



Background Report

Peer Review of the Ukrainian Research and Innovation System

Horizon 2020 Policy Support Facility



EUROPEAN COMMISSION

Directorate-General for Research & Innovation
Directorate A — Policy Development and Coordination
Unit A4— Analysis and monitoring of national research policies

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May 2016

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Luxembourg: Publications Office of the European Union, 2016.

ISBN: 978-92-79-63460-4

DOI: 10.2777/924495

KI-AX-16-102-EN-N

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1. EXECUTIVE SUMMARY

The purpose of the report is to summarise evidence on the situation in the field of science, technology and innovation (STI) in Ukraine to provide a background for the Horizon 2020 Policy Support Facility Peer Review of Ukraine's research and innovation system. This Peer Review, requested by the Ministry of Education and Science of Ukraine, will be implemented by the panel of independent experts and national peers in 2016.

Ukraine is a lower middle-income transformation country with a rich scientific heritage from the Soviet Union and with a good standard of education. However, since independence it is unclear if Ukraine, still quite industrialised and at the same time an agrarian society in its rural areas, has an expressed political will and subsequent activities to transform towards a knowledge based economy. The last 25 years were characterised by a quick sequence of economic and political crises and intermediate phases of recovery. The last crisis in the aftermath of the Maidan revolution, caused by the annexation of the Autonomous Republic of Crimea and Sevastopol by Russia and the war at Donbas region, confronted with an aggressive hostile superpower neighbour, is severely critical, because it cuts the country from its previous most important partner in terms of foreign trade and cultural relations. GDP fell by -15% in 2015 compared to 2014 and the GDP per capita ratio is below the level of 2008.

STI however was continuously shrinking since independence, especially in terms of general expenditures on R&D in % of GDP, the number of institutions and R&D personnel. The situation nowadays is characterised by limited public budget allocations and an economic structure, whose demand for R&D is unassertive. The governance of S&T was periodically reformed, but the dominant R&D institution of the country, the Academy of Sciences of Ukraine (NASU), remained more or less unchanged, at least in its overall governance structure. The post-Euromaidan governments, including the Ministry of Education and Science (MESU), strongly express attempts and efforts for system reform. The association of Ukraine to HORIZON 2020 can be regarded as element of this reform orientation.

Other important stakeholders in the STI governance system next to MESU and NASU are the Ministry of Economy and Trade, the Ministry of Finances, and several other line ministries with R&D responsibilities. Their political orientations and interventions lack coordination among them and also between them and the regional level. The system of research and innovation is also characterized by limited cooperation between public research institutes and the higher education sector as well as low science-industry cooperation.

In 2016, as proclaimed by MESU, the state budget should be used for further investments into basic funding of R&D institutions, grants for nationally funded projects, renovation of research infrastructure, support schemes for young researchers (incl. diaspora return), evaluation of state research institutions and universities, access to R&D databases (Scopus, WoS) and the establishment of a National Research Foundation of Ukraine.

Previous public interventions in the field of STI, however, showed that theory and practice of policy formulation and policy-delivery including follow-up activities are different things, especially concerning R&D funding, which is only directed towards state-owned respectively state-influenced institutions. Most of the state R&D budget is invested in NASU. The dominant funding principle is that of institutional allocation, while competitive project-based funding is very low. Public investment is oriented towards broadly defined R&D priorities which correspond to the still existing broad R&D landscape (at least on paper) of the country. The share of international R&D funding is high but dropped because of the prevailing crisis (~ 20%).

The research infrastructure facilities are overall outdated in Ukraine, which has a negative influence on scientific excellence. In terms of bibliometric indicators, which are often used to assess the scientific excellence of a country, one can observe a low share and negative trend of Ukraine's most cited publications worldwide as % of total scientific publications of Ukraine, a very low level of public-private publications by million population and a rather low but steadily increasing level in international scientific co-publications per million population, which nevertheless is a positive signal given the drastic reduction of scientific personnel during the last 15 years. By international comparison, Ukraine's science communities are specialised in physics and astronomy, material sciences and chemistry, engineering, mathematics and earth and planetary sciences. Over the last ten years, specialisation increased in mathematics, earth and planetary sciences, energy and economics, econometrics and finance.

Concerning the higher education sector, not all universities are subordinated to MESU, which sometimes causes quality problems. Ukraine participates in the Bologna Process and is member of the European Higher Education Area (EHEA) since 2015. However, only the new Higher Education Law, which is currently implemented, introduces far reaching autonomy of universities. Although the higher education

sector absorbs 70% of the scientifically educated personnel, only half of the around 350 universities perform any kind of R&D and of these only a few are seriously engaged in R&D. R&D expenditure in the higher education sector (HERD) was less than 7% of the general expenditure on R&D (GERD) in Ukraine in 2011. Scientifically educated personnel at universities are mostly engaged in teaching, which is hardly surprising given the high number of students enrolled in Ukraine (2.5 million). 70% of HERD comes from state and regional budgets.

Ukraine inherited a relatively well-developed education system from the Soviet Union. The country still has a high public spending on education (incl. tertiary education). However, there are also several shortcomings; (vocational) schools are lacking technical equipment, teaching approaches are old-fashioned and there are several incidents of corruption in the education system at all levels.

University enrolment is very high (80% of 19-25 year-olds), but PhD enrolment is quite low by international comparison which indicates an overall low interest to pursue scientific careers. Also the level of tertiary education attainment is high, but the absorption capacity of the Ukrainian economy is limited. Ukraine belongs to the countries with the highest share of over-qualification within the entire EHEA. In terms of enrolment by disciplines, student enrolment shifted from natural and technical sciences towards humanities, social sciences, business and law.

Only 20% of the growing number of scientifically trained personnel is involved in R&D as primary job task. Doctoral training lacks behind other reforms exercised in the higher education sector. New research positions are few and the number of researchers is constantly declining. This trend will most probably continue because a large number of scientists are at pensionable age in Ukraine.

The absorption capacity of industry for R&D personnel is limited too, although private R&D funding increases slowly albeit from a very low level. The share of researchers in the business enterprise sector by a million inhabitants is low by international standards. In 2013, the business enterprise sector (BES) consumed 55% of GERD in 2013, but financed much less R&D. As a heritage from the Soviet system, several dozens of industrial research institutes and design bureaus are still operating in Ukraine, although mostly on negligible basis, which perform business oriented R&D. 16% of industrial enterprises were engaged in R&D activities in 2014. Ukraine's high- and medium-tech sectors shrunk threefold since the 1990s. Business expenditure of R&D is concentrated on (traditional) machine-building, mostly occupying lower market segments which face fierce competition from emerging economies. Some of the more modern and innovative machine-building companies, especially those in the field of military and dual-use equipment, suffer from the freezing of trade relations to Russia. Public support for innovation financing hardly exists.

To counterbalance the low innovation performance of Ukraine, the UNECE review of the innovation system of Ukraine, which published its report in 2013, recommended a regular evaluation of the system of innovation in Ukraine, the development of a holistic and concise national innovation strategy, the creation of a National Innovation Council to improve the system's governance, the provision of financial resources, to link business promotion with innovation promotion, to foster industry-science linkages and to engage the private sector in public technology programmes through consultations and PPPs.

The technological innovation priorities of Ukraine as stipulated by law are in the fields of energy and energy-efficiency, transportation in general, but also peculiar fields (rocket and space; aircraft industries; ship-building; armament and military technologies), new materials with emphasis on nano-materials, agro-industry, bio-medicine (medical services and treatment devices, pharmaceuticals), cleaner production and environmental protection, and ICT & robotics. The understanding of innovation in Ukraine is very technology determined with limited awareness on a broader understanding of innovation (e.g. service innovation; business-model innovation; public sector innovation; social innovation).

Despite the rich scientific basis of Ukraine, the technological readiness level of the country remains average in international comparisons, especially in terms of foreign direct investments and technology transfer, technological absorption at firm-level and the availability of latest technologies (WEF Global Competitiveness Reports 2012-2016). In the 2016 'ease of doing business-ranking', Ukraine shows relatively good rankings in terms of starting a business (although the survival rate of start-ups is very low) and in getting credit, while other factors severely hamper economic development, such as the enforcement of contracts, the paying of taxes and – not surprisingly – trade across borders, aggravated through the frozen business relations to Russia.

The changing pattern of international relations of Ukraine, characterized by a distinct shift of relations away from Russia, is not only visible in the field of international economic relations, but also in sciences, although educational relations (also of scientific personnel) with Russia are still strong and sustainable

and also nationally patents abroad have by far been filed mostly in Russia. Few patents are recognised in the EU and USA indicating a weak integration of Ukrainian companies in global value chains.

An important, also politically symbolic step was the association of Ukraine to HORIZON 2020 on 20 March 2015. Ukraine had a relatively good participation in FP7 (with funding amounting to €30.9m) with a sufficient success rate (~ 20%). Participation in HORIZON 2020 did not improve yet in quantitative terms and the success rate fell to ~13%, which corresponds to EU average. The highest success rates are in EURATOM; the lowest in 'industrial leadership' which confirms the weak technological orientation of Ukraine's industry. Ukraine also has 25 intergovernmental S&T agreements with EU Member States and countries associated to Horizon 2020 (2014). NASU has 110 bilateral agreements with the most projects jointly implemented with Poland, France, Hungary, Slovak Republic and the Czech Republic. The most important co-publication partners of Ukrainian researchers are residing in Germany, Russia and the USA, followed with some distance by Poland, France, UK, Italy, Spain and Japan.

A final note should be given to data quality as regards the situation of economic and STI analysis of Ukraine. We have been faced with relatively scarcity of and limited accessibility to data, STI policy reports and analysis in English with hardly any information on the regional level. Also international statistics depict evident differences. Specifically data and information about systematic business R&D beyond the operations of industrial research institutes are hardly available or statistically insufficiently recorded, although Ukraine implements an innovation survey inspired by the Community Innovation Survey (CIS). Nevertheless, the observed strong differences in terms of R&D funding and R&D performance by BES indicate a problem area, which is either caused by statistical shortcomings or a real economic fault line or both. Also data on venture capital and venture financing are scarce. There is also no persistent information about private non-profit R&D. Finally, also bibliometric data, although genuinely prepared for this report, have to be interpreted with care because of the relatively low inclusion of Ukraine in international English-speaking publication circles. The data situation, however, will most probably improve due to the inclusion of Ukraine in the IUS/EIS in the forthcoming years.

Whatever the findings of the independent peer review of the STI system of Ukraine will be, the country depicts unique characteristics in the field of science, technology and innovation which are hardly comparable to any other country and, thus, require tailor-made recommendations and solutions.

2. THE SITUATION IN UKRAINE

This chapter is dedicated to the overall political, social and economic situation in nowadays Ukraine. Before elaborating on Ukraine's economic performance in detail (structure of the economy, technological basis and integration into the global economy with a focus on trade and FDI), some light is shed on the current political and social developments in the country.

Certainly the most dramatic developments Ukraine experienced in late 2013, early 2014. After former President Viktor Yanukovich decided not to sign the association agreement between the EU and Ukraine¹ in November 2013, the so-called "Euromaidan" movement formed to fill this suddenly created "political void" in EU-Ukraine relationship. Euromaidan movement was in favour of supporting the political rapprochement between the EU and Ukraine and, generally speaking, to bring the country closer to the Union. The association agreement was signed after all in 2014 then. In March 2014 Russia annexed the territory of the Autonomous Republic of Crimea and Sevastopol. Albeit Russia is denying any direct annexation of these territories, claiming that the local (mainly native Russian) population took a "democratic decision" to legally join the Russian Federation by conducting a fair and objective ballot, the facts as perceived by the international community speak another language.² On top of that, in April of the same year a war in the Eastern territories of Ukraine triggered off, where pro-Russian civilians and militia fight with the regular Ukrainian army about the sovereignty on the two oblasts of Luhansk and Donetsk (subsumed as "Donbas" as a greater region).

According to Ukrainian official statistics, as a result on the territory controlled by the Ukrainian government (Ukrainian state territory without Luhansk and Donetsk oblast) there are now about 43 million people located in Ukraine of which more than 1.5 million are internally displaced persons (IDPs) from the occupied territories. Due to the loss and destruction of the industrial capacities prevailing in the Donbas region, Ukraine's national GDP (Gross Domestic Product) fell by over 15% according to Ukrainian governmental data in 2015 compared to 2014.³

2.1. Societal challenges

Ukraine currently has a population of around 42,7mio people (not including the Crimea peninsula and Sevastopol). The GDP in 2015 amounted to 130,7bn US\$, and to 7,552.4 per capita (PPP\$). As regards the general level of income, Ukraine is considered a lower-middle income country.⁴

According to the World Bank's "World Governance Indicators" from 2013, Ukraine ranks only 110th in regard to political stability and absence of violence/terrorism, 109th in "political effectiveness" and 114th in "rule of law" (out of 141 listed countries)⁵. The "Doing Business 2016" report by the World Bank spots Ukraine only on 83th position in the "ease of doing business" ranking among 189 listed countries, which is a step forward compared to 2015 when Ukraine ranked 96th.

As regards ICT access and use by the Ukrainian society, the country performs somewhere on an average level. Based on a report by the International Telecommunication Union, Ukraine ranks 63rd on the level of ICT access and 89th on the level of ICT use by society (also here around 140 countries are included in the results).⁶

1 http://eeas.europa.eu/top_stories/2012/140912_ukraine_en.htm : accessed on 2 May 2016.

2 For the EU's position: http://eeas.europa.eu/top_stories/pdf/the-eu-non-recognition-policy-for-crimea-and-sevastopol-fact-sheet.pdf and for the UN's position: <http://www.un.org/press/en/2014/ga11493.doc.htm> : accessed on 2 May 2016.

3 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p.2, 2016

4 Cornell University, INSEAD, and WIPO: "The Global Innovation Index 2015: Effective Innovation Policies for Development", Fontainebleau, Ithaca, and Geneva, 2015, p.292

5 Ibid., p.309

6 Ibid., p.328-329

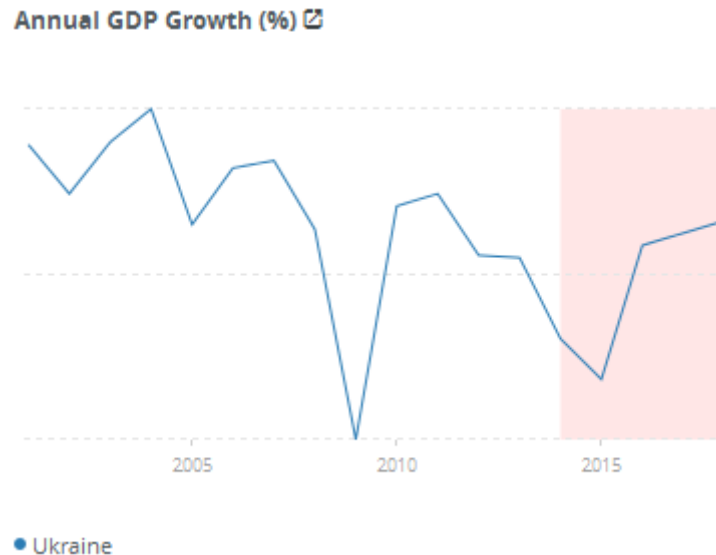


Figure 1: Global Economic Forecast: Growth of Ukraine's GDP in 2015, 2016, 2017, 2018;
source = World Bank Open Economic Data

Ukraine had a drastic drop in its national GDP in 2015, as Figure 1 above shows. Compared to 2014, the GDP decreased by around 10.0% after a first downturn in 2014 (-6.6% compared to 2013). The outlook for this and the upcoming years is positive though. According to the World Bank's data, Ukrainian GDP will grow by 1.0, 2.0, and 3.0 percent respectively from 2016 to 2018.⁷

UNESCO and World Bank provide data on population trends, internet access, trends in GDP, employment and manufactured exports and compare them in the context of all Black Sea region countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova, Turkey and Ukraine). Figure 2 below, which is retrieved from the UNESCO Science Report 2015, shows the following selected facts, important for an assessment of Ukraine's socio-economic environment:

- From 2008 to 2014, Ukraine had a negative population trend (-2.6% growth)
- 41.8 persons/per 100 population had internet access in 2013, which is the lowest number of all Black Sea countries in that year
- In 2013, employment among the adult population was only 59%

The data in Figure 2 show **trends in different sectors related to the socio-economic environment between 2008 and 2013**. Ukraine is the only Black Sea country where GDP per capita almost remains at 2008 level. This is also indicated in the World Bank's open data on the economic situation in Ukraine.⁸

As concerns work, employment and vulnerability, the employment to population ratio is less than 60% (people which are 15 years and older). Distributed to the fields of employment, UNDP lists the following data for Ukraine: around 17% are employed in the agricultural sector and 62% are employed in the service sector. The share of employed persons in industry is around 25% (between 2010 and 2012).⁹ As regards unemployment in general, the rate in Ukraine is currently moving between 10-12%, according to data from the International Labour Organisation (ILO).¹⁰ In fact, the rate might be probably higher, as the statistical counting often does not cover all unemployed people sufficiently enough (non-

7 <http://data.worldbank.org/country/ukraine>: accessed on 2 May 2016.

8 Ibid.

9 Data differs between different sources, which explains the non-achievement of 100%.

10 http://www.ilo.org/gateway/faces/home/polareas/empandlab?locale=en&countryCode=UKR&track=STAT&policyId=2&adf.ctrl-state=n2480je04_78: accessed on 2 May 2016.

registered people in black labour etc.). The long term unemployment rate is at 2.1% and the youth unemployment rate is 17.4% (age 15-24).¹¹

The three columns on the top right side of Figure 2 shed light on the export rate of Ukraine's manufacturing sectors altogether. In 2012, the volume of manufactured exports made up 23.5% of the national GDP. At the same time, manufactured exports made up 60.6% of the total amount of merchandise exports. After Turkey (77.7%), this is the second highest share among Black Sea Region countries. Furthermore, the very right column indicates that the share of manufactured exports as of total GDP reduced by -5.0% within the last ten years. Only Armenia's share shrank more than that (-8.4%).

Table 12.1: Socio-economic trends in the Black Sea countries

	Population trends		Internet access	Trends in GDP			Employment		Manufactured exports		
	Population ('000s) 2014	Cumulative growth 2008-2013	Per 100 population 2013	Per capita (current PPP\$) 2008	Per capita (current PPP\$) 2013	Average growth per annum 2008-2013	As a share of adult population 2013 (%)	Share employed in industry, average 2010-2012 (%)	As a share of total merchandise exports, 2012 (%)	As a share of GDP 2012 (%)	Change over 10 years in share of GDP, 2012 (%)
Armenia	2 984	0.0	46.3	7 099	7 774	1.7	63	17	22.1	3.2	-8.4
Azerbaijan	9 515	6.0	58.7	13 813	17 139	5.5	66	14	2.4	1.1	-0.9
Belarus	9 308	-2.1	54.2	13 937	17 615	4.4	56	26	46.7	33.8	-1.0
Georgia	4 323	-1.6	43.1	5 686	7 165	3.5	65	6	53.4	8.0	4.3
Moldova	3 461	-4.1	48.8	3 727	4 669	4.0	40	19	37.2	11.0	-1.0
Turkey	75 837	6.5	46.3	15 178	18 975	3.3	49	26	77.7	15.0	2.0
Ukraine	44 941	-2.6	41.8	8 439	8 788	-0.2	59	26	60.6	23.5	-5.0

Source: UNESCO Institute for Statistics; for employment and manufactured exports: World Bank's World Development Indicators, accessed November 2014

Figure 2: Socio-economic trends in the Black Sea countries; source = Snapshot of UNESCO Science Report 2015

As regards the **educational sector**, Ukraine inherited a relatively well-developed education system from the Soviet era. It still preserves some positive features of this system with its emphasis on mathematics and natural sciences at school level. However, serious concerns are often raised regarding the quality of S&T education. In chapter 7 and chapter 9 of this report the higher education sector and its interplay with the business environment is scrutinised in detail.

Concerning the Human Development Index, Ukraine performs quite modest. Among 188 covered countries, it ranks on 81st position only with a score of 0.747 points in 2014 – Norway (0.944), Australia (0.935) and Switzerland (0.930) rank first.¹² The score is composed of different factors, which are also important to look at. Life expectancy at birth is 71.0 years (Norway: 81.6), mean years of schooling are 11.3 (Norway: 12.6) and Gross National Income (GNI) per capita is 8,178 PPP \$ (Norway: 64,992).¹³

The total current population is around 42,7mio people of which approx. 21.2% are 65 years and older (i.e. 6.7m people) and of which 21.4% are of young age (0-14). The median age is 39.9 years. Population living in urban areas is around 69.5% and sex ratio at birth (male to female births) is 1.06.¹⁴

11. Ibid.

12. <http://hdr.undp.org/en/composite/HDI> : accessed on 4 May 2016.

13. Ibid.

14. <http://hdr.undp.org/en/countries/profiles/UKR>: accessed on 4 May 2016.

