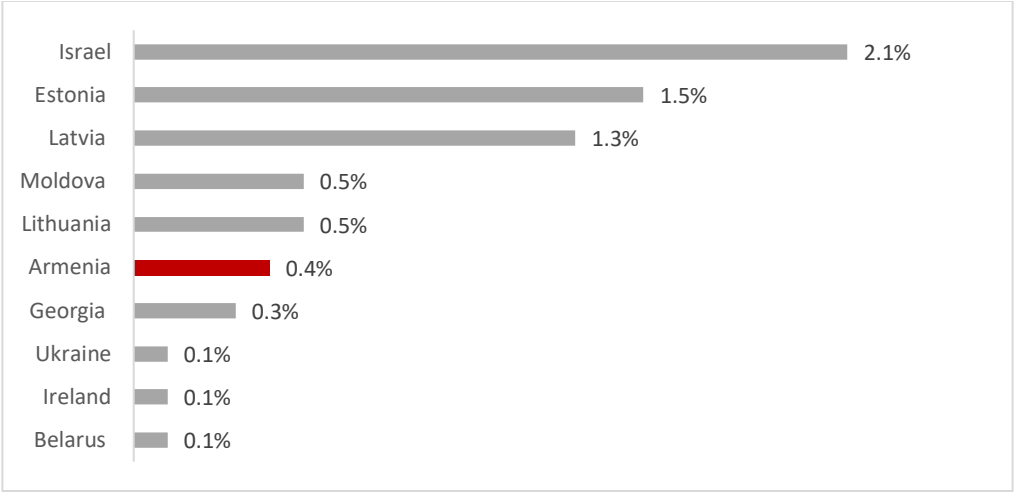
Armenia shows a relatively higher than average lever both in terms of high-tech exports and its growth rates during the past six years compared with EP peers. The increase of this indicator closely correlates to the success of the technology-enabled transformation of the country's economy, and as such is one of the key performance indicators.[47]

As for the export of high-tech services, no direct international data exists. According to EIF estimates, Armenia's export of IT services reached about EUR 301.6 million, accounting for 50% of software and services total output. This high percentage denotes the increasing role of IT in Armenia's exports and economy at large.

An important aspect of Armenia's innovation-based activities can be captured by measuring exports of creative and cultural services (Figure 46). Latvia and Estonia are among the top three with 1.3% and 1.5% shares, respectively. On the other hand, Azerbaijan is among the outliers with 0% of share.

[47] A significant share of Armenia's high-tech exports is in services, and it needs to be factored in as an indicator for a more accurate estimation. Unfortunately, reliable statistics are not available.

Figure 46: Cultural and creative output service exports, Armenia and benchmark countries, 2018



Source: Global Innovation Index, 2018 report

While this measurement does not directly reflect the technological intensity of services, it does reflect the intensity of creativity going into them. In peer comparison, Armenia achieved moderate results on cultural and creative exports with 0.4% in total trade.

8 ARMENIA'S INNOVATION CHALLENGES

Armenia still produces globally competitive scientific research in different subject areas, but the transformation of scientific knowledge into commercial opportunities lags behind. Armenia has underinvested resources in building innovation and technology ecosystems in comparative terms. The operating efficiency of the system measured by ratio of the performance indicator relative to invested resources (including human, financial, and infrastructure) is high, but not sustainable in the long run. Strategic efficiency needs to take priority over operating efficiency. The former requires investing much larger resources in the emerging patterns of technological shifts.

Armenia's enabling environment has yet to become largely conducive to technology development, innovation, and science-based development. There are important flaws and gaps, particularly in S&T and innovation policies as well as research capabilities in the areas that define the next technological revolution. The technology-enabled leap can be achieved only if those gaps and flaws are addressed quickly and efficiently.

Armenian scientific and technological specialisation is undermined by a lack of critical mass of human and financial resources in selected key fields. This is due to fragmented research funding and an insufficient number of STEM graduates. Hard choices are required in terms of the focusing of limited government funding on selected scientific fields where Armenia can realistically 'excel'. Business-education-research cooperation in selected advanced technology fields requires a long-term investment framework to generate real growth potential.

While the current state of the Armenian science and innovation system is far from optimal, there are a number of **positive developments** that create a basis for science and innovation development in the country, in partcular:

- Government programmes prioritising the high-tech sector;
- Advancment in selected fields of science and relatively strong scientific output results;
- Success in building a dynamic and internationally linked innovation ecosystem in ICT and, to some extent, engineering service sectors;
- Networked and experienced diaspora in science, technology and business sectors;
- Large-scale educational initiatives and positive attitude towards education.