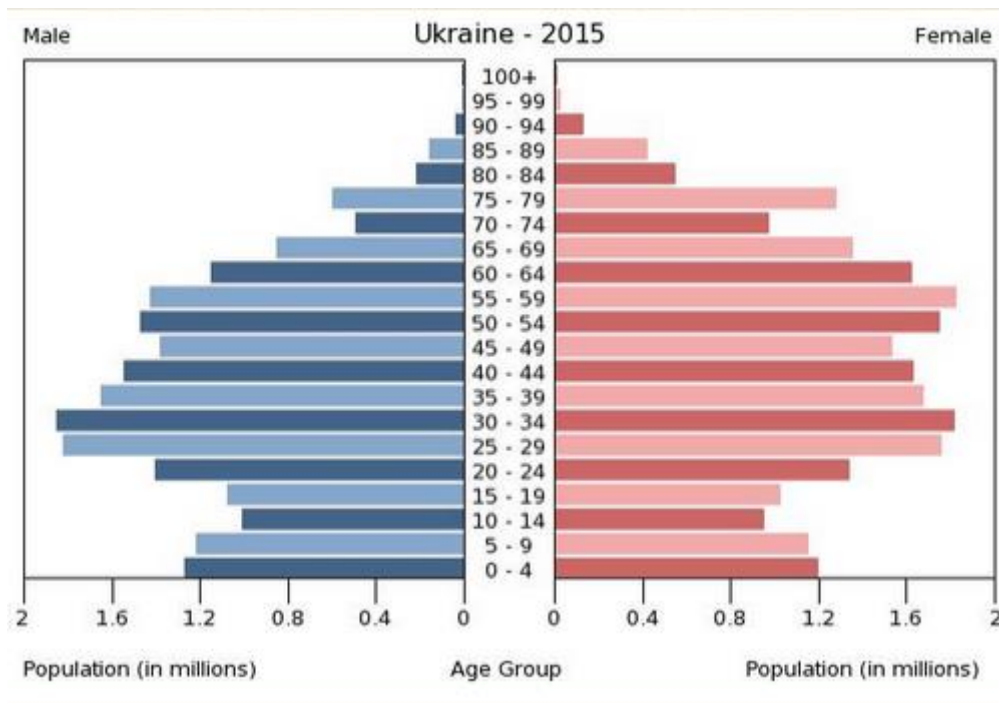


Figure 3: Population pyramid for Ukraine in 2015; source = CIA (Central Intelligence Agency) World Factbook

Figure 3 above shows the population pyramid for Ukraine in 2015. It is based on data from the CIA World Factbook.¹⁵ According to these data, the share of old people decreased compared to 2014. The World Factbook outlines a share of 15.8% of old people (65 years and older).

The corruption perceptions index from Transparency International ranks Ukraine 130 from 188 countries in 2015 (with a score of 27 out of 100). It is based on how corrupt a country's public sector is perceived to be. It is a composite index, drawing on different sources of corruption-related data.¹⁶ As regards the control of corruption in Ukraine (*control of corruption* reflects perceptions of the extent to which public power is exercised for private gain), Ukraine achieves a low 17% from a possible total of 100% control. Public opinion in Ukraine assesses the following institutions as most affected by corruption (from 5 = extremely corrupt to 1 – not at all corrupt):¹⁷

1. Judiciary (4.4)
2. Police (4.3)
3. Parliament and Legislature AND Public Officials and Civil Servants (4.1)

Least affected: Religious Bodies (2.3)

15 <https://www.cia.gov/library/publications/the-world-factbook/geos/up.html> : accessed on 4 May 2016.

16 <https://www.transparency.org/country/#UKR> : accessed on 4 May 2016.

17 https://www.transparency.org/country/#UKR_PublicOpinion : accessed on 4 May 2016.

2.2. Structure and specialisation of the Ukrainian economy (including its technological basis)

According to the latest report of the World Economic Forum's Global Competitiveness Report in 2015-2016, Ukraine remained on a mediocre position in 2014-2015 and 2015-2016 (see Table 1). While the country was ranked 76 previously, it ranks 79 now¹⁸.

UKRAINE in the GCI	RANK (out of 140)	SCORE (1-7)
Global Competitiveness Index 2015-2016	79	4.0
GCI 2014-2015 (out of 144)	76	4.1
GCI 2013-2014 (out of 148)	84	4.1
GCI 2012-2013 (out of 144)	73	4.1

Table 1: Ukraine's ranking in the Global Competitiveness Index from 2012 to 2016; source = World Economic Forum's (WEF) Global Competitiveness Report 2015-2016

The drop of Ukraine in the GCI compared to 2014-2015 is a consequence of the country's worsened performance in the following areas:¹⁹

- Macroeconomic environment: 134th place (previous: 105th)
- Financial Market Development 121st place (previous: 107th)
- Infrastructure: 69th place (previous: 68th)
- Technological Readiness: 86th place (previous: 85th)

Ukraine is both an industrial and agrarian country, predominantly producing different kinds of raw materials. As regards the types of industry, the main prevailing sectors in accordance with the United Nations International Standard Industrial Classification²⁰ are

- Heavy engineering
- Ferrous and non-ferrous metallurgy
- Shipbuilding
- Automotive industry²¹
- Aerospace industry
- Manufacturing and supply for power plants
- Oil, gas and chemical industry

It has to be noted, however, that the remaining aerospace industry in Ukraine is severely affected by the termination of contractual relations with Russia. Also the automotive sector and the shipbuilding sectors are declining.

The current Global Competitiveness Report 2015-2016 by the World Economic Forum (WEF) provides some insights into the "technological readiness level" of Ukraine²², which help to set the scene for this chapter.

18. The absolute positions of countries in the WEF's Global Competitiveness Report has to be interpreted with care, because the number of countries in the annual surveys change.

19. Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p. 354

20. <http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27> : accessed on 4 May 2016.

21. According to Igor Yegorov, it is problematic to consider this sector as a key one: now Ukraine produces less than 1000 cars per quarter.

Ukraine's performance in the GCI based on the factor "technological readiness"	GCI 2012-2013: ranking and grade	GCI 2013-2014: ranking and grade	GCI 2014-2015: ranking and grade	GCI 2015-2016: ranking and grade
Technological readiness level (overall)	81 / 3,6	94 / 3,3	85 / 3,5	86 / 3,4
Availability of latest technologies	69 / 4,8	106 / 4,3	113 / 4,1	96 / 4,3
Firm-level technology absorption	80 / 4,8	100 / 4,3	100 / 4,2	100 / 4,2
FDI and technology transfer	109 / 4	131 / 3,6	127 / 3,7	117 / 3,8
Individuals using Internet, %	88 / 30,6	93 / 33,7	82 / 41,8	80 / 43,4
Fixed-broadband internet subscriptions per 100 inhabitants	69 / 7	71 / 8,1	68 / 8,8	72 / 8,4

Table 2: Ukraine's level of technological readiness, given by stipulated indicators; source = WEF Global Competitiveness Reports 2012 to 2016

Compared to the last GCI from 2014/15, Ukraine remained on a mediocre position in terms of its technological readiness level. The scores given in the table are on a 1-7 scale, with 7 indicating the best score (apart from the values indicated in %). Based on the sub-fields, which specify the technological readiness level, Ukraine improved most in "availability of latest technologies" (from 113th to 96th position²³). Ukraine ranked best in 2012-2013, when the technological readiness of the country was assessed with a score of 3.6 (second left column).

Ukraine's overall top-ranking before the most obvious political turmoil (2012/2013) is well reflected in all of the listed indicators. The level of **availability of latest technologies** in the country (both in the research and industrial sector) was highest in these years (69th place among 140 countries with a score of 4.8), as well as the firm-level technology absorption (80th place with a score of 4.8) and the level of FDI and technology transfer (109th place with a score of 4.0), which all have worsened since then. Only on the levels of individuals using the internet and fixed-broadband internet subscriptions Ukraine improves – in 2014/2015 41.8% of Ukrainians used the internet and 68 of 100 inhabitants had a fixed-broadband internet subscription respectively, which are both the highest shares of Ukraine within all the listed Global Competitiveness indexes.

Aspects of doing business in Ukraine

Important aspects for doing this assessment are the access to finance (credits, loans, and venture capital), the ease of technology adaption (distance to the technology frontier and innovation culture) and similar potential barriers when doing business.

First, data from the World Bank Group are scrutinised. In the current "ease of doing business-ranking 2016" Ukraine takes the 83rd position from 189 countries in total.²⁴ More exactly, this snapshot is the junction of several smaller assessments in different aspects related to economy. Those, particularly important for our analysis, are the following

22. Schwab, Klaus (2015): „The global competitiveness report 2015-2016“, Insight Report by World Economic Forum, p. 355.

23. The positions should be only regarded as indicative, because they are based on experts assessments rather than on valid indicators.

24. <http://www.doingbusiness.org/rankings> : accessed on 29 April 2016.

- Ukraine in “starting a business”: 30th of 189
- Ukraine in “registering property”: 61st of 189
- Ukraine in “getting credit”: 19th of 189
- Ukraine in “protecting minority investors”: 88th of 189
- Ukraine in “paying taxes”: 107th of 189
- Ukraine in “trading across borders”: 109th of 189
- Ukraine in “enforcing contracts”: 98th of 189

Other additionally interesting aspects, covered by further sources such as the World Bank’s “World Development Indicators database”²⁵, the International Monetary Fund’s “World Economic Outlook Database”²⁶, the World Economic Forum’s “Executive Opinion Survey”²⁷, the International Labour Organisation’s “database of labour statistics”²⁸ include:

- “Domestic credit to private sector” in Ukraine: 42nd of 141 (2013)
- “Market capitalisation of listed companies” in Ukraine: 86th of 141 (2012)
- “Venture capital deals” (Venture capital per investment location: Number of deals) in Ukraine: 51st of 141 (2014)
- “Intensity of local economic competition in the market” in Ukraine: 97th of 141 (2014)
- “Employment in knowledge-intensive services” in Ukraine: 39th of 141 (2013)

Political instability as a reference to the current situation is also among the most mentioned factors of doing business in Ukraine. Other factors, heavily discouraging global businesspersons to become active in the country are corruption, access to financing and inflation as shown in Figure 4.

The most problematic factors for doing business

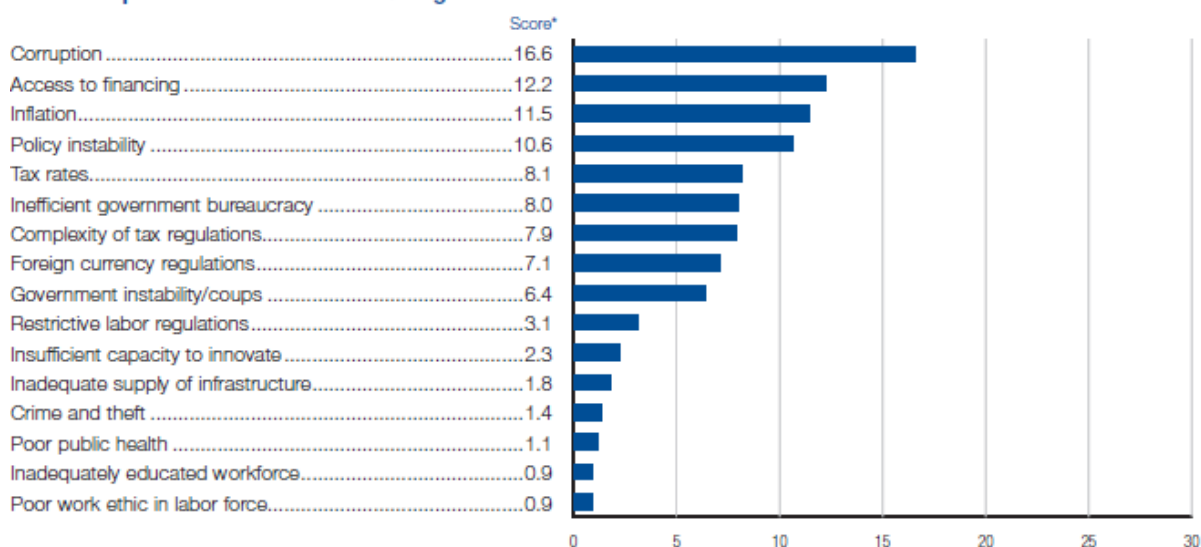


Figure 4: Most problematic factors for doing business in Ukraine; source = Screenshot of WEF Global Competitiveness Report 2015-2016

25 databank.worldbank.org/wdi : accessed on 29 April 2016.

26 <https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/index.aspx> : accessed on 29 April 2016.

27 <http://reports.weforum.org/global-risks-2015/executive-opinion-survey-2014/> : accessed on 29 April 2016.

28 <http://www.ilo.org/ilostat> : accessed on 29 April 2016.

2.3. Patent based analysis of Ukrainian economy

Patent statistics provide major indicators for assessing the innovation potential and are one of the key indicators of the technological development of countries and regions. According to WIPO data (World Intellectual Property Organisation), Ukraine demonstrates relatively high patent activity (please consult also chapter 9.3 for more information on Ukraine's patent activities).

The State Intellectual Property Service of Ukraine, which is the main office for patent filing in Ukraine, reports that in 2012²⁹ the activity in filing of applications for industrial property rights (IPRs) remained stable compared to previous years. Filing of applications for IPRs can serve as an indicator for the national industrial performance (as pointed out in the report³⁰ by the European Patent Office for instance). 10.1% of the applications were applications for inventions, 20.8% applications on utility models and 65.3% applications for trademarks on goods and services (a share of 28.9% of this number was filed under the Madrid system³¹). The smallest number of applications went on industrial design, accounting for 3.8 %.³²

The industrialised regions of Ukraine play the most important role in terms of patent activities: The analysis of the distribution of the total number of applications for inventions and utility models by regions in 2012 indicates that over 76% of applications were submitted by enterprises and organisations located in the industrialised regions of Vinnytsia, Dnipropetrovsk, Donetsk, Luhansk, Lviv, Odessa, Kharkiv and Kyiv. As mentioned earlier, on today's data must be looked very differently, as the regions of Donetsk and Luhansk are currently not under Ukrainian governmental control and administration.

Many patent applications are made in the sector "performing operations and transport", while the textiles and paper sector on the other hand shows very little patent applications. The Ukrainian chemistry and metallurgy sector is relatively more prominent in the national patent application portfolio than at international level. Physics play a much larger role in Ukraine's PCT (Patent Cooperation Treaty) output than in its national patent output (please see chapter 9.3 for more details on the difference between PCT and nationally filed patent applications). Also electricity is a field with more prominence in PCT patents than in nationally filed patents in Ukraine.

National filed patent applications in the technological sector

The following two illustrations give an overview on Ukraine's national filed patent applications in the technology sector from 2003 to 2013. To put the data in some context, the numbers of national filed patent applications in selected nearer and farer neighbouring countries of Ukraine are indicated as well. Table 3 pours the data on Ukraine's national filed patent applications in detailed numbers. The data are taken from a recent background paper on patenting activities in the Black Sea Region, prepared within the "BLACK SEA HORIZON (BSH) project".³³

Ukraine has the largest national share (21.3%; next to Azerbaijan with 28.7%) in the instruments area. Chemistry is also important in Ukraine's output portfolio. Among all comparison countries listed in Table 3, Ukraine has second most patent applications (17,327) after Russia (214,406) in total, almost doubling Turkey which follows. In terms of quantity, most applications made by Ukrainian inventors were in the chemistry sector, with 5,659 national filed applications in total. Ukraine's specialisation pattern is similar to the ones of Romania or Russia and, thus, resembles overall regional characteristics. Chemistry is the field with the highest output, followed by mechanical engineering.

29 Last available data.

30 http://ec.europa.eu/internal_market/intellectual-property/docs/joint-report-epo-ohim-final-version_en.pdf : accessed on 29 April 2016.

31 <http://www.wipo.int/madrid/en/> : accessed on 2 May 2016.

32 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p.33

33 BLACK SEA HORIZON: "Analysis of Black Sea relevant data in PATSTAT", Deliverable within BLACK SEA HORIZON project, 2016, p.29-30 (DRAFT)

National filed patent applications (technological sector) in absolute numbers and in %

Country / Sector	Electrical engineering	Instruments	Chemistry	Mechanical engineering	Other fields	Row total
AM	48	15	41	14	12	130
AZ	10	58	53	26	55	202
BG	670	285	477	537	200	2169
GE	51	63	279	267	56	716
MD	335	741	1410	855	176	3517
RO	1234	1325	2144	2048	619	7370
RU	19050	42234	81069	51642	20411	214406
TR	1295	948	1803	3102	1815	8963
UA	1601	3694	5659	5038	1335	17327
AM	36.9%	11.5%	31.5%	10.8%	9.2%	100%
AZ	5.0%	28.7%	26.2%	12.9%	27.2%	100%
BG	30.9%	13.1%	22.0%	24.8%	9.2%	100%
GE	7.1%	8.8%	39.0%	37.3%	7.8%	100%
MD	9.5%	21.1%	40.1%	24.3%	5.0%	100%
RO	16.7%	18.0%	29.1%	27.8%	8.4%	100%
RU	8.9%	19.7%	37.8%	24.1%	9.5%	100%
TR	14.4%	10.6%	20.1%	34.6%	20.2%	100%
UA	9.2%	21.3%	32.7%	29.1%	7.7%	100%

Table 3: National filed patent applications in Ukraine and selected other countries from 2003-2013 (technological sector only); source = BSH deliverable (draft)

There is a slight specialisation pattern detectable in the area of instruments. At the level of technology fields, Ukraine's relative specialisation is strong in medical technology (1,871, almost 10% of its output), and measurement (1,260 applications or almost 7% of its output). Remarkable are further the specialisation grades in materials/metallurgy (1,499 applications), machine tools (867 and with almost 5% a higher share than in any other Black Sea country) and other special machines (1305).³⁴

PCT filed patent applications in the technological sector

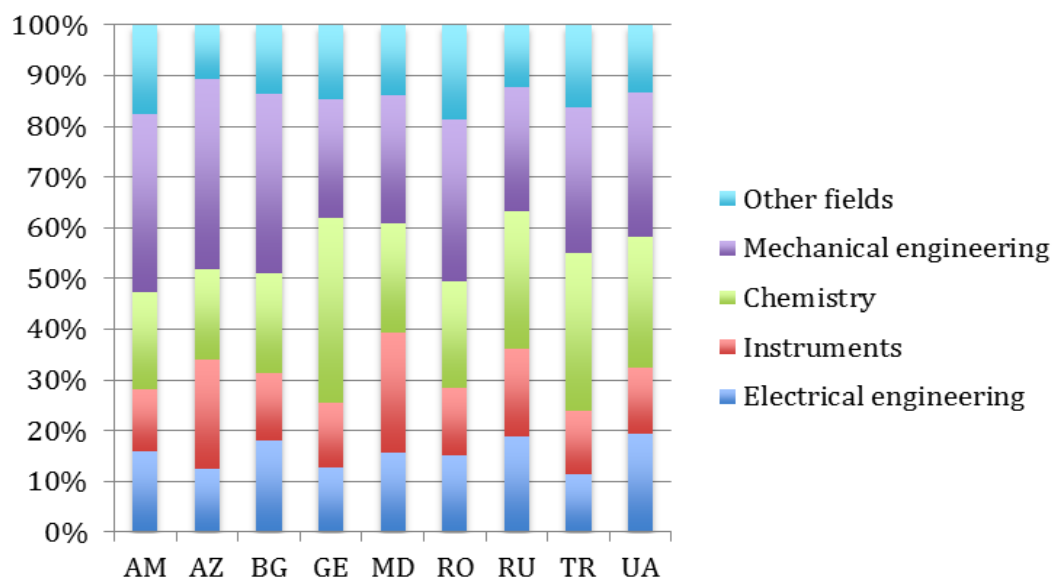


Figure 5: PCT filed patent applications in Ukraine and selected other countries from 2003-2013 (technological sector only); source = BSH deliverable (draft); source = BSH deliverable (draft)

Figure 5 shows the share of technological PCT filed applications in percent (according to the total sum of 100%), and Table 4 translates these shares into exact numbers.

PCT filed patent applications (technological sector) in absolute numbers and %

Country / Sector	Electrical engineering	Instruments	Chemistry	Mechanical engineering	Other fields	Row total
AM	9	7	11	20	10	57
AZ	7	12	10	21	6	56
BG	49	36	54	96	37	272
GE	7	7	20	13	8	55
MD	8	12	11	13	7	51
RO	31	27	43	65	38	204
RU	1,588	1,443	2,278	2,044	1,040	8393
TR	195	215	534	493	279	1716
UA	219	145	292	320	149	1125
AM	15.8%	12.3%	19.3%	35.1%	17.5%	100%
AZ	12.5%	21.4%	17.9%	37.5%	10.7%	100%
BG	18.0%	13.2%	19.9%	35.3%	13.6%	100%
GE	12.7%	12.7%	36.4%	23.6%	14.5%	100%
MD	15.7%	23.5%	21.6%	25.5%	13.7%	100%
RO	15.2%	13.2%	21.1%	31.9%	18.6%	100%
RU	18.9%	17.2%	27.1%	24.4%	12.4%	100%
TR	11.4%	12.5%	31.1%	28.7%	16.3%	100%
UA	19.5%	12.9%	26.0%	28.4%	13.2%	100%

Table 4: PCT filed patent applications in Ukraine and selected other countries from 2003-2013 (technological sector only); source = BSH deliverable (draft)

As Table 4 depicts, from 2003 to 2013, Ukraine has a total output of 1,125 PCT filed patent applications in the technological sector, which is less than Russia and Turkey. PCT filed applications are made under the international "Patent Cooperation Treaty", introduced by the World Intellectual Property Office (WIPO), and guarantee international patent protection. However, the more countries an inventor wants to have a protection for his patent in, the more costly such an application is. Currently 148 countries are members of the PCT.

Most PCT filed applications from Ukraine were made in the mechanical engineering sector (320, representing 28.4% of the total national share in PCT filed applications). Least patents were filed in the instruments sector (145 or 12.9% of the total share).

Concluding, Ukraine's PCT output shows a stronger concentration on electrical engineering (share of 19.5% in PCT filed applications compared to a share of 9.2% in national filed ones) and less focus on instruments compared to its national filed applications (share of 21.3% in national filed applications compared to 12.9% in PCT filed ones). The drastic difference in the total output numbers (17,327 national filed applications vs. 1,125 PCT filed applications) is caused firstly, as mentioned above, by the fact that PCT filed applications are far more costly. Secondly, for a PCT filed application the inventor's application has to conform to the international patent standards as stipulated in the patent cooperation treaty. As these standards are usually more complex than national standards, which are set up by national offices, the number of applications to national authorities are higher.

Concerning the specialisation grades in Ukraine's PCT applications, audio-visual technology, digital communication and computer technology (all from the electrical engineering sector) are relatively important in its total portfolio.

2.4. Integration in the global economy (trade, FDI)

The productivity of Ukrainian enterprises depends on investment in modern equipment, their capacity to adapt this to customer requirements and to offer additional services or added-value vis-à-vis their competitors. The growth of an economy is often directly linked to gains in investment- and efficiency-driven productivity. Such gains, on the other hand, are made possible by alignment of production standards to foreign markets and investors attracted to invest in the national economy both with money and with knowledge sources in order to help national enterprises in catching up to more developed markets on a higher technological level. However, as the "Innovation Performance Review for Ukraine" states, *"Ukraine is poorly integrated in global value chains, with research showing it to be outside both 'buyer-driven' networks (e.g., clothing), as well as 'producer-driven' global networks, including trade in parts and final manufacturing products"*.³⁵

Ukraine's integration into the GVC (Global Value Chain) through FDI (Foreign Direct Investment) and external trade patterns is examined in this chapter.