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Web of Science Database

10 GLOSSARY

ACR	Armenian Competitiveness Report
AIPA	Armenian Intellectual Property Agency
AMD	Armenian Dram
ANEL	Armenian National Engineering Laboratories
BSI	Black Sea Interconnection
CAGR	Compound annual growth rate
CANDLE	Center for the Advancement of Natural Discoveries using Light Emission
CBA	Central Bank of Armenia
CEE	Central and Eastern Europe
CEPA	Comprehensive and Enhanced Partnership Agreement
CIF	Competitive Innovation Fund
CIS	Commonwealth of Independent States
DB	Doing Business
DFA	Development Foundation of Armenia
EaP	Eastern Partnership
EAEU	Eurasian Economic Union
EFTA	European Free Trade Association
EEN	Enterprise Europe Network
EEU	Eurasian Economic Union
EIC	E-Society and Innovation for Competitiveness
EIF	Enterprise Incubator Foundation
ERA	European Research Area
FAST	The Foundation for Armenian Science and Technology
FDI	Foreign Direct Investments

FEZ	Free Economic Zone
GBAORD	Government Budget Appropriations or Outlays for Research and Development
GCI	Global Competitiveness Index
GCR	Global Competition Review
GDP	Gross Domestic Product
GDP PPP	Purchasing Power Parity
GERD	Gross domestic expenditure on R&D
GII	Global Innovation Index
GNI	Gross national income
CNRS	National Centre for Scientific Research
GSP	Generalised Scheme of Preferences
GVA	Gross value added
H2020	Horizon 2020
HDI	Human Development Index
IAE	Institute of Archaeology and Ethnography
ICT	Information and Communications Technology
IGS	Institute of Geoloigal Sciences
IIAP	Institute for Informatics and Automation Problems
IMB	Institute of Molecular Biology
IP	Intellectual Property
IPR	Institute for Physical Research
IRPhE	Institute of Radiophysics and Electronics
ISFIE	Initial strategy of the formation of innovation economy
ISTC	International Scientific and Technical Centre

IT	Information Technologies
MEDI	Ministry of Economic Development and Investments
MENA	Middle East and North Africa
MES	Ministry of Education and Science
MNC	Multinational corporation
NAS	National Academy of Science
NATO	North Atlantic Treaty Organisation
NBE	National Bureau of Expertise
NIM	National Institute of Metrology
NIS	National Institutes of Standards
NSS	National Statistical Service
NPUA	National Polytechnic University of Armenia
OSCE	Organisation for Security and Cooperation in Europe
RA	Republic of Armenia
R&D	Research and development
RDTI	Research, Development, Technology and Innovation
R&I	Research and Innovation
SCRA	Statistical Committee of the Republic of Armenia
SCS	State Committee of Science
SDG	Sustainable Development Goals
SME	Small and Medium Entrepreneurship
SMEDA	Support to SME Development in Armenia
SME DNC	Small and Medium Entrepreneurship Development National Center
SPDSS	Strategic Program for the Development of Science Sector

S&T	Science and Technology
STAN	Science and Technology Angels Network (STAN)
STCOPC	Scientific Technological Center of Organic and Pharmaceutical Chemistry
STEM	Science, Technology, Engineering and Mathematics
STEP	Science & Technology Entrepreneurship Programme
STI	Science, technology and innovation
TIFA	Trade and Investment Framework Agreement
UEICT	Union of Employers of Information and Communication Technologies
UITE	Union of Information Technology Enterprises
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
VC	Venture Capital
WB	World Bank
WDI	World Development Indicators
WIPO	World Intellectual Property Organisation
WTO	World Trade Organization
YCRDI	Yerevan Computer Research and Development Institute
YerPHI	Yerevan Physics Institute
YSU	Yerevan State University

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The Horizon 2020 Policy Support Facility (PSF) has been set up by the Directorate-General for Research and Innovation (DG RTD) of the European Commission under the EU Framework Programme for Research and Innovation 'Horizon 2020'. It supports Member States and countries associated to Horizon 2020 in reforming their national science, technology and innovation systems.

This background report aims to provide information on the economic situation, the state of affairs in research and development in Armenia, as well as innovation and, more specifically, on the quality of science base, human resources and framework conditions for R&I . The report will be used for PSF Specific Support, as requested by the Armenian authorities, in relation to the:

• Development of a model for evaluation and assessment of the public research institutions performance

• Assessment and improvement of the performance-based funding system and advice on its implementation

• Measures aimed at bridging the gap between higher education and research

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