Figure 6 below provides an overview on **Ukraine's balance in imports of goods and services**, ranging back until 1991 (the year, when the country became independent). Evident is the significant drop in imports in 2009, when net imports decreased by 38.90%. The drop in import numbers in 2009 must be seen against the backdrop of the gas crisis at that time, when Russia stopped supplying Ukraine (and, as a matter of fact, Europe) with gas for several weeks.³⁶ From 2010 to 2012 the number of imports began to grow again, however since 2013 the net number is again negative. In 2014 Ukraine experienced a similar cut in its import numbers remembering of those in 1992 and 2009 (see figure below).



Figure 6: Ukraine's import rate of goods and services (annual growth in %); source = World Bank Open Economic Data

35 World Bank, 2005, From Disintegration to Reintegration: Eastern Europe and the Former Soviet Union in International Trade, Edited by Harry G. Broadman, Chapter 7, cited in: United Nations Economic Commission for Europe: "Innovation Performance Review Ukraine", New York and Geneva, 2013, p.50

36 See here for an example of media reports on the gas crisis in 2009: <http://www.economist.com/news/briefing/21600111-reducing-europes-dependence-russian-gas-possiblebut-it-will-take-time-money-and-sustained>: accessed on 2 May 2016.

Looking more closely on the composition of imports in Ukraine, the most important goods imported are:

- High-tech imports
- Communications, computer and information services imports
- Energy (mainly natural gas)
- Advanced agricultural machinery
- New and used passenger cars

The next Figure 7 compares **Ukraine's export rate of goods and services to the annual GDP**. Since 1991, Ukraine had the highest export rate in 2000, amounting to 62.44% of the total GDP in that year. More recently, Ukraine's export rate was more or less stable and reached between 40% and 50% of GDP. In 2014, exports contributed nearly to half of the total Ukrainian GDP. Obviously, exports are decisive for the prosperity of Ukraine's economy, hence, for the well-being of the country. Ukraine relies on a strong performance of its export-oriented sectors, such as heavy engineering, oil, gas and chemical engineering and ferrous and non-ferrous metallurgy.

The export of high-tech products, on the other hand, is still weak in its performance. In 2013, for instance, high-tech exports made up only 2.42% of Ukraine's total trade volume.³⁷ In 2013, the high-tech merchandised exports of Ukraine accounted for 49.3 USD per capita, which is considerably higher than in 2008 (33.5 USD per capita) and also in Turkey (34.8) or Brazil (45.0), but lower than the Russian Federation (63.7), Tunisia (72.6) or Belarus (82.2).³⁸

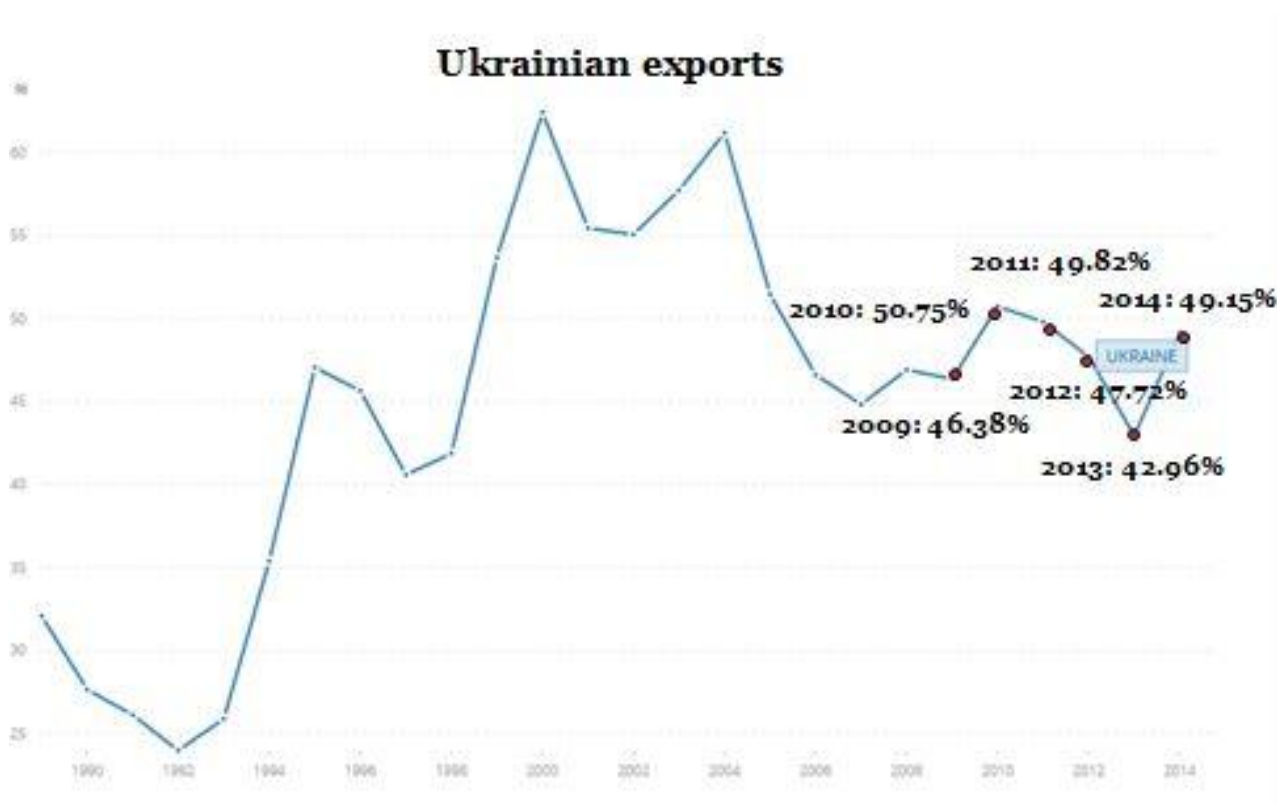


Figure 7: Ukraine's export rate of goods and services as compared to the annual GDP (% of GDP); source = World Bank Open Economic Data

37 United Nations, COMTRADE database; Eurostat 'High-technology' aggregations based on SITC Rev. 4; WTO Trade in Commercial Services database, cited in: The Global Innovation Index 2015, p.372

38 UNESCO Science Report 2015

There has been little change in the export structure over the past decade. Observed shifts have been to some extent explained by price fluctuations in key export sectors such as steel and agricultural production. Metallurgy products still dominate exports according to data from the United Nations Innovation Performance Review 2013 for Ukraine³⁹. Exports of agricultural and food products have remained resilient throughout the crisis, accounting for 25% of total exports in this period. Mineral products and chemicals are also important exports. Altogether, these define a concentrated export structure dominated by low value-added goods where price volatility is a source of vulnerability.

The CIS (Commonwealth of Independent States) is the largest trading partner, accounting for an average 36% of exports and 44% of imports over 2009-2011. Over the same period, the EU shares were 26% and 32%, respectively.⁴⁰ Asia is also an important destination for Ukrainian exports, accounting for 28% of total exports. While Ukraine is able to export more sophisticated products to CIS markets, its machine building products have not been upgraded over time to penetrate other markets successfully. There are, however, exceptions to that especially with regards to military equipment. For instance, Ukraine supplied 80% of engines to Russian-made helicopters and turbines for military vessels.

FDI in Ukraine plays still a minor role. Ukraine is far from competing with top-attracting FDI countries, such as Hong Kong (China), Luxembourg, Mozambique or Ireland, whose FDI inflows in 2013 ranged between 20% and 50% of the national GDP. Ukraine, in the same year, attracted only 2.13% of FDI as compared to the national GDP. The FDI outflow from Ukraine into other countries in 2013 was even lower, amounting to 0.24% of the GDP of that year.⁴¹ Also compared to economically more advanced countries in Central and Eastern Europe, both FDI inflow and outflow levels remain relatively low.

FDI is important because it supports economic development through the transfer of technology and managerial skills and through the creation of employment opportunities. According to the United Nations Conference on Trade and Development (UNCTAD) 2012 World Investment Report, Ukraine is a transition economy with FDI inflows of more than USD 5 billion and outflows of less than USD 0.5 billion.⁴² The top investors to Ukraine over the past several years have been the United States (12%), Germany (12%), Russia (10%), and France (8%). In 2010, the largest investors came from the European Union (54%) and Russia (16%).⁴³ It is, however, worthwhile to mention that Cyprus is a key foreign investor to Ukraine with more than one third of total FDI. Although investments from Cyprus are attributed to the category of investments from the EU, the country is also heavily used for reinvestment of Ukrainian and Russian money into the Ukrainian economy.

3. GOVERNANCE OF THE R&I SYSTEM

3.1. Research and innovation strategy and policy mix

Ukrainian STI national priorities are not defined in a common national strategy but by law.⁴⁴ Currently, two laws adopted by Verkhovna Rada of Ukraine (the unicameral parliament of Ukraine) define the national STI priorities⁴⁵.

The first one, the Law of Ukraine on **the Priority Directions of Science and Technology** (adopted in 2001) defines the following national S&T priorities for the period 2010-2020:

- Basic scientific research of the most important problems of scientific and technological, social and economic, political and human potential development to ensure Ukraine's competitiveness in the world and sustainable development of its society and state;
- Energy and power efficiency;

39 UN, Innovation Performance Review Ukraine, p.31

40 Ibid.

41 World Bank World Development Indicators Database, cited in: The Global Innovation Index 2015, p.374

42 http://unctad.org/en/PublicationsLibrary/wir2012_embargoed_en.pdf, p.56 : accessed on 2 May 2016.

43 Ibid.

44 Yegorov, I. (2012): ERAWATCH Country Reports 2012: Ukraine.

45 Bilat UKR*AINA project - <http://www.st-gateukr.eu/en/195.php> : accessed on 18 April 2016.

- Efficient nature management;
- Life sciences, new technologies for the prevention and treatment of the most wide-spread diseases;
- New substances and materials.⁴⁶

The innovation related priorities are defined by the Law of Ukraine **on Priorities in Innovation Activities in Ukraine** (adopted in 2011). This law⁴⁷ defines the following strategic innovation priorities for the period 2011-2021:

- adoption of new technologies regarding energy transportation, implementation of energy-efficient and resource-saving technologies, take-up of alternative sources of energy;
- adoption of new technologies of high technology development of the transportation system, rocket and space field, aircraft industry and shipbuilding, armament and military technologies;
- adoption of new technologies for materials production, their processing and interconnection; creation of nano-materials and nano-technologies industry;
- technological modernization and development of agro-industrial complex enterprises;
- introduction of new technologies and equipment for quality medical service, medical treatment and pharmaceuticals;
- wide use of technologies for cleaner manufacturing and environment protection;
- development of modern information and communication technologies and robotics.

In terms of the policy mix it should be noted that the above mentioned priorities are targeted by different national policies, policy instruments, etc. In addition, it is important to know that several ministries and other governmental bodies are involved into the governance of Research and Innovation (R&I) in Ukraine (see section 3.2).

For the implementation of national priorities four **State Targeted Funding Programmes**⁴⁸ are in force:

- State Target Science and Technology Programme on realisation of research in the Antarctic 2011 – 2020
- State Target Scientific and Technical Space Programme
- State Target Programme for innovation infrastructure development
- State target Programme on marine research for 2025

The analysis of Ukrainian past and running funding programmes was conducted by the FP7 funded project BILAT-UKR*AINA⁴⁹ in 2015 and can be accessed online⁵⁰.

Due to the political situation following the war in 2014 and the decrease in state funds for research and innovation not all objectives of the national action plans were met⁵¹.

Under the new **Law of Ukraine on Scientific and Technical Activities** (see section 3.2) a new permanent advisory board of the Cabinet of Ministries of Ukraine, the **National Council of Ukraine on the Development of Science and Technology** will be established. Among the tasks of this board will be the contribution to a strategic vision for research and innovation in Ukraine as well as the definition of new priorities.

46 Bilat UKR*AINA project - <http://www.st-gateukr.eu/en/195.php> : accessed on 18 April 2016.

47 Bilat UKR*AINA project - <http://www.st-gateukr.eu/en/195.php> : accessed on 18 April 2016.

48 Ministry of Education and Science of Ukraine and www.bilat.eu : accessed on 18 April 2016.

49 BILAT-UKR*AINA Project: http://www.bilat.eu/235.php?country=UA&programme_type=any&thematic_area=any&textsearch=&submit=Search and INCREAST Portal: Country Report Ukraine: <http://www.increast.eu/en/139.php> : accessed on 16 April 2016.

50 [http://www.bilat-ukraine.eu/media/D2.27- Progress report on regular input to www.BILAT.eu final.pdf](http://www.bilat-ukraine.eu/media/D2.27-Progress_report_on_regular_input_to_www.BILAT.eu_final.pdf) : accessed on 25 March 2016.

51 Source: Ministry of Education and Science, Department of International Cooperation.

Due to association to Horizon 2020 in 2015, MESU (Ministry of Education and Science Ukraine) is leading consultations with wider R&I stakeholders to prepare and adopt a **National Strategy on cooperation of Ukrainian R&I organisations in the European Research Area**. This strategy should be finished until the end of 2016.

Ukraine has adopted many initiatives in the past, some of them as special laws. However, implementation has been uneven, due to the lack of necessary follow-up steps to give concrete expression to high-level objectives, including the provision of financial resources⁵².

The government formed in 2014 (until 18.4.2016) developed a series of measures to address the following key issues in Ukrainian research policy⁵³:

- establishment of research priorities which correspond to the goals of national development;
- a clear orientation of R&D towards respecting the best EU standards, with the intention of joining the European Research Area;
- administrative changes to improve the governance of the R&D system.

In particular, in 2016 MESU focuses on the increase of the state budget dedicated to R&D in current, but not constant prices⁵⁴,

- including basic funding of the institutions;
- grants for nationally funded projects;
- financial support for research infrastructure both in universities and state research institutes;
- establishment of a special support mechanism for young researchers to stay in or to return to the country;
- evaluation and validation of state research institutions and universities (currently an evaluation of NASU institutes is under way (see section 3.3);
- financial support for accession to R&D databases (i.e. Scopus, Web of Science, etc.);
- and the establishment of the **National Research Foundation of Ukraine**⁵⁵.

Furthermore, Ukraine needs to respond to current national challenges such as the decline of general R&D expenditure (GERD) from 3% to 0.66% between 1990 and 2014; a low level of demand for R&D results from the domestic economy sector; brain drain of leading researchers; the decline of R&D personnel, old research infrastructure, aging personnel etc.⁵⁶

Until now, (May 2016), the newly appointed Government of Ukraine⁵⁷ has not yet announced any significant changes as regards the strategy for Ukrainian R&I policy.

52 UNECE: <https://www.unece.org/fileadmin/DAM/ceci/publications/icp7.pdf> : accessed on 15 April 2016.

53 UNESCO Science report towards 2030 (2015): <http://unesdoc.unesco.org/images/0023/002354/235406e.pdf> : accessed on 5 April 2016.

54 This could rather result overall in a declining budget.

55 Source: Department of Scientific and Technical Development of MESU

56 Self-assessment report: SCIENTIFIC AND TECHNOLOGICAL SPHERE OF UKRAINE, MESU, 2016

57 http://www.kmu.gov.ua/control/en/publish/article?art_id=247077686&cat_id=247605901 : accessed on 20 April 2016.

3.2. Policy making & policy implementation

The main legal basis for the implementation of research and innovation policy in Ukraine is the **Law of Ukraine on Scientific and Technical Activities** (adopted in 2001, last amendment in November 2015 and in force since January 2016)⁵⁸. Apart from this new law, the following laws and governmental decrees related to Ukrainian R&I are currently in force⁵⁹:

Laws:

- Law of Ukraine on Scientific Technical Information
- Law of Ukraine on Scientific and Scientific Technical Expertise
- Law of Ukraine on the Priority Directions of Science and Technology
- Law of Ukraine on Scientific Parks and the corresponding Law of on Scientific Park "Kyiv Polytechnic"
- Law of on Special Regime for Innovation Activity in Technological Parks
- Law of Ukraine on Innovation
- Law of Ukraine on Innovation Activity Priorities in Ukraine⁶⁰
- Law of on National Security of Ukraine
- Law on Technology Transfer

Governmental decrees:

- Concept of the national innovation system development
- Priority R&D thematic areas for the period until 2015
- Medium-term priorities of innovation activity of national and sectorial levels until 2016
- Concept of reforming the system of funding and management of scientific and technical activities and action plan until 2017 to implement the Concept

The key players defining R&I in Ukraine are the **Ukrainian President**⁶¹, who sets the strategic development, the **Ukrainian Parliament** (Verkhovna Rada) with its parliamentary body responsible for R&I, the **Committee for Education and Science**⁶², which in its capacity as main legislative body shapes the country's R&I by adopting all legal acts, strategies and priorities as well as international agreements in the field of R&I; and **Cabinet of Ministers** which creates incentives for the national R&I infrastructure.

On the operational level the **Ministry of Education and Science of Ukraine** (MESU) is, among other issues, in charge of the implementation of the state sectorial policy in Science and Higher Education on behalf of the Government of Ukraine⁶³. MESU is also responsible for strengthening research capacities in

58 Law of Ukraine on Scientific and Scientific Technical Activities 2015 (in Ukrainian). Link: <http://zakon3.rada.gov.ua/laws/show/848-19>: accessed on 10 April 2016.

59 All laws and decrees are available in Ukrainian language only: <http://zakon5.rada.gov.ua> : accessed on 18 April 2016. There are around 80 different legal acts related to science, technology and innovation.

60 Law of Ukraine on Innovation (1993/2003). Link: http://www.wipo.int/wipolex/en/text.jsp?file_id=182883 (EN-summary) : <http://zakon5.rada.gov.ua/laws/show/3689-12> (UA): accessed on 18 April 2016.

61 President of Ukraine: <http://www.president.gov.ua/en/> : accessed on 16 April 2016.

62 Ukrainian Parliament: <http://gapp.rada.gov.ua/radatransl/Home/Committees/en> : accessed on 10 April 2016.

63 Government of Ukraine (EN): http://www.kmu.gov.ua/control/en/publish/article?art_id=247077686&cat_id=247605901: accessed on 20 April 2016.

universities. Approximately 180 institutions (universities and research institutions) are directly subordinated to MESU⁶⁴.

Apart from MESU, several other ministries deal with R&D and innovation issues.⁶⁵ The **Ministry of Finance** has a very important role by determining the national budget for the R&I sector. The **Ministry for Economy and Trade** is responsible for the R&D policy and competitiveness of industry and the technology transfer to the business sector. It is accountable for some S&T programmes targeting economic development. The **Ministry for Foreign Affairs** is responsible for international agreements with other countries and international organisations. Currently, there are approximately 50⁶⁶ bilateral agreements in force.

R&I activities are also carried out in research institutions and universities subordinated to the **Ministry of Health, Ministry of Infrastructure, Ministry of Internal Affairs, Ministry of Culture** and **Ministry of Agrarian Policy and Food**.⁶⁷ All these ministries have some sector budgets related to R&I activities.

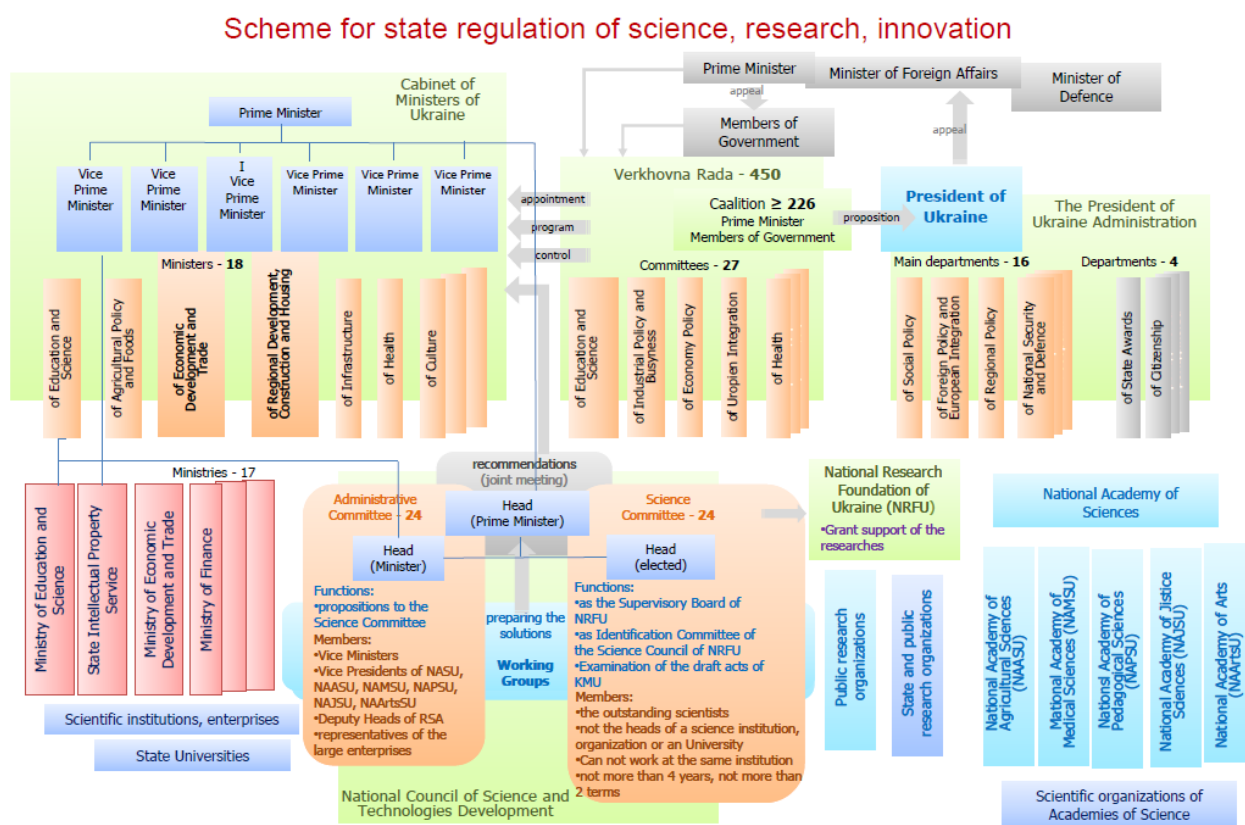


Figure 8: Organogram of the R&I system in Ukraine⁶⁸

64 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016

65 Source : Ministry of Education and Science of Ukraine, Department International Cooperation and European Integration

66 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016

67 Source: Ministry of Education and Science of Ukraine, Department of International Cooperation and European Integration

68 Compiled by the authors of this report from the information provided by MESU

The **National Academy of Sciences of Ukraine**⁶⁹ (NASU), an independent public institution dealing with research and innovation, receives around 50%⁷⁰ of the yearly state budget allocated for S&T, therefore playing a key role in the Ukrainian system of research. NASU is very important in terms of research performance and research infrastructure as it gathers approximately 120 institutes, scientific centres, labs, etc. under its roof. The academy's main task is the coordination of the country's research and expertise in all fields of science and technology.

According to Ukrainian legislation also the regions can provide funds from their own regional budget for R&I⁷¹. Some of the regions and bigger cities have their own departments and offices responsible for innovation issues. MESU, being responsible for the implementation of Horizon 2020 in Ukraine, has established not only National Contact Points, but also Regional Horizon 2020 Contact Points⁷² in all regions.

Due to recent changes in the legal framework, Ukraine is currently going through systemic reforms aimed at improving the overall R&I governance.

The **amendments to the Law of Ukraine on Scientific and Technical Activities**⁷³ bring several changes with regard to this issue, which are in line with the country's efforts to foster both R&I on national level and international cooperation, being a newly associated country to the Horizon 2020 programme.

According to the Ministry of Education and Science of Ukraine, these latest amendments foresee the establishment of a **National Council of Ukraine on the Development of Science and Technology**⁷⁴. This body, consisting of two committees, will act as a joint and permanent advisory body to the Cabinet of Ministers, contributing to a strategic vision for Ukraine. The **Scientific Committee** shall have 24 members, consisting of representatives of the heads of the national academies of science, leading universities and scientific institutions as well as prominent scholars from abroad. The **Administrative Committee**, too, shall have 24 members. The Council will be headed by the Prime Minister of Ukraine. Its mission will be to develop a **new vision of the priorities of Ukrainian science and to restructure the existing system of scientific institutions.**⁷⁵

The main functions of the National Council are:

- To prepare proposals for the policy framework development for scientific and technological activities and to submit appropriate recommendations to the Cabinet of Ministers of Ukraine
- To prepare proposals for the integration of national science into international science, taking into account national interests
- To evaluate reports on use of funds for scientific and technical activities and results achieved which are to be submitted by the National Research Fund of Ukraine, the National Academy of Sciences, central executive authorities, etc.

To this date (April 2016) the National Council is not established yet, but it is foreseen that in the next months the members who applied under the public call launched by MESU will be selected. Expected start of the Council is beginning of 2017⁷⁶.

69 <http://www.nas.gov.ua/Pages/default.aspx> : accessed on 20 April 2016.

70 Self-assessment report: SCIENTIFIC AND TECHNOLOGICAL SPHERE OF UKRAINE, MESU, 2016

71 Source : Ministry of Education and Science, Department of International Cooperation and European Integration

72 List of NCPs and RCPs: <http://www.bilat-ukraina.eu/en/393.php#RCP> : accessed on 20 April 2016.

73 Law of Ukraine on Scientific and Scientific Technical Activities 2015 (in Ukrainian). Link: <http://zakon3.rada.gov.ua/laws/show/848-19> : accessed on 10 April 2016.

74 Law of Ukraine on Scientific and Scientific Technical Activities 2015 (in Ukrainian). Link: <http://zakon3.rada.gov.ua/laws/show/848-19> : accessed on 10 April 2016.

75 Source : Ministry of Education and Science, Department of International Cooperation and European Integration

76 Source : Ministry of Education and Science, Department of International Cooperation and European Integration

The amendments of the law foresee also the establishment of a new independent institution, the **National Research Foundation of Ukraine**. This organisation is supposed to carry out financial support for institutional, collective and individual grants in the fields of fundamental research and applied sciences. One of its targets is to make Ukraine an attractive research location, causing young researchers either to stay in the country or to return back after finishing their studies abroad.

A significant part of the amended law is devoted to the **development of a strategy towards strengthening of academic and university research cooperation**, in particular the **establishment of Joint Centres** for the use of scientific equipment and key state laboratories as well as the **establishment of start-ups**⁷⁷.

With regard to **intellectual property**, the new legal framework provides a possibility for public research institutions and universities to be co-founders of companies and to invest their intellectual property rights as part of the authorized capital of such enterprises. The funding of **grants**, the competitive selection of applications as well as their evaluation is regulated as well⁷⁸.

3.3. Evaluation, consultations, foresight exercises

The last overall evaluation of the Ukrainian innovation performance system was done under the **United Nations Economic Commission for Europe (UNECE)** in 2012. The **"Innovation Performance Review: Ukraine"**⁷⁹ was prepared by international and national experts from different fields of R&I and published in 2013. The review provides a comprehensive assessment of the factors that drive innovation, paying attention to the linkages and relations between the various components and actors of the national innovation system as well as identifying the good practices that could be useful for other countries with economies in transition.

The review describes the evaluation of the national innovation system as such and contains a dedicated chapter on Science and Technology and also lists the recommendations for improvement of the Ukrainian innovation system in different fields (e.g. funding, business environment, framework conditions, innovation policies, instruments, etc.).

General policy advice and a number of recommendations can be derived from this review in order to increase the efficiency of the national innovation system as well as to enhance the innovation capabilities of Ukrainian stakeholders. However, the Ukrainian R&I governance system has changed since 2012 due to the overall economic and political situation and the adoption of new laws and governmental decrees (see section 3.2).

The **main recommendations** of this review are the following⁸⁰:

- Evaluation of the national innovation system on a regular basis,
- Development of a single, comprehensive national innovation strategy for Ukraine as part of a holistic, consistent approach to policy prioritisation that would integrate and replace many existing policy measures,
- Creation of a National Innovation Council which should contribute to improving the governance of the national innovation system,
- Improvement of policy making including the provision of financial resources,
- Linkage of Ukraine's future promotion policy to the promotion of innovation,

77 Source : Ministry of Education and Science, Department of International Cooperation and European Integration

78 Law of Ukraine on Scientific and Scientific Technical Activities 2015 (in Ukrainian). Link: <http://zakon3.rada.gov.ua/laws/show/848-19> : accessed on 10 April 2016.

79 UNECE "Innovation Performance Review: Ukraine": <https://www.unece.org/fileadmin/DAM/ceci/publications/icp7.pdf> : accessed on 15 April 2016.

80 UNECE: http://www.unece.org/fileadmin/DAM/press/pr2013/Policy_Recommendations_InnovationUkraine.pdf : accessed on 15 April 2016.

- Emphasis on the important role of industry-science linkages (ISL) in the national innovation system,
- Engagement of the private sector in public technology programmes through close consultation or public-private partnerships to ensure that venture capitalists have better information on potential opportunities.

As regards **foresight activities**, the Ukrainian government adopted in 2004 a **"National Target S&T and Innovation Development Forecast Programme"**, with the main task to define strategic STI priorities. The programme was financed by the Ministry of Education and Science (MESU) and carried out by the STEPS Centre of the National Academy of Sciences⁸¹, which was particularly responsible for the analytical work. This programme was implemented in two phases, 2004-2008 and 2008-2012. The results were used as an informative tool for policy makers and did not have any impact so far on the national S&T priorities setting.⁸²

The analysis showed a scientific potential in some disciplines while the country's research system overall lags behind with regard to international standards. The final report outlines some priorities for policy-making:⁸³

- Creation of new forms to integrate science and production sectors;
- Improvement of management skills in the Ukrainian research sector and the dissemination of best practices nationwide;
- Development of high-tech sectors and acceleration of socio-economic development in the regions;
- Active implementation of R&D results and advanced technologies in different sectors of the national economy;
- Internationalisation of the Ukrainian RTDI.

In recent years, no significant foresight studies have been carried out in Ukraine due to lack of funding⁸⁴.

An **evaluation of the research-performing institutions in Ukraine** is currently being conducted based on the **Governmental Decree on Approval of the Concept of reforming the system of funding and management of scientific and technical activities** (2008). In line with this decree, the new methodological framework and indicators (i.e. research quality, innovation performance, co-publications, international recognition, international cooperation, etc.) for the evaluation were set up with the objective to evaluate the performance of the research organisations⁸⁵. The methodology was tested in several research institutions and then further elaborated by NASU with the help of international partners, e.g. DLR on behalf of the German Federal Ministry of Education and Research (as bilateral activity carried out under the intergovernmental agreement) and by the FP7-funded BILAT-UKR*AINA project.

The evaluation of all research-performing organisations in Ukraine was requested by MESU following recent amendments to the Law of Ukraine on Scientific and Technical Activities. After the evaluation, the results will be validated by MESU to implement the next steps⁸⁶. NASU plans to test the new approach in

81 G.M.Dobrov Center for Scientific and Technological Potential and Science History Studies, <http://stepscenter.ho.ua/indexen.htm> : accessed on 15 April 2016.

82 Igor Yegorov (2015): Nauka i Naukovedenie (Science and Science of Science), N.2(88), p.12-20

83 Igor Yegorov (2015): Nauka i Naukovedenie (Science and Science of Science), N.2(88), p.12-20

84 Correspondence with Igor Yegorov (20 April 2016)

85 Vitalii Gryga, Victor Rybachuk, Olha Krasovska (2014): Evaluation of R&D Institutions in Ukraine – The New Approach. https://www.researchgate.net/publication/279979841_Evaluation_of_RD_Institutions_in_Ukraine_-_The_New_Approach : accessed on 20 April 2016.

86 Source: Ministry of Education and Science, Department of International Cooperation and European Integration.

June and July 2016. 14 institutes were selected for this survey, which is based on the Leibniz Association approach for the evaluation of research institutes.⁸⁷

4. FINANCING OF R&D

4.1. System and extent of governmental R&D funding incl. indirect funding

In comparison with Ukraine's GDP per capita (which is slightly above 7,500 PPP), Ukraine still affords herself a relatively high level of GERD/GDP relation (around 0.7% in 2013/2014), which equals the one of significantly richer countries (measured in GDP per capita) such as Slovakia, Poland, Croatia or South Africa.⁸⁸

The successive crisis of the economy in the late 2000s causing depreciation of the national currency, the Ukrainian hryvnia (UAH), and then the 2013-2015 Euromaidan Revolution followed by war have had a negative impact on R&D funding. State funding of R&D has itself fluctuated over the past decade accounting for 36% of GERD in 2002, 55% in 2008 and 47% in 2013.⁸⁹

In the budget of Ukraine for 2016, allocations for scientific and technical support for the military-industrial complex have been significantly increased due to the military conflict in the occupied eastern Ukrainian territory. As a consequence, the budget for R&D decreased. According to a high-ranking MESU representative⁹⁰, the state budget is expected to increase in the next years because of the importance of RTDI for the further development and economic growth of Ukraine.

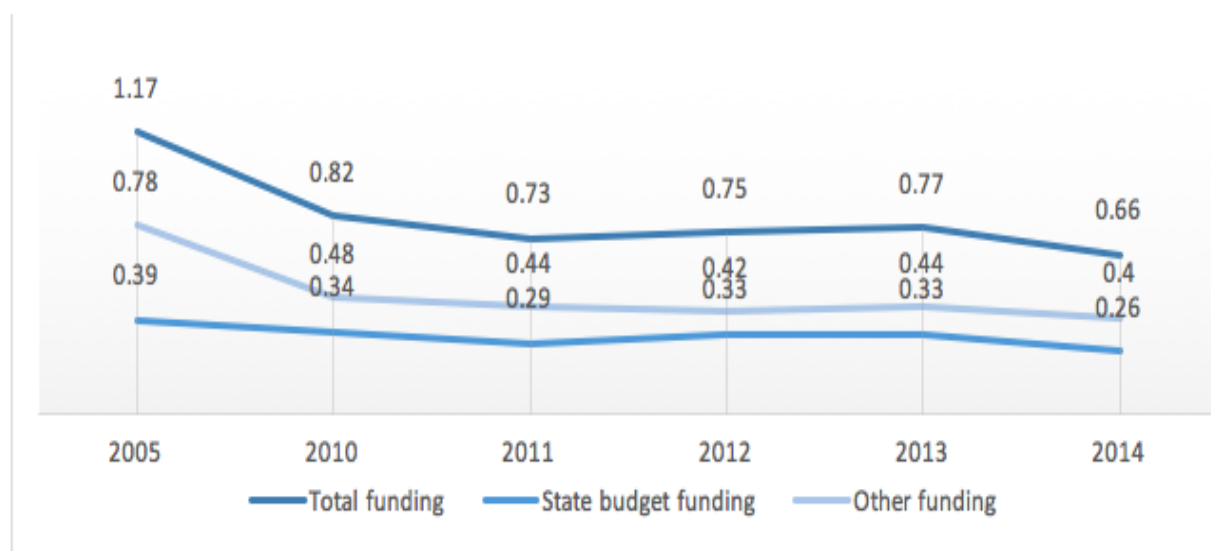


Figure 9: Gross domestic expenditure on R&D (GERD) 2005 – 2014 (Source = OECD)

The gross domestic expenditure on R&D (GERD) decreased from 1.17% in 2005 to 0.66% in 2014⁹¹ (see Figure 9 above). This also caused a decrease in the total number of researchers and a considerable brain drain. The state budget was used mainly for the institutional (basic) funding of universities, academies and research institutions. Competitively allocated grants for bigger research projects were almost not available at all.

⁸⁷ Information on this was provided by Professor Igor Yegorov, Deputy Director of the [Institute for Economics and Forecasting](#) of the [National Academy of Sciences of Ukraine](#).

⁸⁸ UNESCO Science Report 2015.

⁸⁹ Ibid.

⁹⁰ Presentation of Dr Strikha, Deputy Minister at MESU, at EaP panel training for EaP countries, 14.March 2016

⁹¹ Source 2015: OECD Statistics, MESU

Year	Gross Domestic Product (GDP) at current prices, billion UAH	Governmental R&D expenditures	
		absolute value, thousand UAH	a share of GDP, %
2014	1 587	4 897 618,3	0,31
2015	1 979	4 627 311,0	0,23
2016 ⁹²	2 262	4 607 183,5	0,20

Table 5: Research and Development expenditures in Ukraine (state budget)

The latest data available⁹³ (see Table 5) show a significant reduction of governmental public R&D expenditure. The projections for 2016 show a further decrease in state budget allocations for R&D in real prices.

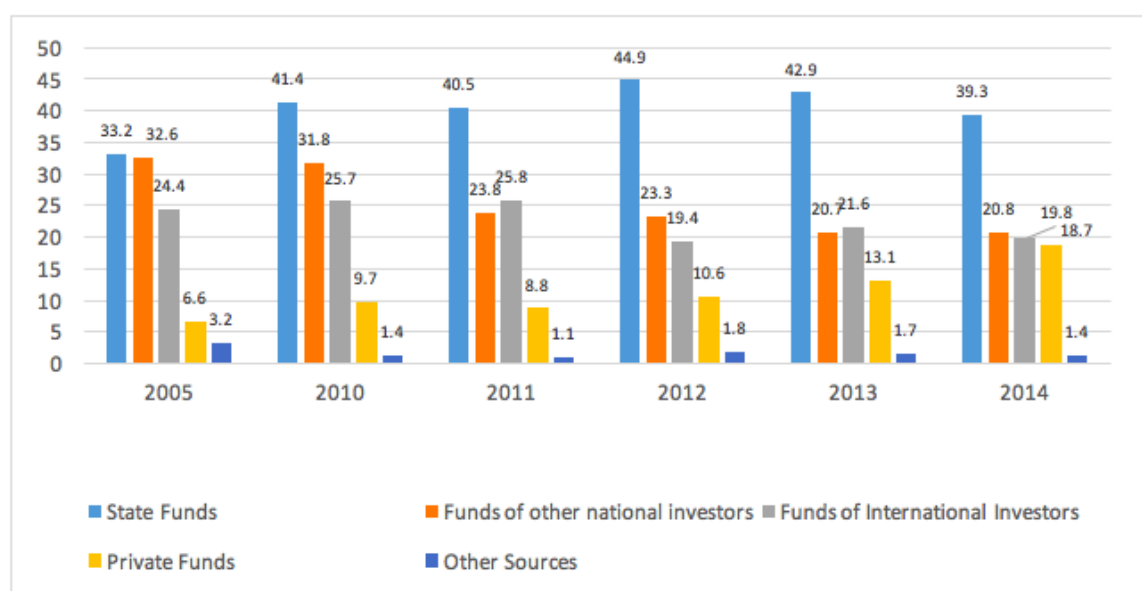


Figure 10: Percentages of R&D funding by funding source

As shown in Figure 10, the government funded directly 39.3 % of the whole expenditure for R&D in 2014⁹⁴. The rest was funded by other national sources (20.9%), foreign investments in R&D (19.8%) and private funds (18.7%).

The figure below shows the 2014 funding for different scientific/research fields in Ukraine in total from the state budget. The majority of the budget (57.6%) was allocated to technical sciences, followed by natural sciences (31.4%). However, only 14% of overall funding for technical sciences came from governmental sources, while humanities received 96.1% of their total funding from state budget and social sciences 89%.

92 Projections, according to the Law of Ukraine on State Budget of Ukraine for 2016, MESU.

93 Source: Ministry of Education and Science, Department of International Cooperation and European Integration Integration

94 Ibid.

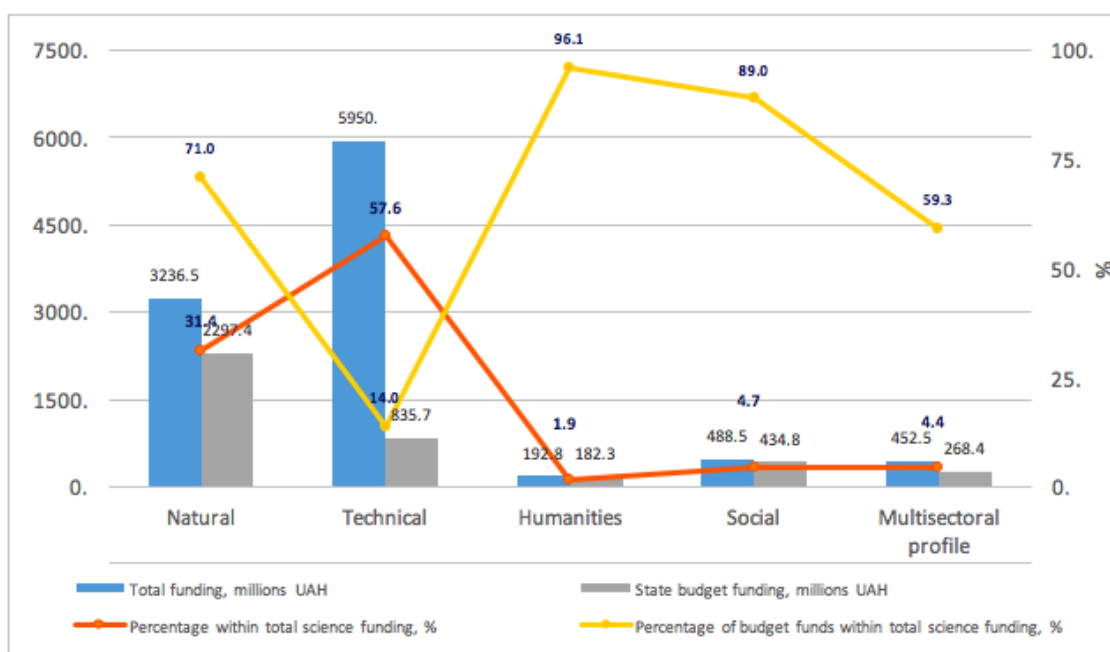


Figure 11: Funding sources for different fields of science in 2014⁹⁵

4.2. Private and other national funding sources

In 2013, the Business Enterprise Sector consumed 55.3% of GERD, while the governmental sector consumed 38.6% and the higher education sector only 6.2%.⁹⁶ This high share of R&D consumption by the Business Enterprise Sector, however, should not be overrated, because its contribution to R&D funding has dropped since 2003 (36%). It hit a low of 26% in 2009 when international prices for steel slumped, forcing the metallurgy and machine-building industries to reduce wages and to lay off workers and when gas supplies by Russia were suspended due to a dispute over Ukraine's natural gas debt in January 2009. Since then the financial contribution of the Business Enterprise Sector to GERD has stagnated (29% in 2013).

In 2014, however, the private funding (in current prices) has increased compared to 2013 by 5.6% of the total R&D expenditure in Ukraine. However, it should be noted that overall GERD has decreased in the last five years. This development shows that private funding could have an important role in the future as the state funding further decreases, but it has hardly the capacity to counterbalance public reductions in the short and medium term. The reason for this negative perspective is the specific structure of the Ukrainian economy: two-thirds of business spending on R&D is concentrated in machine-building, an industry which has seen its contribution to the national economy contract since independence in 1991. Because of the crisis with Russia, it is assumed that this industry will further decline, because Russia has been the main customer for machine-building products of Ukraine until now.

⁹⁵ Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016

⁹⁶ UNESCO Science Report 2015.

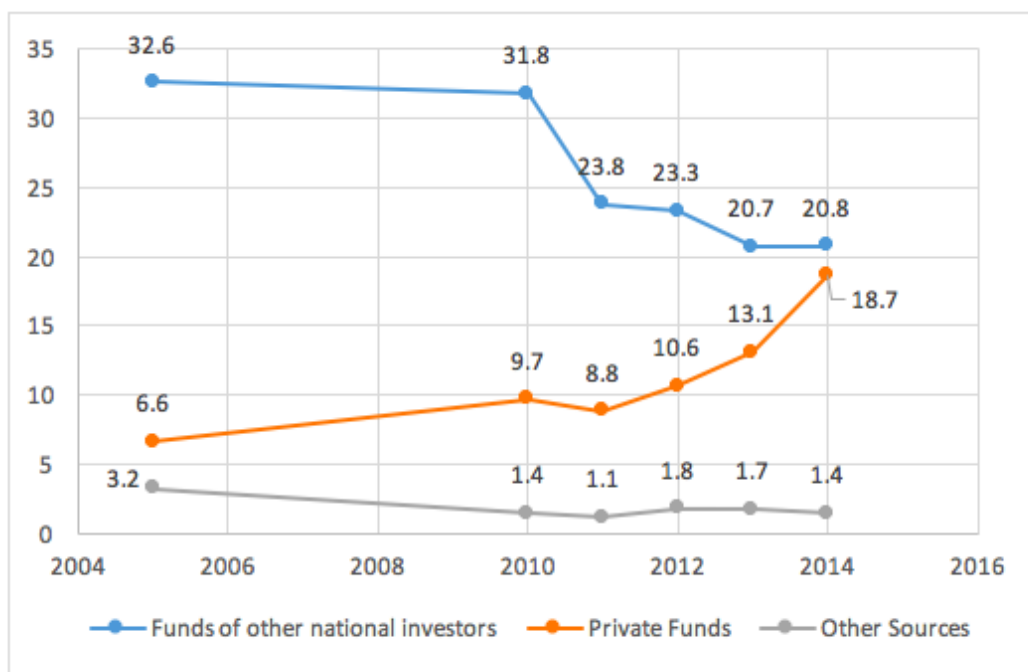


Figure 12: Percentage of other and private funding of Ukrainian R&D (2005-2015)

As regards funding from other sources, Figure 12 above shows that in 2014 the percentage of “other national investments” in R&D (e.g. investments by public companies) has practically remained stable (+0.1 %) compared to 2013. However, the data also show that this type of funding decreased in the last ten years by almost 12% compared with 2005.

4.3. Foreign investments in R&I

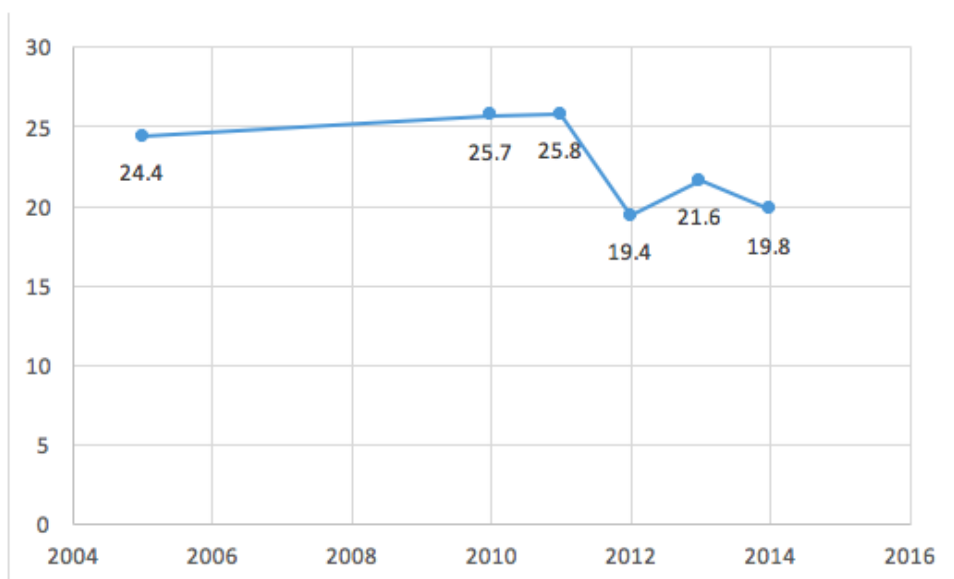


Figure 13: Share (%) of the foreign investments in R&D in Ukraine (2005-2014)

According to the available data, the share of **foreign investments** in R&D in Ukraine is at a high level of about 25% of GERD in 2010-2013, but has dropped⁹⁷, not at least due to the political and economic instability since 2011 and the recent military conflict in the occupied eastern regions. In 2005, this share was 24.8%, and in 2014 19.8 %⁹⁸ (latest data available, see Figure 13 below). However, this share of **foreign investments** in Ukrainian R&D is still relatively high compared to the other Eastern Partnership (EaP) countries. Detailed data about the sectors of investment and the origin of investors are not available.

In order to attract foreign investments, the Ukrainian state offers certain measures to protect foreign investments against future changes in legislation. Among these is the possibility for non-native investors to register their assets with state authorities to enjoy guarantees for foreign investment for a certain period of time after the investment has been made.⁹⁹

The Ukrainian state statistics do not provide information about the distribution of funding by country of origin. However, it is known that a substantial share is associated with the Russian Federation, the USA, EU and China.¹⁰⁰

Exact data on **R&D funding by the private non-profit sector**, especially the international research orientated NGOs, are not available, as this funding category is presumable very small and thus not yet disclosed every year by official statistics¹⁰¹.

Some local branches of international foundations and agencies, for example the Soros Foundation¹⁰² or USAID¹⁰³ are organized as private non-profit organizations, but they are referred to under the category "Funding from abroad".

5. RESEARCH PERFORMERS

5.1. Public Research Organisations

Around 1000 academic and industrial research institutions operate in Ukraine.¹⁰⁴ Most of them are public research organisations, although the boundaries between public and private are blurred in Ukraine. The latter situation refers especially to industrial research institutes, engineering departments and special engineering bureaus which also carry out research.

Most of the Ukrainian research institutions are located in Kyiv (city) (26%), Kharkiv (16%), Lviv (6%) and Dnipropetrovsk (6%).

Academic science is mainly forwarded by the National **Academy of Sciences** of Ukraine, which is the highest state-supported research organisation. It unites under its roof academicians, corresponding members and foreign members as well as regular researchers working in around 120 institutions and 200 research establishments, summing up to around 37,000 employees¹⁰⁵. The national Academy of Sciences of Ukraine consumes above 50% of the state budget allocated for R&D.

In addition, specialised academies of sciences are active in the country, including the Ukrainian Academy of Agrarian Sciences, the Academy of Medical Sciences, the Academy of Pedagogical Sciences, the

97 UNESCO Science report towards 2030 (2015): <http://unesdoc.unesco.org/images/0023/002354/235406e.pdf>, p.334 : accessed on 15 April 2016.

98 Source: Ministry of Education and Science of Ukraine

99 <http://usa.mfa.gov.ua/en/ukraine-us/trade/Investment+Opportunities+in+Ukraine> : accessed on 29 April 2016.

100 UNESCO Science Report 2015.

101 It can be speculated that NGO financing is concentrated in social science projects, which are, however, not officially registered by the state at full extent.

102 <https://www.opensocietyfoundations.org/about/offices-foundations/international-renaissance-foundation> : accessed on 2 April 2016.

103 <https://www.usaid.gov/where-we-work/europe-and-eurasia/ukraine> : accessed on 2 April 2016.

104 <https://http://www.ukrstat.gov.ua/> : accessed on 4 May 2016.

105 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

Academy of Legal Sciences and the Academy of Arts. These consume another 25% of the state budget allocated for R&D. The Academies are responsible for basic research but they also have co-ordinating and practically delivery functions in many R&D and innovation-related programmes, the establishment of S&T priorities and the provision of scientific advice (e.g. to the ministries, including MESU).

State-sponsored academies of sciences are not subsumed to the Ministry of Education and Science but to the Cabinet of Ministries of Ukraine. They have a relative autonomy and need to coordinate their activities with the Ministry.

5.2. Higher Education Institutions

As for 2015, 664 **universities, colleges and technical schools** are active in Ukraine. According to the latest ERAWATCH report on Ukraine (2012), only half of the slightly more than 350 universities performed any kind of R&D in 2011.¹⁰⁶ Around 25% of the universities are private universities. The total expenditure on R&D in higher education was less than 7% of GERD in 2011. 70% of this funding came from the state and regional budgets. Two thirds of persons with degrees of candidates of sciences and doctors of sciences are working in the higher education sector. According to the national statistics, they produce almost 78% of research papers, but the National Academy of Sciences has more publications in internationally recognised journals.

According to Yegorov (2012), uncertainty about IPR and distribution of income contributed to the unwillingness of university personnel to do R&D work actively within the existing system of relations between them and the universities. This led them doing research on contracts with foreign or domestic customers, which in many cases were not officially registered through universities or research institutes.¹⁰⁷

The following universities make the top five according to the national rating of 2014 conducted by the Project 'Top-200 Ukraine':

- Taras Shevchenko National University of Kyiv;
- National Technical University of Ukraine 'Kyiv Polytechnic Institute';
- Bogomolets National Medical University;
- National University of Kyiv-Mohyla Academy;
- V.N.Karazin Kharkiv National University.

The main focus of Ukrainian universities is on teaching. The number of students grew from 1.5m in 2001 to 2.5m in 2009-2011, but at the same time the demographic situation in Ukraine is such that the number of students will rather decline in the next coming years. The number of foreign students is not high and they do not play a significant role in the educational system. Several foreign universities have established campuses in Ukraine, including Moscow Lomonosov University and the International Solomon University.¹⁰⁸

A list of intergovernmental agreements on the recognition of educational documents with foreign countries can be found at the INCREAST website.¹⁰⁹

Universities are usually subordinated to MESU, but if they have an evident industry affiliation, they are supervised by the corresponding ministry. Thus, the University of Civil Aviation and the Academy of Railway Transport are working for instance under the control of the Ministry of Transport respectively Infrastructure, although the influence of MESU on them has increased through the establishment of certain regulations and provisions in recent years.

5.3. Business Enterprise Sector and Other institutions

The **industrial research institutes**, engineering departments and special engineering bureaus are associated with specific economic areas and focus on industrial R&D. According to Yegorov (2013)¹¹⁰

106 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

107 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

108 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

109 <http://www.increast.eu/en/194.php> : accessed on 2 May 2016.

these organisations are formally subordinated to the different ministries and state agencies but in recent years ties with the ministries have weakened. It is worth to mention that the boundaries between the state and private R&D organisations in Ukraine are 'blurred' and a number of 'mixed ownership' organisations exists, which are owned partly by the state and, partially, by the employees. These organisations receive a fraction of their financing from the state in form of block grants, giving the ministries the right to be involved in the nomination of their directors. The share of direct financing from the ministries is usually not higher than 25% of an organisation's total budget. The rest of the financing is contracted both from state-owned and private companies. Many Ukrainian companies, however, prefer to purchase technologies from abroad, as foreign partners could provide more effective solutions and better services.¹¹¹

Systematic business R&D beyond the operations of the industrial research institutes, engineering departments and special engineering bureaus, is either hardly present in Ukraine or statistically insufficiently recorded. The demand for R&D results and innovation from the side of domestic companies dropped substantially since the independence of the country. This is also evidenced by the fact that the share of Ukraine's high and medium tech sectors shrunk threefold since the beginning of the 1990s, while at the same time the shares of the energy and ferrous metallurgy sectors grew substantially.¹¹² These low value added sectors have a more stable and mature technological base, which does not require a lot of R&D, but are less innovative than high and medium tech sectors that contributed to the overall decline of the number of innovative enterprises. According to Yegorov (2013) even the remaining enterprises of the machine-building sector (for example shipbuilding) occupy very often the lowest segments in the world markets, not mentioning ferrous metallurgy and production of basic chemicals. Competition in such markets is particularly fierce and Ukrainian companies are persistently under pressure to lose their existing positions to firms from developing countries.¹¹³

6. QUALITY OF THE SCIENCE BASE

6.1. R&D Infrastructure

As a heritage from the Soviet Union, Ukraine accommodated nearly 20% of the experimental facilities of the USSR including nuclear reactors, astronomic observatories, and ships for marine research, but a substantial part of this infrastructure has been lost during independence.

Today, the research infrastructure facilities for Ukrainian researchers are overall outdated, since financial resources to renew research equipment have been very low. Together with the low salaries paid to Ukrainian researchers, this bad situation of the research facilities is considered a major driver for brain drain. According to Yegorov (2013) the *"problem developed over many years and has now reached such proportions that neither quick nor inexpensive solutions are feasible"*.¹¹⁴

Ukraine still has a few R&D infrastructures in operation which are, although insufficiently funded, internationally recognised. Most of these are located at different institutes of the Academy of Sciences of Ukraine. Up-to-date, 15 Ukrainian research entities are included in the European Research Infrastructure Observatory. These are

- A.O. Kovalevskiy Institute of Biology of Southern Seas, National Academy of Sciences of Ukraine
- Association of users of Ukrainian Research and Academic Network URAN
- Danube Hydrometeorological Observatory of State Hydrometeorological Service of Ministry of Ukraine of Emergencies and Affairs of Population Protection from Consequences of Chernobyl Catastrophe
- G.V.Kurdyumov Institute for Metal Physics, National Academy of Sciences of Ukraine

110 The entire paragraph is taken from Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

111 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

112 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

113 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

114 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine, p. 27.

- Institute of Geological Sciences, National Academy of Sciences of Ukraine
- Innovation Center of the National Academy of Sciences of Ukraine
- State Museum of Natural History, National Academy of Sciences of Ukraine
- Ukrainian Lingua-Information Fund, National Academy of Sciences of Ukraine
- Odessa National I.I. Mechnikov University
- Southern Scientific Research Institute of Marine Fisheries and Oceanography
- Taurida National V.I. Vernadsky University
- Marine Hydrophysical Institute, National Academy of Sciences of Ukraine
- Ukrainian Scientific and Research Institute of Ecological Problems
- Ukrainian Scientific Centre of Ecology of the Sea
- Ukrainian Scientific Research Hydrometeorological Institute, National Academy of Sciences of Ukraine – marine branch

The coordination and cooperation between Ukrainian and European Research Infrastructures in any of these fields is reluctant beyond specifically funded projects, of which many are supported by the 7th European Framework Programmes for RTD and HORIZON 2020.

6.2. Positioning Ukraine scientific excellence along bibliometric indicators

The following bibliometric indicators to position Ukraine in terms of scientific excellence are discussed briefly as follows:

- the number of scientific Ukrainian publications among the **10% most cited publications** worldwide as % of the total scientific publications of the country
- **public-private** Ukrainian co-publications by million population
- **international scientific co-publications** with authors from Ukraine per million population

Based on CWTS findings for Ukraine¹¹⁵, the quality of a country's research basis can be approximated by the number of scientific publications among the **10% most cited publications** worldwide as % of the total scientific publications of the country. According to this indicator, Ukraine shows regularly low shares in the available time series from 2002 to 2013, ranging around 3% (2002: 3.4%; 2013: 3.1%), with a negative trend from 2008 (3.1%) to 2012 (2.2%). The EU average meanders between 9.8% in 2002 and 10.5% in 2012, depicting a positive upwards trend. The Ukrainian performance lies below all EU cohesion countries (e.g. Bulgaria 2013: 3.5%; Czech Republic: 7.3%; Hungary: 6.5%; Poland: 5.0%; Romania 4.7%; Slovakia 5.5%) but also below Turkey (2013: 4.8%) and Russia (3.3%). Among all countries analysed for the IUS/EIS, it only surpasses the performance level of Albania. It goes without saying, that the gap between Ukraine and the best performing countries in this respect (Switzerland: 15.7% in 2013; Netherlands: 14.5%; USA: 14.0%; UK: 14.2%; Denmark: 13.3%) is even increasing (except USA).

Another important indicator used for assessing fundamental science-industry relations refers to the **public-private co-publications** by million populations. It indicates the level of knowledge-based cooperation between academic and business R&D of a given country. The higher the indicator, the higher is this sort of knowledge-based inter-sector cooperation. While the EU average between 2008 and 2014 fluctuates quite heavily between 34.1 in 2008 and 33.9 in 2014 with a peak as high as 41.6 in 2011 and a low 33.9 in 2014, the Ukrainian time series data are stable, but at a very low level. It shows 1.0 in 2014 with a peak of 1.5 in 2010 and a low of 0.9 in 2013. Among the countries covered by the IUS/EIS similar low recent levels can only be found in Latvia, Turkey, the Former Yugoslav Republic of Macedonia, Montenegro, Bosnia and Herzegovina, Albania, Moldova and – India (which hints to an influence of size effects). The countries with the highest number of public-private co-publications by million populations in 2014 are Switzerland (217.6),¹¹⁶ Iceland (187.3), Denmark (143.5), and Sweden (107.8). Russia has a

115 Data from CWTS were provided by the European Commission.

116 The highest number actually has Liechtenstein (727,2), but is not taken here for comparison because of its size.

low value of 1.7 in 2014 and the EU cohesion countries are usually varying at higher levels (e.g. Bulgaria 2.1 in 2014; Czech Republic: 13.8; Hungary 23.2; Poland: 3.7; Romania 2.6; Slovakia 8.1).¹¹⁷

Finally, the **international scientific co-publications per million populations** are taken as a proxy for the international openness and connectedness of the domestic research communities with their fellows from abroad. Also with respect to this indicator, Ukraine shows a rather low, but steadily increasing performance ranging from 40.1 in 2005 to 59.4 in 2014. For comparison, Russia shows 76.3 in 2014, Moldova 56.8, Turkey 75.1, Slovakia 372.4, Romania 163.7, Poland 235.2, Hungary 398.1, Czech Republic 610.0 and Bulgaria 175.4. The top performers in 2014 are Switzerland (2,743.2), Iceland (2,364.3), Denmark (1,889.5), Sweden (1,670.2), and Norway (1,527.2).¹¹⁸

6.3. Introduction to the bibliometric co-publication analysis¹¹⁹

Co-publications are regarded as one indicator for measuring cooperation and are used as one of many proxies for the assessment of the current state of (bi-regional) collaboration in sciences. The following sections assess the activity and impact of Ukrainian research and international research cooperation based on bibliometric findings and discuss recent developments in academic cooperation between EU28/AC and Ukraine and points to emerging scientific topics.

The analysis of the publication data of Ukraine is based on the two main academic citation databases Web of Science (WoS) and Scopus for the timeframe 2003 to 2013.

It provides an overview on:

- the Ukrainian scientific publication and co-publication output,
- the most involved partner countries in Ukraine's co-publications,
- the main scientific research fields of Ukrainian publications,
- overall co-publications and co-publications with EU28/AC¹²⁰ countries with special focus on the joint Ukrainian-EU28/AC priority areas Aerospace & Aeronautics, Biotechnology, Nanoscience & Nanotechnology and Information & Communication Technologies,
- the Specialisation Index of Ukrainian scientific publications and some highlights regarding scientific impact.

Data and methodology

The data for the following detailed analysis was retrieved in summer 2014 from Elsevier's Scopus database (Scopus) and Thomson Reuter's Web of Science (WoS). The data cover a 11-year-period from 2003 to 2013 for the overall Ukrainian scientific publication output. On the basis of the retrieved raw data, raw data tables containing records and affiliations from Scopus and WoS were created separately. A combined data set was then created using a series of processing steps in an SQL database and with a specifically developed web interface for a multi-stage data cleaning process (e.g. duplicate detection, raw data correction) including both, automatic and manual steps.

The data unification and cleaning steps lead to a significant increase in data quality and a remarkable gain in data coverage. After the unification process 92,763 Ukrainian publications could be identified. 62,376 of these publications were listed in WoS only and 80,335 publications in Scopus only.

The method and data used has also certain restrictions:

117 These data are taken from CWTS.

118 These data are taken from CWTS.

119 This chapter is mostly based on the Deliverable 2.20, EU-Ukrainian co-publication analysis including emerging trends, funded under grant agreement no 311839 (BILAT-UKR*AINA) by the European Union's Seventh Framework Programme for research, technological development and demonstration.

120 The 28 EU Member States and the countries associated to the EU's Framework Programme 7 (FP7). These include Turkey, Montenegro and Macedonia; Switzerland, Israel, Norway, Iceland, Liechtenstein as well as Western Balkan countries.

- Impact measures (cited counts) should be treated with caution, because data can only give punctual snapshots (August/September 2014 in this study) and the cited counts are naturally constantly changing. Also research fields with a small number of (co-)publications should be treated with caution because low number of records can skew the results.
- Control of duplicates: In case a specific piece of research is published via multiple channels in similar ways, there is no way of control for this kind of duplicates at the meta-level.
- Limitations due to the general validity of bibliometric data and limitations inherent to the data source (with regards to the amount and coverage of journals and the quality of the data source e.g. misspellings, ambiguity in subject classification etc.) exist and have to be accepted. Despite considerable efforts in data processing and cleaning, there is always a certain margin of error in the data to be considered (a rough analysis of possible errors points to an error probability of 1-5%).
- Limitations in benchmarks: The data set is unique and therefore hardly comparable with total sums published in other studies as they usually only use one data source. If benchmarks have to be made, figures by Scopus/SCImago are being used, but direct comparison has to be interpreted with caution.
- Comparability of research fields: The average number of authors per (co-)publication is typically significantly higher in some fields (e.g. physics) than in others.

Cultural and organisational aspects of scientific communities have to be considered as well. For Ukraine, the role of scientific publications in the academic community have been determined by a considerable decline in the number of researchers in the country¹²¹ and the low incentives for publishing in international journals until 2012 as the system of academic promotion was based on the number of publications in national journals. Additionally, the poor knowledge of foreign languages, especially English, hinders publications in international journals.

6.4. Ukraine's scientific (co-)publication output 2003-2013

By using the unified data from both Thomson Reuter's *Web of Science* and Elsevier's *Scopus* databases, we observe that Ukraine's overall scientific publication output amounts to 94,135 publications for the

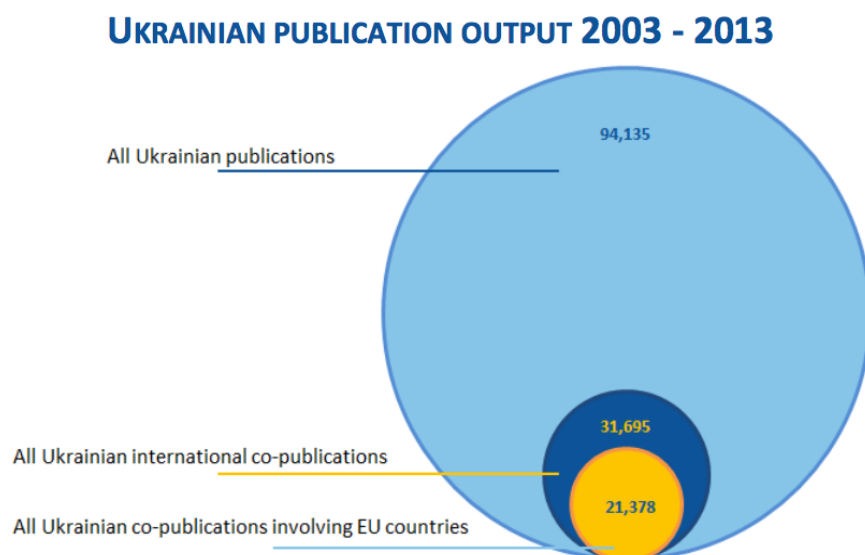


Figure 14: Ukraine's publications, international co-publications and EU28/AC co-publications (Source = WoS+Scopus)

121 As the Ukrainian statistics do not use FTE (full time equivalents) it is difficult to provide a correct figure of decline.

period 2003 to 2013. Of these 94,135 publications 31,695 publications involve at least one author affiliated in Ukraine and one author affiliated in another country. Consequently, the share of international co-publications in Ukraine's overall publication output is 33.46%, which is comparatively low.

In 21,378 of Ukraine's co-publications published in the observed time span, at least one EU28/AC author is involved: Therefore, around 22.6% of Ukraine's overall publications and 67.45% of all Ukraine's international co-publications are published with an author affiliated in an EU28/AC country (see Figure 14).

Ukraine's annual **output of co-publications** is growing slightly faster (around 55% more co-publications in 2013 [3,549 co-publications] than in 2003 [2,279 co-publications]) than of Ukraine-EU28/AC co-publications (around 53% more co-publications in 2013 [2,394 co-publications] than in 2003 [1,563 co-publications]), which are in turn growing faster than the annual output of Ukraine's overall publications (around 44% more publications in 2013 [10,440 publications] than in 2003 [7,257 publications]).

In Figure 15 the annual output of 2003 is taken as the benchmark for the following years, indicating 100% as the initial value. Whereas until 2009 there have been sometimes slight drops in the annual output from one year to another, from 2009 onwards the numbers of (co-)publications experienced a steady rise (see Annex 1 for the complete list of absolute numbers of Ukrainian (co-)publications).

Although the observable increase of Ukraine's (co-)publications follows a global trend, globally the annual scientific output in 2013 nearly doubled compared to the output in 2003 (around 84% more publications worldwide in 2013 than in 2003 [Source: Scopus]) and thus is growing faster than for Ukraine. This means that the internationalisation speed of Ukraine remains below the global average, but it needs to be taken into account that the overall R&D personnel in Ukraine significantly decreased in this period.

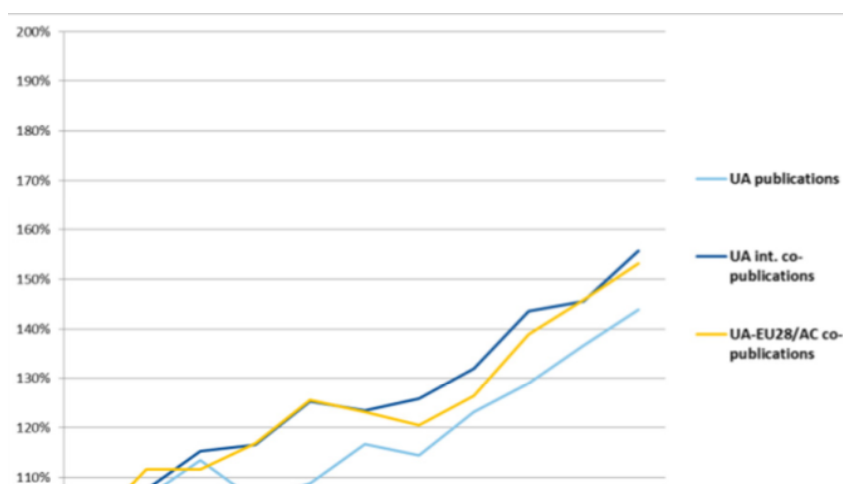


Figure 15: Growth rates over time of Ukrainian publications, co-publications and EU28/AC co-publications, 2003-2013 (Source = WoS+Scopus)

Ukraine's **partner countries, which are mostly involved in Ukraine's co-publications**, are highlighted in Figure 16. Out of these twenty partner countries, thirteen are countries from EU28/AC. Germany, followed closely by Russia and the USA, is the country with most co-publications with Ukrainian authors. Ukraine's co-publications involving authors from Italy, Spain, Switzerland, South Korea, the Czech Republic, Austria, Belgium, Mexico, China or Finland have more than 350 different authors involved on average. This indicates that for those partner countries big science collaborations, e.g. Physics & Astronomy, might be the main link. Ukraine's co-publications involving authors from Japan or Sweden do involve only slightly more than 80 authors on average (see Annex 2).

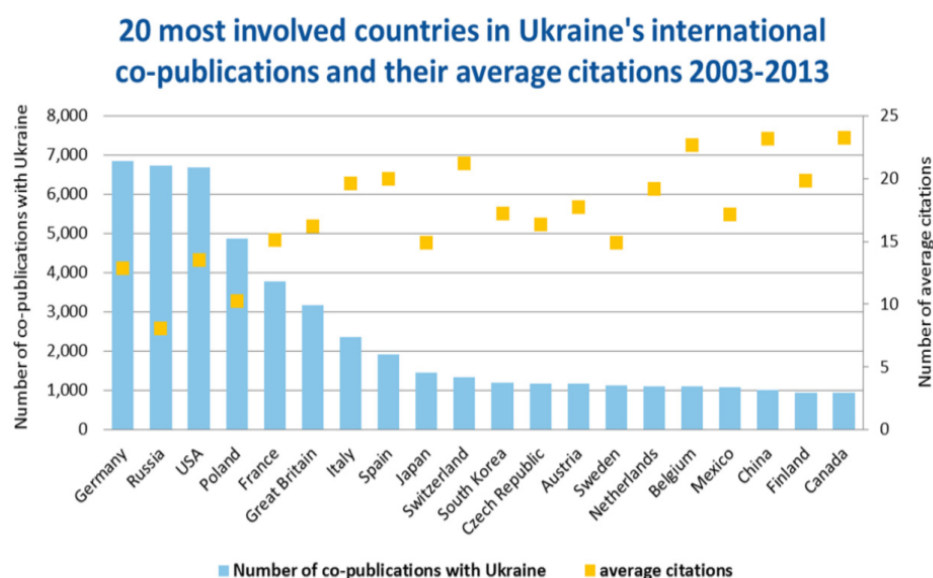


Figure 16 : 20 most involved partner countries in Ukraine's international co-publications, 2003-2013 (Source = WoS+Scopus)

Figure 17 shows the Salton's Measure for Ukraine and the main EU28/AC co-publication partners of Ukraine. For its calculateion we have used data on overall publication output for the EU28/AC countries from the SCImagoJR database as we do not have the unified data for all of these countries overall publications. For Ukraine, the unified data for overall publications and for the co-publications were used.

SALTON'S MEASURE

...helps to assess the cooperation density between two countries comparing their co-publication output with the overall output of the countries involved in the collaboration – it is an indicator for the relevance of the co-publication relationship for the two involved countries' scientific communities.

Country pair	Salton's Measure	Country pair	Salton's Measure
Ukraine-Germany	1.88%	Ukraine-Poland	2.92%
Ukraine-France	1.23%	Ukraine-Great Britain	0.84%
Ukraine-Italy	0.86%	Ukraine-Spain	0.77%
Ukraine-Switzerland	0.75%	Ukraine-Czech Republic	1.01%
Ukraine-Austria	0.89%	Ukraine-Sweden	0.71%

Salton's Measure for the most active Ukraine-EU28/AC co-publication country pairs

Source: WoS+Scopus, ScimagoJR

Figure 17: Salton's Measure for the most active Ukraine-EU28/AC co-publication country pairs, 2003-2013 (Source = WoS+Scopus; ScimagoJR)

The analysis shows that relations between Ukraine and Poland, Germany, France and the Czech Republic are quite strong (Salton's Measure over 1%). The co-publication relations between Ukraine and Austria, Italy and UK also amount to a significant share of their overall research output (Salton's Measure over 0.8%).

The results of a **co-publication analysis in terms of thematic areas** depend much on the definition of these specific areas. For this study we used the Science Metrix Classification of Science, a three-level journal subject classification system. It builds on comprehensive work on standardisation and classification of journals, partly financed by the European Commission. The main difference between the

Science Metrix Ontology and classification systems used by Scopus and Web of Science is the disjunctive classification, i.e. each journal is attributed to one (not one or more) subject category.

Table 6 shows the Science Metrix domains (column 1), with the publication output by Ukraine-based authors, including all citable article and article-like publications from 2003 to 2013 in the second column, Ukraine's international co-publications (column 4) and all Ukraine-EU28/AC co-publications in column 6. Additionally, the share of each Science Metrix domain of the overall Ukrainian publication output (column 3), of the Ukrainian international co-publication output (column 5) and of the Ukrainian-EU28/AC co-publication output (column 7) is given.

Natural Science is the major research domain for Ukrainian publications, especially for Ukrainian-EU28/AC co-publications; 66.34% of all Ukrainian-EU28/AC co-publications fall under this research domain. The share of the research domains Applied Sciences, Health Sciences and Economic & Social Sciences is highest for the overall Ukrainian publications. In those research domains international co-publications are – slightly in the case of Health Sciences – less relevant.

Science Metrix domain	UA publications	Share	UA int. co-publications	Share	UA-EU28/AC co-publications	Share
Natural Sciences	45,131	48.25 %	20,099	63.67 %	14,085	66.34 %
Applied Sciences	34,775	37.18 %	7,321	23.19 %	4,465	21.03 %
Health Sciences	10,119	10.82 %	3,340	10.58 %	2,173	10.23 %
Economic & Social Sciences	2,583	2.76%	253	0.80%	183	0.86%
Arts & Humanities	497	0.53%	229	0.73%	166	0.78%
General	423	0.45%	323	1.02%	160	0.75%









Table 6: Science Metrix domains of Ukrainian (co-)publications, 2003-2013 (Source = WoS+Scopus)

Ukraine has in particular a strong link with co-publication partner countries in the EU28/AC in the scientific area of Physics & Astronomy. Whereas 28.6% of all Ukrainian publications are published in the field Physics & Astronomy, 42.02% of all Ukrainian international co-publications fall under this research area and 44.43% of all Ukrainian – EU28/AC co-publications are published in this field. Compared to many other countries¹²², this share of Physics & Astronomy in Ukrainian (co-)publications is particularly high.

Second most Ukrainian publications are in the field of Enabling & Strategic Technologies (15.86%). In this field, however, the share of international co-publications with EU28/AC is comparatively low (only 5.16%) although the general share of international co-publication in this field amounts to 12.75% (see Figure 18). This indicates that research in the field of Enabling & Strategic Technologies was rather conducted with other countries (probably Russia) than with the EU.

Chemistry is the field with the second highest EU28/AC co-publication share of 10.74%. Chemistry, ranks fifth in the overall Ukrainian publication count (9.58%) (see Figure 18).

122 E.g. the share of Physics & Astronomy in international co-publications of countries within the Danube Region is considerably slower; e.g. for Austria the share is 13.08%, for Bulgaria 25.67%, Czech Republic 20.79%, Hungary 18.18%, Romania 22.98% or for Slovakia 22.74%. Smaller countries have even to some extent lower shares e.g. Albania has a share of 3.46%, Bosnia and Herzegovina has a share of 6.24%. (cf. Lampert et al. (2015)) This is also true for many other countries.

8 MOST IMPORTANT RESEARCH FIELDS** FOR UKRAINE			
Research field	# of UA publications and share	# of UA co-publications and share	# of UA-EU co-publications and share
 Physics & Astronomy	26,752 28,6%	13,228 42.03%	9,433 44.43%
 Enabling & Strategic Technologies	14,830 15.86%	4,014 12.75%	2,555 5.16%
 Engineering	10,162 10.87%	1,934 6.14%	1,096 5.16%
 ICT	9,313 9.96%	1,121 3.56%	641 3.02%
 Chemistry	8,956 9.58%	3,341 10.62%	2,224 10.47%
 Clinical Medicine	5,835 6.24%	1,791 5.69%	1,196 5.63%
 Mathematics & Statistics	5,711 6.11%	1,813 5.76%	1,375 6.48%
 Biomedical Research	3,779 4.04%	1,373 4.36%	880 4.14%

Source: WoS+Scopus

Figure 18: most important Science Metrix fields in Ukraine's (co-)publications, 2003-2013 (Source = WoS+Scopus)

The annual output of UA-EU28/AC co-publications in Information & Communication Technologies is growing particularly strong: the output in 2013 is more than five times as high as in 2003. Growth in Economics & Business was even higher, i.e. the output grew tenfold in the same period. In Clinical Medicine, Biology, Engineering, and Mathematics & Statistics, the annual output roughly doubled from 2003 to 2013. For most of the other research fields, the annual growth of UA-EU28/AC co-publications is steady but rather low with yearly deviations and might be too low to be measured on a yearly basis (see Annex 3).

6.5. Specialisation of Ukrainian scientific publications

According to the Specialisation Index (S.I.)¹²³ Ukraine is considered highly specialised in Physics and Astronomy, Materials Science and Chemistry, and specialised in Mathematics, Engineering, and Earth and Planetary Sciences (in the timeframe between 2003-2013). Ukraine is similar to the world average in the fields of Computer Sciences, Chemical Engineering and Energy. All other fields have in the timeframe between 2003 and 2013 an S.I. below 1 which indicates an 'under-specialisation' in these fields.

By comparing Ukraine's S.I. in 2003 and 2013 one can see that the specialisation of Ukraine in the fields Mathematics, Earth and Planetary Sciences, Energy and Economics, Econometrics and Finance is growing considerably stronger from 2003 to 2013 (see Figure 19).

123 The S.I. = the share (%) of publications of region x (Ukraine) in field Y divided through the share (%) of world publications in field Y. A S.I. > 1 indicates that region X is specialized in field Y. A S.I. < 1 indicates an 'under-specialisation' of region X in field Y; a S.I. = 1 indicates that region X is similar to the world average in field Y. (UNESCO, 2005)

	SI 2003-2013	SI 2003	SI 2013
Physics and Astronomy	3,32	3,31	3,31
Engineering	1,48	1,82	1,32
Materials Science	2,57	2,97	2,61
Chemistry	1,82	1,62	1,57
Computer Science	1,02	1,5	1,04
Mathematics	1,66	1,44	1,61
Biochemistry, Genetics and Molecular Biology	0,65	0,58	0,53
Earth and Planetary Sciences	1,32	0,94	1,67
Chemical Engineering	1,05	1,25	1,01
Medicine	0,13	0,15	0,18
Environmental Science	0,77	0,76	0,61
Energy	1,22	0,97	1,91
Agricultural and Biological Sciences	0,4	0,26	0,49
Social Sciences	0,31	0,07	0,43
Economics, Econometrics and Finance	0,74	0,06	2,96
Pharmacology, Toxicology and Pharmaceuticals	0,35	0,23	0,49
Neuroscience	0,38	0,29	0,26

Figure 19: Specialization Index (S.I.) for the 20 Subject Areas Ukraine has published most frequently in 2003-2013, (Source = Scopus)

Most of the strongest EU28/AC co-publication country partners of Ukraine cooperate with authors affiliated in Ukraine in the same ten Science Metrix fields which are the ten most important research fields in Ukraine. Switzerland is the only country where the Science Metrix field *Engineering* does not occur among the top ten research fields in co-publications with Ukraine, and *Information and Communication Technologies* is not among the top ten Science Metrix fields in Ukrainian co-publications with authors from Spain, Austria or Sweden. In those cases, *General Science & Technologies* is the Science Metrix field among the top ten fields instead of *Engineering* or *Information and Communication Technologies*.

Germany, Poland, France, UK and Italy are the most involved EU28/AC countries in the Top 10 Science Metrix fields of Ukrainian co-publications (see Annex 4). *Physics & Astronomy* is the strongest scientific field in co-publications in all of the listed relations. For example, the Ukrainian-German co-publications in *Physics & Astronomy* make up 3,269 co-publications, which is a share of 53.40% of all Ukrainian co-publications with Germany. The Ukrainian-Poland co-publications in this field account for 2,362 (share of 48.81%), the Ukrainian-France co-publications account for 1,858 (49.52%), the Ukrainian-UK co-publications account for 1,511 (48.12%) and the Ukrainian-Italian co-publications account for 1,474 (63.26%).

In many of the 10 fields, Germany appears as the strongest partner country, i.e. having the highest output of co-publications with Ukraine compared to the others. The only outlier is the field of *Biomedical Research*, in which Ukraine shares the highest number of co-publications with the UK (205 co-publications).

Out of the ten most involved EU28/AC partner countries for Ukraine, Germany has the highest relative share of co-publications (measured against the overall common co-publication output with Ukraine) in *Chemistry* (11.67%). Poland has the highest share in *Enabling & Strategic Technologies* (10.87%) and *Engineering* (5.04%), UK in *Information & Communication Technologies* (3.09%), Spain in *Mathematics & Statistics* (6.74%), Switzerland in *Physics & Astronomy* (67.71%), the Czech Republic in *Biology* (3.58%) and Sweden in *Clinical Medicine* (11.4%), *Biomedical Research* (8.01%) and *Earth & Environmental Sciences* (4.72%).

Looking closer at the four priority areas jointly identified by the European Commission and Ukraine¹²⁴, *Biotechnology* is the research field with the lowest numbers of publications: out of 176 Ukrainian publications (2003-2013) in the field of *Biotechnology*, 109 publications are international co-publications and three quarters of them, i.e. 82 co-publications, involve authors affiliated in EU28/AC. The level of internationalisation in this field is quite high.

Figure 20 shows the ten most involved countries in Ukraine's co-publications in the field of *Biotechnology* and their average citations: Poland, followed by Israel and the USA, is the most involved partner country. Poland and Israel also have a rather high number of average citations compared to the other countries, but this has to be interpreted with caution, as the overall number of co-publications is rather low.

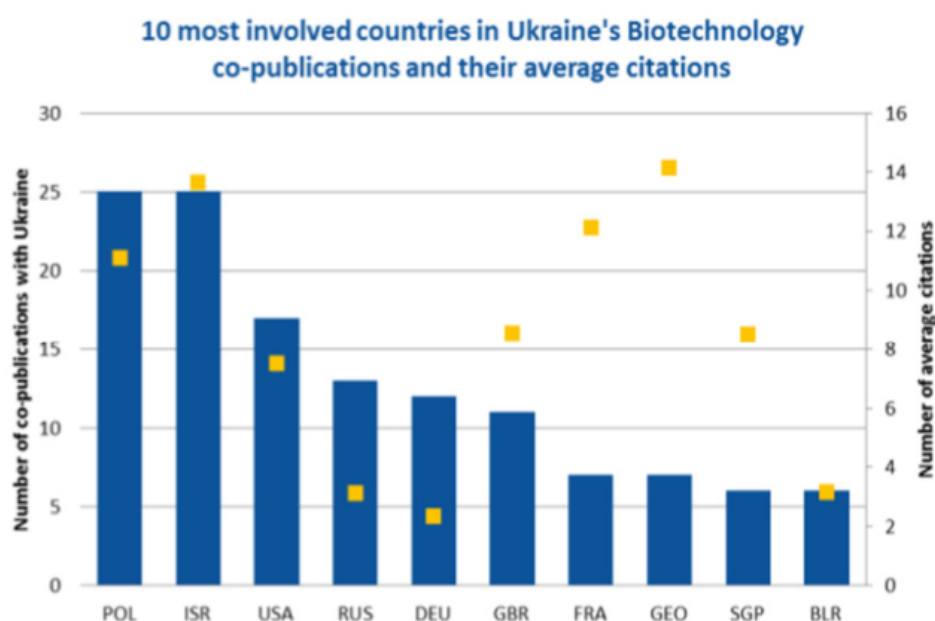


Figure 20: 10 most involved countries in Ukraine's Biotechnology co-publications and their average citations, 2003-2013 (Source = WoS+Scopus)

Aerospace & Aeronautics is the priority area with the second lowest (co-)publication output: out of 451 Ukrainian publications from 2003 to 2013 in this field, 111 co-publications are international co-publications and nearly half of them, 46 co-publications, are co-authored by authors affiliated in EU28/AC. This research field is not as internationalised as *Biotechnology* and seems to be not that relevant for EU28/AC.

Figure 21 shows the 10 most involved countries in Ukraine's international co-publications in the field *Aerospace & Aeronautics*. Russia and the USA are the main co-publication partner countries in this field, followed by Mexico, Italy and UK. Co-publications with Russia seem to have slightly more impact than with the USA. Because of the low numbers of co-publications with the other countries, the average citations have to be interpreted with caution.

124 As defined by the Ukrainian-EU Joint S&T Committee (JSTCC).

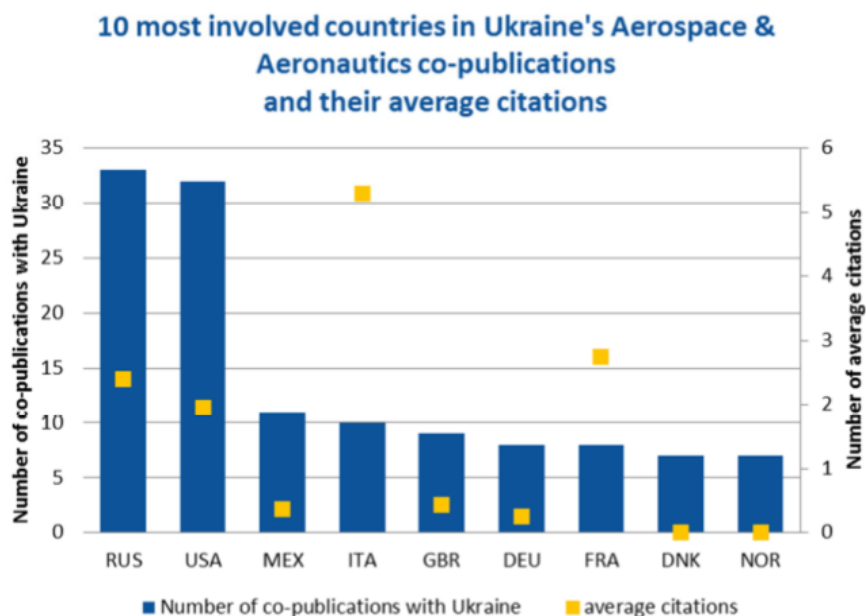


Figure 21: 10 most involved countries in Ukraine's Aerospace & Aeronautics co-publications and their average citations, 2003-2013 (Source = WoS+Scopus)

Out of the 938 Ukrainian publications from 2003 to 2013 in the field of *Nanoscience & Nanotechnology*, 418 publications are international co-publications and nearly two thirds of them, 256 co-publications, are co-authored by authors affiliated in EU28/AC. The internationalisation of this field is therefore somewhat in the middle – nearly 50% of all Ukrainian publications in the field of *Nanoscience & Nanotechnology* are international co-publications.

Figure 22 shows the 10 most involved countries in Ukraine's international co-publications in the field of *Nanoscience & Nanotechnology* in the period 2003 to 2013. USA, Germany, France and Russia are the most frequently involved partner countries and co-publications involving authors affiliated in the USA have a comparatively high number of average citations.

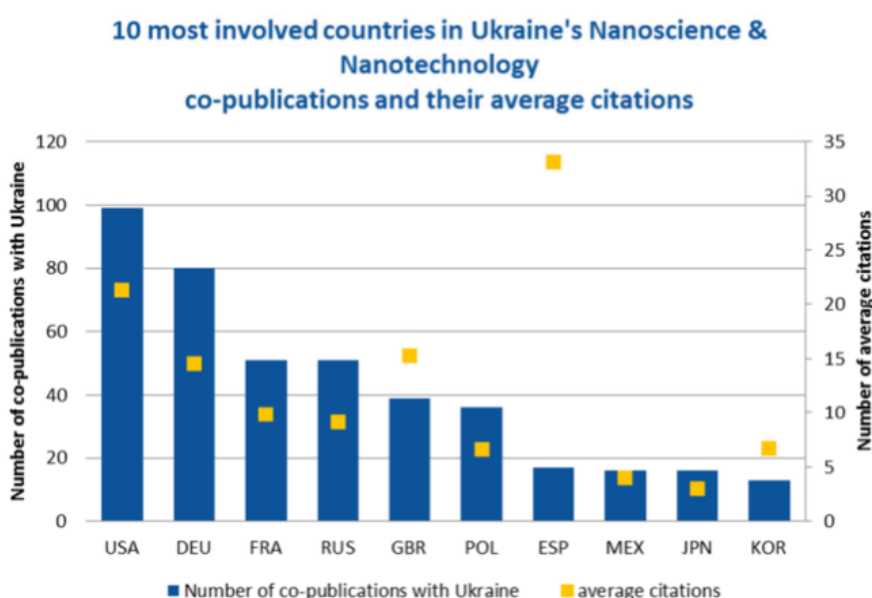


Figure 22: 10 most involved countries in Ukraine's Nanoscience & Nanotechnology co-publications and their average citations, 2003-2013 (Source = WoS+Scopus)

Information & Communication Technologies is the priority area with most Ukrainian publications. From the 9,312 Ukrainian publications from 2003 to 2013 in this area, 1,121 publications are international co-publications and more than half of them, 641 co-publications, involve authors affiliated in EU28/AC countries. The percentage of international co-publications in this research field is low compared to the other priority areas.

Figure 23 shows the ten most involved countries in Ukraine's international co-publications in the field of *ICT*. Russia, followed by Germany, France and the USA, are the most involved partner countries. Co-publications with France have a comparatively high average citation count.

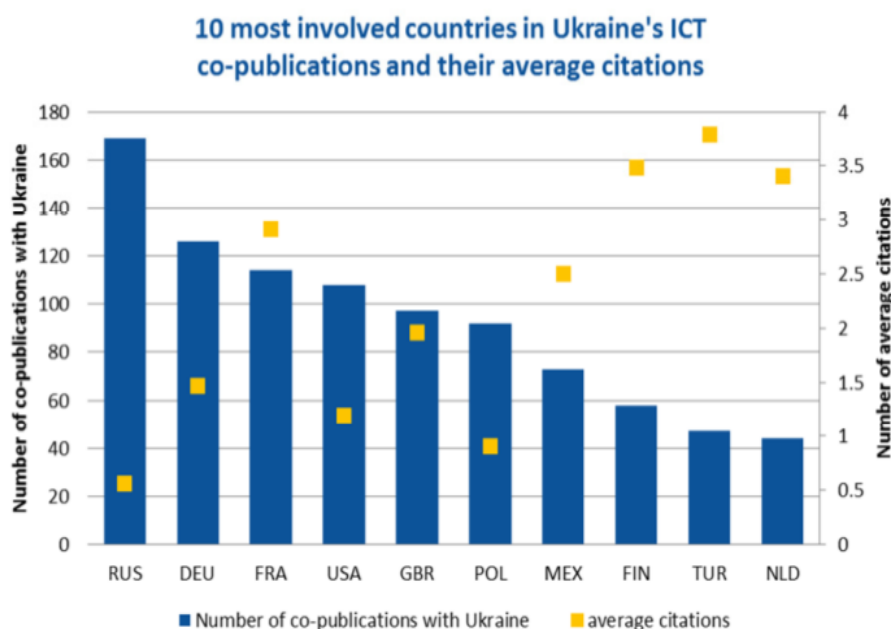


Figure 23: 10 most involved countries in Ukraine's Information & Communication Technologies co-publications and their average citations, 2003-2013 (Source = WoS+Scopus)

Biotechnology and *Nanoscience & Nanotechnology* are research fields, where Ukrainian authors and authors affiliated in EU28/AC countries co-published frequently. Also in *Information & Communication Technologies* more than half of all Ukrainian international co-publications involve at least one author from EU28/AC, but the internationalisation measured in terms of co-publications is low in this field. *Aerospace & Aeronautics* is the priority area with the least involvement of EU28/AC authors.

6.6. Impact of Ukrainian scientific publications and co-publications

In bibliometrics, the impact of scholarly works is typically approximated by the number of citations a published work receives. Readers should keep in mind that the impact in terms of average citations may vary greatly between scientific fields. Thus, comparisons should be done cautiously. A comparison within the same field but between different countries and/or over time is more plausible. A limitation to take note of is that the average citations for fields with few publications should not be taken at face value because they tend to fluctuate widely, e.g. if there is only one publication that has been cited 40 times and, later on, there is another one in the same field that has just 2 citations, the average citation drops from 40 to 21. Thus it may be sensible to exclude such cases.

Within the analysed period of 2003 to 2013, the average citation of a publication involving at least one author from Ukraine amounts to 3.7, i.e. each publication has been cited on average 3.7 times. The number of citations of publications that were solely authored by Ukrainian authors is quite low, namely 1.39 times. Works co-authored with at least one author from a foreign country are cited more often: 8.24 is the number of average citations for internationally co-authored works involving at least one Ukrainian author. Works co-authored with at least one author from EU28/AC are cited 9.48 times on average, i.e. 15 % more often than all international co-publications involving at least one Ukrainian author (again, on average).

When looking back at Figure 16 it becomes visible that Ukrainian co-publications with most of the twenty most involved countries are cited more than 10 or even more than 15 times on average. This is – at least to some extent – due to the fact that they have fewer publications than the overall Ukrainian co-publications and therefore the highly cited papers do have more impact on the average citation value than if there would have been more (co-)publications overall.

Comparing the average citations of the overall Ukrainian publications (for a list of average citation counts for the 15 research fields Ukraine publishes most see Annex 5) with the average citations of co-publications in the research fields with the most co-publication output, the following countries show especially high average citation counts:

- Ukrainian publications in *Clinical Medicine* have an average citation of 5.51, but Ukrainian co-publications are cited 16.1 on average. Ukrainian-**Spanish** co-publications are cited 61.57 times on average, Ukrainian-**Italian** co-publications 55.81 times, Ukrainian-**Dutch** co-publications 48.93 times, Ukrainian-**Russian** co-publications 44.15 times and Ukrainian-**Belgian** co-publications 44.87 times.
- Ukrainian publications in *Physics & Astronomy* have an average citation of 5.72, but Ukrainian co-publications are cited 9.18 times on average. Ukrainian-**Finish** co-publications are cited 22.93 times on average, Ukrainian-**Canadian** co-publications 22.17 times, Ukrainian-**Swiss** co-publications 21.61 times and Ukrainian-**Belgian** co-publications 19.04 times.
- Ukrainian publications in *Biomedical Research* have an average citation of 5.46, but Ukrainian co-publications are cited 11.6 times on average. Ukrainian-**Swedish** co-publications are cited 33.74 times on average, Ukrainian-**French** co-publications 30.57 times, Ukrainian-**German** co-publications 25.9 times and Ukrainian-**Russian** co-publications 20.68 times.
- Ukrainian publications in *Biology* have an average citation of 3.56, but Ukrainian co-publications are cited 7.7 times on average. Ukrainian-**British** co-publications are cited 17.5 times on average and Ukrainian-**German** co-publications 13.93 times.
- Ukrainian publications in *Chemistry* have an average citation of 4.72, but Ukrainian co-publications are cited 8.82 times on average. Ukrainian-**Italian** co-publications are cited 16.82 times on average and Ukrainian-**British** co-publications 16.31 times.
- Ukrainian publications in *Enabling & Strategic Technologies* have an average citation of 2.52, but Ukrainian co-publications are cited 6.2 times on average. Ukrainian-**British** co-publications are cited 12.52 times on average, Ukrainian-**Spanish** co-publications 10.71 times and Ukrainian-**Italian** co-publications 9.25 times.

7. HUMAN RESOURCES

7.1. The knowledge base of Ukraine and the human resource basis of the economy

Ukraine inherited a relatively well-developed education system from the Soviet area, which still preserves some positive features with an emphasis on mathematics and natural sciences at school level. However, serious concerns have risen as to the quality of S&T education since the early 1990s.

Although the Ukrainian education system seems to be chronical underfinanced¹²⁵, almost all major indicators such as share of public expenditures for education in % of GDP or in % of the public budget show Ukraine in a comparatively favourable position.¹²⁶ This contradiction can be partially explained by the relatively low absolute financial allocation, which might not be sufficient to maintain the comprehensive system of education in a country as big as Ukraine. It could indicate, however, inefficiencies within the system too. For instance, in elementary schools around 600 teaching hours are taught per school year, which is 100 - 200 teaching hours less than in the majority of European countries.

125 <https://www.liportal.de/ukraine/gesellschaft/#c4543> : accessed on 6 May 2016.

127 <http://www.kooperation-international.de/buf/ukraine/bildungs-forschungs-und-innovationslandschaft/bildungslandschaft.html> : accessed on 6 May 2016.

In particular, schools and vocational schools are lacking technical equipment. Curricula are still partly based on Soviet style patterns and teaching approaches and have to be continuously adapted to new requirements. Teachers receive low salaries, which causes high levels of corruption, both in primary and secondary schools as well as tertiary institutions (e.g. trade with diplomas and titles, ghost writing, awarding of performance).¹²⁷

At the positive side it seems, that education for handicapped pupils as well as promotion of giftedness receives more attention than previously. Moreover, efforts to improve the access to education in rural areas are implemented.¹²⁸

Ukraine has compulsory schooling for children usually at the age of six or seven years (depending on the choice of the parents). The pre-tertiary educational system in Ukraine comprises a minimum of 12 years. School education is organised along three levels: primary school (three or four years), lower secondary school and upper secondary school. The school system became highly diversified in the 1990s. Different types of schools, such as gymnasia, lycées and colleges emerged, which aimed at providing a more specialised secondary school education (e.g. with emphasis on languages or mathematics). Also private run schools are licensed.¹²⁹

During Soviet times, industrial corporations practically 'owned' the system of vocational education. Due to the decline of many fabrics and enterprises, the number of vocational educational institutes and colleges, assigned to these companies, demised. Today, vocational education is structured in three levels: elementary vocational education at no charge; a further four-year long training for which no higher education entrance level is necessary and, thirdly, higher vocational education for engineering professions at universities.¹³⁰

University enrolment in Ukraine is very high. Around 80% of 19-25 year-olds Ukrainians are enrolled in universities.¹³¹ With its 2.35m students enrolled, Ukraine belongs to the group of five countries of the European Higher Education Area (EHEA), which together represent slightly more than 54 % of the total tertiary student's population in the EHEA.¹³² Most of the university students in Ukraine are aiming to receive a Master diploma. The fraction of students enrolled at ISCED 6 level, which are programmes that lead directly to the award of an advanced research qualification (e.g. PhD), is considerably lower in Ukraine (1.52%) than overall in the EHEA (2.7%), which indicates a rather low interest to pursue a scientific career.

Higher education attainment levels are steadily rising in the EHEA. The Bologna median value is 37.3 % for the 25-34 age group, 29.4 % for the 35-44 year olds and 22.9 % for the 45-64 age group. This increasing tertiary attainment according to age is the dominating pattern in almost all Bologna countries. Ukraine has a high level of tertiary education attainment. In the youngest age group, higher education attainment has reached 50 % in Ukraine (as well as in Cyprus, Ireland and Lithuania). Higher education attainment is the lowest (less than 20 %) in Albania and Bosnia and Herzegovina.

Comparing 2013 median levels of unemployment ratios¹³³ shows that the general expectation remains true, that the higher the level of education is, the lower is the unemployment ratio. The EHEA median of unemployment ratios for young people with low educational attainment (at most lower secondary education) is 17.7 %, while for those with medium educational attainment (at most post-secondary non-tertiary education) it is 10.4 %, while it is 7.6 % for the highly educated with tertiary education. According to the Bologna Report 2015, however, Ukraine is different. In Ukraine the unemployment ratio of people aged 20-34 with higher education attainment is slightly higher (8.0%) than for people of the same age cohort with medium educational attainment (6.7%), albeit unemployment rates for both are at a comparatively low level. Also unemployment of people aged 20-34 with higher education attainment was faster increasing during 2008 and 2013 in Ukraine (+4.9%) than for people of the same age cohort

127 <https://www.liportal.de/ukraine/gesellschaft/#c4543> : accessed on 6 May 2016.

128 <http://www.kooperation-international.de/buf/ukraine/bildungs-forschungs-und-innovationslandschaft/bildungslandschaft.html> : accessed on 6 May 2016.

129 <https://www.liportal.de/ukraine/gesellschaft/#c4543> : accessed on 6 May 2016.

130 <https://www.liportal.de/ukraine/gesellschaft/#c4543> : accessed on 6 May 2016.

131 UNESCO Science Report 2015.

132 Bologna Process Implementation Report 2015.

133 The unemployment ratio is calculated as the share of the unemployed at the total population of a given educational attainment level and age group.

with medium educational attainment (+1.2%), which indicates a limited absorption capacity of the Ukrainian economy for persons with tertiary education attainment. In this respect, however, Ukraine is not an exception within the EHEA. The labour force with tertiary education was 36% in Ukraine during 2009-2012.¹³⁴

The gap between the unemployment ratios of young people with high and low educational attainment is also different for women and men. When looking at the EHEA region as a whole for the year 2013, the difference is pronounced in the case of young people with low educational attainment, while the unemployment ratios of young women and men were nearly identical among the highly educated. In Ukraine, Georgia and Moldova, however, young males with higher education attainment have had a higher unemployment ratio than young males with lower levels of education.¹³⁵

Ukraine also belongs to the countries with the highest share of over-qualification (32.9%), defined as the percentage of young people with tertiary education occupying a job position which is not traditionally regarded as necessitating a tertiary qualification (i.e. occupation level 4 to 9 according to the International Standard Classification of Occupations [ISCO]). The countries with the highest over-qualification rates (above 30 %) were Albania (45 %), Cyprus (39.7 %), Spain (38.8%), Ireland (36.9 %), Turkey (35.2 %), Greece (34.1 %), Bulgaria (33.3 %) and Ukraine (32.9 %).¹³⁶ This also indicates that the absorption of the Ukrainian economy for highly-educated is limited.

The biggest differences between female and male over-qualification rates are on the one hand in Albania, Ukraine, Switzerland, Turkey and Austria (with higher over-qualification rates for men) and on the other hand in Finland, the Czech Republic, Portugal and Italy (with higher over-qualification rates for women).

7.2. The system of higher education

In terms of post-secondary institutions, which are allowed to grant higher degrees, institutions with different ranks are distinguished from each other in Ukraine according to the qualifications granted, and by the academic qualifications of teaching and research staff.¹³⁷

- Institutions accredited Rank I subsume general vocational and technical high schools providing vocational training and final examination.
- Institutions accredited Rank II subsume various colleges, affiliated faculties and institutions with similar classification.
- Institutions with Rank III and IV are institutes, universities, conservatories and academies depending on the result of the accreditation¹³⁸

According to Kovács, the first rank consists from post-secondary small and highly specialized institutions, which are designed to provide vocational education finishing with the Junior Specialist diploma. They have to provide qualifications for the supply of lower occupational tasks (e.g. assistant pharmacist). The training time is usually 1-3 years. The colleges and affiliated faculties from the second rank comprise medium size institutions, which are providing professional and vocational education in various levels according to their accreditation (e.g. at Junior Specialist level and some of them even at Bachelor level). Rank I and rank II institutions are not university-type institutions.

The third rank consists of small, mono-disciplinary university-level institutions, which do not conduct R&D and who are not entitled to grant PhDs. The fourth rank comprises large scale, traditional universities offering programs from low to advanced levels. They also conduct R&D and are entitled to grant PhDs¹³⁹. Rank III institutions provide a higher degree (bachelor or specialist), which ensures professional training for the students having a secondary school-leaving exam. The study length is usually 4-5 years. The Rank IV universities ensure professional and scientific education for the students having a secondary

134 UNESCO Science Report 2015.

135 Bologna Process Implementation Report 2015.

136 Ibid.

137 Kovács, Klára (no year): the Bologna Process in Ukraine.
http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine : accessed on 6 May 2016.

138 Orosz 2005, pp. 54-59; Cited in Kovács, Klára (no year): the Bologna Process in Ukraine.
http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine, p.4.

139 <https://www.daad.de/laenderinformationen/ukraine/land/de/5492-hochschul-und-bildungswesen/> : accessed on 6 May 2016.

school-leaving exam and who passed the university entry examination. Usual training time is 5-6 years.¹⁴⁰

Rank IV institutions receive the highest budget allocations from the state and have the highest number of students, despite the introduction of student fees, which are levied for 75% of all study places. The level of the study fees is comparatively high and depends on the study programme and the diploma.¹⁴¹

In general one can distinguish in Ukraine the following tertiary education diplomas: Junior specialist, Bachelor, Specialist or Master, Aspirant (PhD training), Candidate of Science (which is comparable to a PhD)¹⁴², and Doctor of Science (which is comparable to a habilitation).

In Ukraine, the Bachelor programmes are usually 4 years long, but they hardly qualify for jobs. Therefore, most university students strive for a higher diploma. According to Kovács, one can find on one side academic second stage programmes with low practical value, and on the other side, there are vocational, practice-oriented programmes, with low academic curricular emphasis, which makes mobility between stages and study programmes difficult. In addition, there is the question of who will get a Specialist degree (which is still mostly applied to vocational-oriented studies) and who will get a Master degree after the fifth year.¹⁴³

Since the mid-2000s the share of students studying humanities and the arts has grown by 5% and in social sciences, business and law by as much as 45%. On the other hand, the share of graduates in natural sciences, with the exception of agriculture, health care and services, has shrunk by one-quarter and in technical sciences by more than one-fifth since the mid-2000s.¹⁴⁴

It is noticeable, that in 2012 the share of university graduates in natural sciences was already considerable lower (5.3%) than for instance in Germany (12.6%). This is caused by the fact that the demand for degrees in some technical disciplines has declined, especially in industry, after graduates were unable to find a job suited to their qualifications.

The structural socio-economic and ideological transformation of the higher education system after the independence of Ukraine was accompanied with an orientation towards the Bologna process during the last 10 years. In May 2005, Ukraine signed the Bergen Declaration, thus officially joining the EHEA (European Higher Education Area). In the academic year 2006-2007 ECTS was introduced in every institution of higher education ranked III-IV. The adoption of Bologna and especially ECTS, however, was often criticised by Ukrainian professors, which suspected a "de-intellectualisation process".

In 2008 a new type of entry system to the universities was introduced, according to which every student intending to study in a higher education institution must take an advanced level exam in Ukrainian in an independent centre providing maturity exams and entrance exams. This decision, however, affected negatively the main national minorities.¹⁴⁵

According to Kovács, one of the most important problems is the imperfect monitoring of the reform objectives. The value of the introduced formal changes and of the high-sounding modernisation strategies, which have been proclaimed throughout the pre-Maidan revolution years, remains uncertain if the supervision of the implementation of the reform elements is not solved.

Despite the often unclear reform of the curricular system in Ukraine, which aggravates Ukraine's higher education system alignment within the EHEA, and which also seems to offer several opportunities to

140 Orosz 2005, p. 54; Cited in Kovács, Klára (no year): the Bologna Process in Ukraine. http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine, p.4.

141 <https://www.liportal.de/ukraine/gesellschaft/#c4543> : accessed on 6 May 2016.

142 The Soviet Candidate of Science, however, must not hold a master's degree but also count no fewer than five publications to his or her name. The Soviet Doctor of Science must be a Candidate of Science with substantial scientific expertise and at least 20 international publications (see footnote 17 of the UNESCO Science Report 2015).

143 Kovács, Klára (no year): the Bologna Process in Ukraine. http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine

144 UNESCO Science Report 2015.

145 Kovács, Klára (no year):: the Bologna Process in Ukraine. http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine

introduce incidents of corruption¹⁴⁶, Ukraine belongs to those countries of the EHEA with the highest annual public expenditure on tertiary education (around 2%). The Ukrainian share is only below the level the Nordic countries (ranging from 2 % of GDP in Sweden to 2.4 % of GDP in Denmark). In comparison, annual public expenditure on tertiary education is the lowest and below 1 % of GDP in Slovakia, Croatia, Romania, Italy, Bulgaria, Azerbaijan, Armenia and Georgia.¹⁴⁷

Also in terms of public expenditure for tertiary education in % of all public expenditures, Ukraine belongs to the EHEA countries allocating a high share of public budget to tertiary education expenditure. This share of Ukraine was even increasing since 2005 from 4.1% to 4.6% in 2011. Within the EHEA, only Norway spends a larger share of its public budget to tertiary education (4.83 %) in 2011, followed by Ukraine (4.64 %), Cyprus (4.56 %), Denmark (4.23 %) and Switzerland (4.08 %). There are a few countries that devote less than 2 % of their public funding to tertiary education, such as Croatia (1.94 %), Bulgaria (1.82 %), Italy (1.67 %) and Azerbaijan (1.06 %).¹⁴⁸

Nearly 81 % of the 2.35m Ukrainian students are enrolled in theoretically-based programmes (ISCED level 5A) in the first two cycles, which corresponds to the EHEA average, while 15.1 % are enrolled in programmes that are more occupationally specific (ISCED level 5B; e.g. universities of applied sciences) (compared to 15.6% at EHEA average).¹⁴⁹

Compared to the overall trend in other countries of the EHEA, Ukraine has a high share of part-time students. In six countries (Poland, Ukraine, Kazakhstan, Hungary; Slovakia and Croatia), more than 85 % of higher education part-time students are aged between 30 and 34, although in case of Ukraine the share of the older age-group of students is less than 10% of all students, which is a comparatively low value. However, also in the younger age-group of students, 44.5% belong to the group of part-time students in Ukraine. This is the highest share within the EHEA followed by Poland (37.2 %), Sweden (29.7 %) and Azerbaijan (25.3 %).¹⁵⁰

More than 46,000 Ukrainian citizens are studying abroad¹⁵¹. Among the most preferred countries for studying abroad are Poland, Germany, Russia, Canada, Czech Republic, Italy, USA, Spain, France, Australia and UK, with the highest growth rate dynamics in Poland.¹⁵² According to the INCO NET EaP Country Report (updated 2015) more than 63,000 foreign students are enrolled in Ukraine. They come mostly from Turkmenistan, China, Russia, India and Jordan.¹⁵³

Despite the increasing outward student mobility to EU, Ukraine is practically not yet fully integrated in the EHEA and the Bologna system. This can be evidenced from the level of study recognition. While recognition of credits seems to be a common practice in the majority of EHEA countries, only 27% of Ukrainian students (second lowest after Armenia with 26%), who have been enrolled abroad have seen their credits gained abroad recognised, while it was the case for 75% of students in France, the Netherlands and Denmark. Moreover, the share of students who do not get any recognition of credits seems to be relatively high in Armenia, Hungary, Croatia, Sweden and Ukraine.¹⁵⁴

7.3. Doctoral training and merit-based recruitment of researchers

The total number of doctors of science and of candidates of sciences is growing in Ukraine. The latter grew from 59,000 in 2000 to 85,000 in 2011, and the number of doctors of sciences from 10,300 to

146 Kovács, Klára (no year):: the Bologna Process in Ukraine.
http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine

147 Bologna Process Implementation Report 2015.

148 Bologna Process Implementation Report 2015.

149 Bologna Process Implementation Report 2015.

150 Bologna Process Implementation Report 2015.

151 These numbers vary; according to https://www.daad.de/medien/bma_ukraine.pdf 38,666 Ukrainians are studying abroad.

152 INCO NET EaP Country Report (updated June 2015, source: NIP Ukraine).

153 https://www.daad.de/medien/bma_ukraine.pdf 38,666 : accessed on 6 May 2016.

154 Bologna Process Implementation Report 2015.

14,900 during the same period. However, only 20.6% of this growing number of doctors and candidates of science were involved in R&D as their primary job task in 2011.¹⁵⁵

Doctoral education in Ukraine is hardly structured along professional research education standards (e.g. doctoral schools). The content of doctoral programmes contains both interdisciplinary subject units (lectures, seminars etc.) and individual research work. Credits can be acquired on the basis of work load and performance. It seems that the doctoral education lags behind the transformation of other levels of higher education.

Having PhD degrees from abroad acknowledged in Ukraine was a long and complicated process until recently, which corresponded to a kind of "second defending". Firstly, a number of documents had to be collected and presented to the independent State Qualifying Commission, and when these were accepted, the Committee appointed another committee consisting of 2-3 experts of the given field, which evaluated the dissertation and gave an opinion on it. On the basis of the candidate's answers given to the questions of the committee they decided whether to accept or refuse the dissertation¹⁵⁶. This slow and burdensome approval process seems to have been considerably accelerated since the Commission was subordinated to MESU recently.

Concerning the recruitment of researchers, new positions are few and the number of researchers is constantly declining in Ukraine since 1990s, which led to an internal and external brain drain. The latter, however, does not seem alarming anymore at first sight: in 2005-2011, less than 50 researchers with scientific degrees (candidates and doctor of sciences) emigrated from the country annually.¹⁵⁷ At the same time, however, approximately 1,000 researchers had long-term visits abroad every year and more than one quarter of them stayed longer than one year in foreign countries. According to Yegorov (2013) this *"means that the mode of emigration has changed from permanent migration to a 'shuttle' one."*¹⁵⁸

The labour market for researchers in general is not very dynamic since it is difficult to terminate an existing contract with an individual researcher without serious reasons. There is also hardly any influx from foreign researchers. Although foreigners could compete for positions in Ukrainian research institutes and universities, language is often a barrier, because all higher education activities, as a rule, have to be in official state languages. The second reason relates to the general tax regulations for employment of foreigners, which give a clear advantage for the citizens of Ukraine. The third and maybe most important reason is the relatively low salary paid in the research sector in Ukraine.¹⁵⁹

To attract young scientists, special state stipends were increased two to four fold in the last couple of years, depending on the type of the stipend. The same holds true for state awards for advancement in science which support the most talented and which should stimulate their work within the country.¹⁶⁰ According to Yegorov (2012), young scientists have access to four main types of special support stipends, which in total are less than 1,500 per year: special stipends for young doctors of science; stipends of the President of Ukraine, stipends for young scientists from the presidium of the National Academy of Sciences and regional stipends for young scientists; all of which range between €30 and €200 per month. Although the number of stipends and their financial levels have changed in the last couple of years, their basic structure and principles of provision remained almost the same.¹⁶¹

The over-ageing of research personnel in Ukraine, could lead to a slightly better labour market for younger researchers in the future, if the system of research funding does not further shrink. A large number of scientists are at pensionable age in Ukraine. The average age of Doctors of Science is more

155 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

156 Gabóda – Gabóda 2008; Cited in Kovács, Klára (no year): the Bologna Process in Ukraine. http://www.academia.edu/3500678/The_Bologna_Process_in_Ukraine, p. 10.

157 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

158 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine, p. 24.

159 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

160 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

161 Information provided by Professor Igor Yegorov, Deputy Director of the [Institute for Economics and Forecasting](#) of the [National Academy of Sciences of Ukraine](#) on 23 May 2016.

than 61 years and that of Candidates of Science more than 53.¹⁶² The average age of researchers has been growing by one year every three years in the last decade.¹⁶³

7.4. Employment and working conditions of researchers

The number of personnel at the research institutions is 109,636 according to the State Committee of Statistics of Ukraine, of whom 53.5% are researchers (as for 2014, without Crimea). 45.8% of these are women.¹⁶⁴ By head counting¹⁶⁵ 65,641 researchers are working in Ukraine in 2013. 16,512 are working in the field of natural sciences, 27,571 in engineering sciences, 4,200 in medical sciences, 5,289 in agricultural sciences, 4,644 in social sciences and 2,078 in humanities.¹⁶⁶

Although researchers in Ukraine usually have permanent contracts, R&D seems neither to be an attractive field of work for the young generation in Ukraine nor for foreigners. The latter are even subject to higher income tax than Ukrainian citizens are.¹⁶⁷ The average salary in Ukrainian research institutes and universities was around € 600 per month before the most recent crisis, but dropped in real terms due to the collapse of the national currency in 2014 and 2015. Next to the low salary, the poor state of research infrastructure makes the working conditions for researchers most unattractive.

To counterbalance the low salaries, the government has also special stipends for experienced scientists. Their number and size vary. Not more than 150 of such stipends were provided in recent years.¹⁶⁸ However, approximately 1,000 academicians and corresponding members of the state academies of sciences receive a monthly stipend of €250-€450 until the end of their life. These stipends are higher than the level of average monthly wages in the country. All stipends are added to the salaries or pensions.¹⁶⁹

In 2013, 511 researchers per one million inhabitants were employed by the business enterprise sector in Ukraine. This is a relatively low ration, slightly below that of Turkey (609) and considerably below that of Belarus (1,183).¹⁷⁰ The development of this ratio is negative since 2004 in Ukraine, which indicates a severe demand-sided absorption problem of the business enterprise sector.

7.5. Gender equality and gender mainstreaming in R&D

Gender equality is perceived as a 'cultural heritage' of the Soviet System. Women are widely represented in R&D. Like in Georgia or Moldova, also in Ukraine the majority of PhD graduates (or equivalent) are women (57%). They make up half of PhD graduates in natural sciences, 35% in engineer sciences (which is a very high level compared to the EU) and 59% in health and welfare related studies.¹⁷¹ Despite this over-proportional rate in PhD graduation, they constitute only 45.5% of the total number of researchers in Ukraine (2011),¹⁷² which indicates a first glass-ceiling level at the scientific jobs' entry phase.

The share of female researchers is 44.5% in natural sciences, 37.2% in engineering sciences, 65.0% in medical sciences, 55.0% in agricultural sciences, 61.4% in social sciences and 67.8% in humanities.

There are no acts or regulations in Ukraine in place which promote a higher representation of women in R&D. According to Yegorov (2012), however, women have in reality more problems in building their research careers than men, because they are supposed to combine childcare and related career leaves

162 UNESCO Science Report 2015.

163 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

164 <http://www.increast.eu/en/194.php> : accessed on 4 May 2016.

165 In Ukraine statistical difficulties occur in calculating full-time equivalents of researchers.

166 UNESCO Science Report 2015.

167 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

168 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

169 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

170 UNESCO Science Report 2015.

171 UNESCO Science Report 2015.

172 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

with uninterrupted professional activities. As a result, very few women have reached highest positions in the Ukrainian scientific hierarchy.¹⁷³

8. INTERNATIONAL R&D COOPERATION AND MOBILITY

International R&D cooperation gains more and more importance. Cross-border cooperation with the European Union (EU) and with its Member States (MS) bilaterally forms one of the pillars of Ukrainian international R&D cooperation.

From the EU's perspective, Ukraine is a third country within the Eastern Partnership and the only country in this region with whom a separate Science and Technology Cooperation Agreement was signed in 2002 (into force since 2003). The association to HORIZON 2020 (succeeding FP7 and running from 2014-2020) on March 20, 2015, was not only an important milestone to continue the EU-Ukrainian cooperation in RTDI, but also proves the current political will to establish Ukraine's future together with the EU. Last but not least the association is a premiere, since it is the first full association of Ukraine to any of the EU framework programmes.

8.1. Integration in the European Research Area

One of the main priorities for Ukraine's international R&D cooperation is the **integration in the European Research Area (ERA)**¹⁷⁴. This integration is fostered by multilateral and bilateral cooperation with the EU and its member states.

Already in 2002, the Ukraine-EU Agreement on Science & Technology (S&T) cooperation was signed. Under the terms of this agreement, the **Joint Science & Technology Cooperation Committee (JSTCC)** was established. In the frame of Joint Committee meetings, both sides provide up-to-date information on current developments in research and innovation policy and related programmes in the EU and Ukraine respectively.

There are several EU programmes targeting the RTDI cooperation between the Union and Ukraine.¹⁷⁵

- FP7 – Seventh Framework Programme for Research and Innovation (closed; some projects are still running)
- HORIZON 2020 – Framework Programme for Research and Innovation (succeeding FP7 and currently running)
- Erasmus Mundus
- Tempus
- Jean Monnet Programme under the Lifelong Learning Programme
- INSC and INOGATE – both funded through the European Neighbourhood and Partnership Instrument (ENPI)
- Cross-Border-Cooperation Programmes – funded by ENPI
- Central Europe Programme – as part of the European Trans-regional Cooperation Programmes

As regards FP7, the success rate of Ukrainian researchers was 19.5%. 155 grant agreements were signed, involving 215 participants from Ukraine to whom €30.9m of European funding from FP7 were allocated.

In terms of the number of successful grant agreements in FP7, Ukraine ranks 7th among all third countries both in number of participations and in budget share.¹⁷⁶

173 Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

174 http://ec.europa.eu/research/era/index_en.htm : accessed on 2 May 2016.

175 Olena Melnyk, Olena Koval: „Progress Report on monitoring of Ukraine participation in FP7 and Horizon 2020, p.6, 2015, Deliverable 2.18 in BILAT-UKR*AINA project

In FP7, Ukraine was most active in the following areas (based on signed grant agreements)¹⁷⁷:

- Environment (16)
- Transport (15)
- INCO (International Cooperation) (15)
- Marie Curie Actions (15)
- Nanotechnologies (13)

Figure 24 shows the full list of thematic areas in which Ukrainian researchers participated in the frame of FP7 and the funding allocated to each priority respectively.

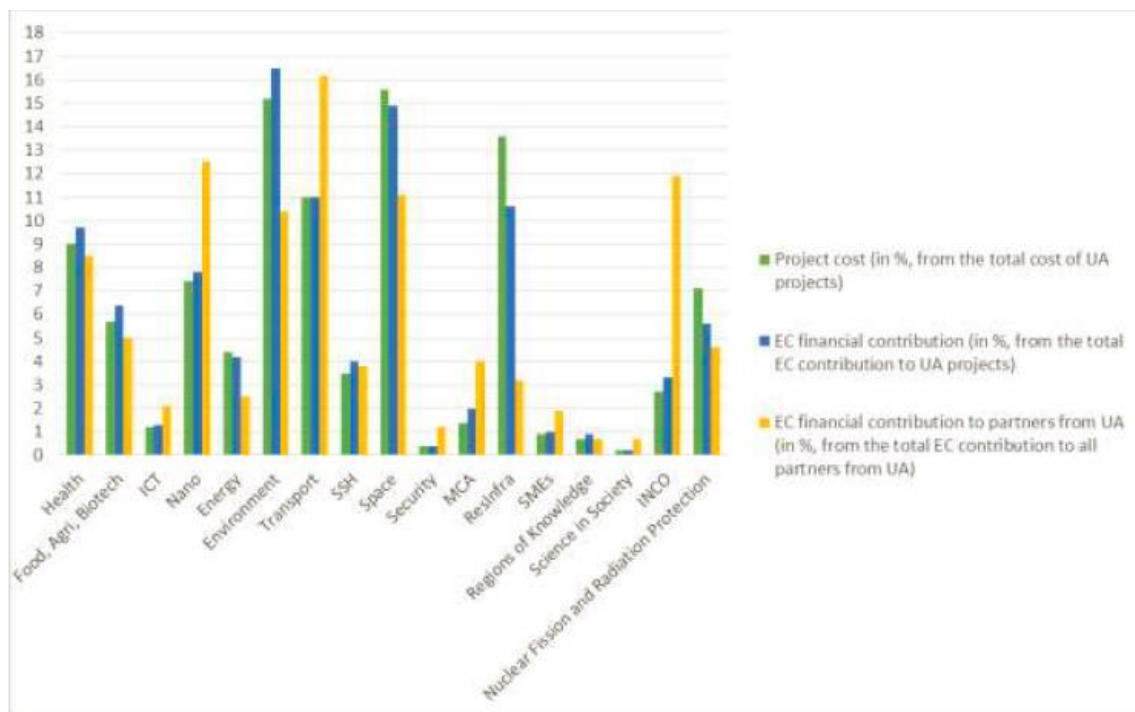


Figure 24: Total number of signed FP7 GA: project costs, EC contribution (including EC contribution to partners from Ukraine)¹⁷⁸

According to the funding schemes available in FP7, Ukraine's successful 155 grant agreements stem from the following instruments:

176 Ibid.

177 Ibid., p.9

178 Melnyk, Koval: Progress Report on monitoring of Ukraine participation in FP7 and Horizon 2020, 2015, p.10

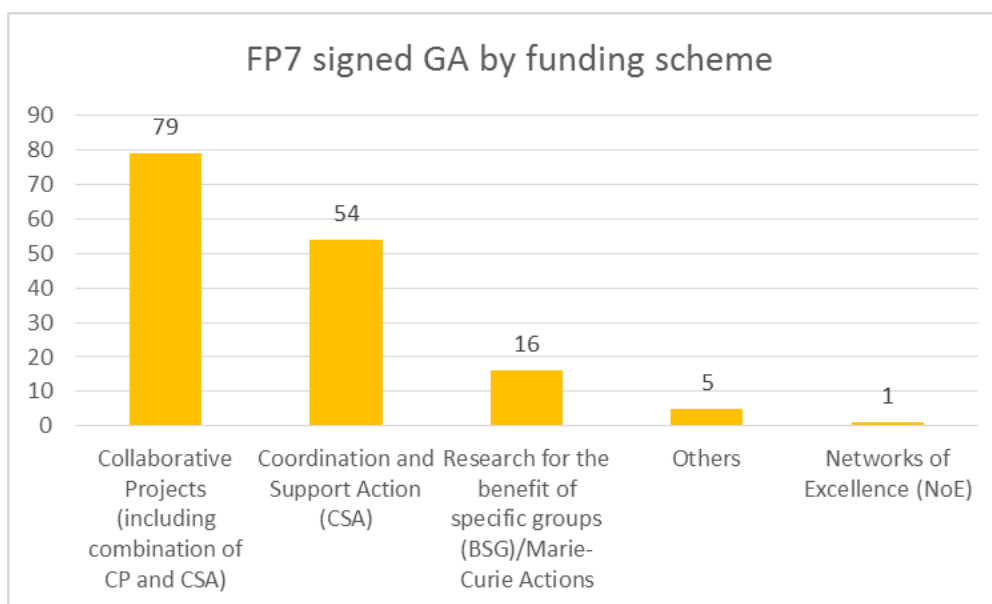


Figure 25: Signed GA in FP7 by funding instruments¹⁷⁹

Based on the available data by May 2015, applicants from Ukraine submitted 173 proposals in total to HORIZON 2020, of which 23 were selected for funding, involving 29 participants from Ukraine (see Table 7).

Ukraine in H2020	Proposals submitted	% of total submissions (rounded)	Proposals funded
Excellent Science (Marie Skłodowska-Curie actions etc.)	69	39.88	10
Industrial Leadership	30	17.34	3
Societal Challenges	62	35.83	9
Science with and for Society	6	3.46	0
EURATOM	6	3.46	1
Total	173	100%	23

Table 7: Total UA submissions in HORIZON 2020 and their success rates¹⁸⁰

The number of funded projects does not necessarily reflect the share of the total budget accrued by Ukrainian institutions in HORIZON 2020. As Figure 26 reveals, the nine funded projects from the Societal Challenges pillar received the largest share of total funding for Ukraine in HORIZON 2020 (67% of the total funding).

¹⁷⁹ Ibid.

¹⁸⁰ Melnyk, Koval: Progress Report on monitoring of Ukraine participation in FP7 and Horizon 2020, 2015, p.30

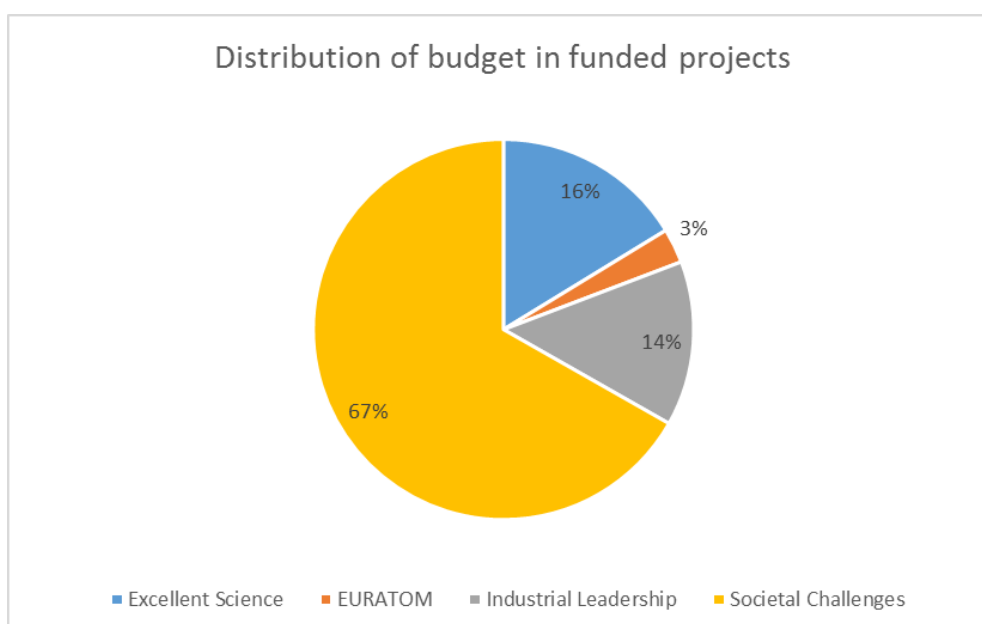


Figure 26: Distribution of budget in funded UA projects in HORIZON 2020¹⁸¹

The average success rate of Ukrainian researchers in HORIZON 2020 was 13.29% (data for 2014). It varies across the different pillars as shown in Figure 27. The highest success rates could be attained in EURATOM and the lowest in 'industrial leadership', which reconfirms the traditional low industrial participation of Ukraine in European R&I cooperation.

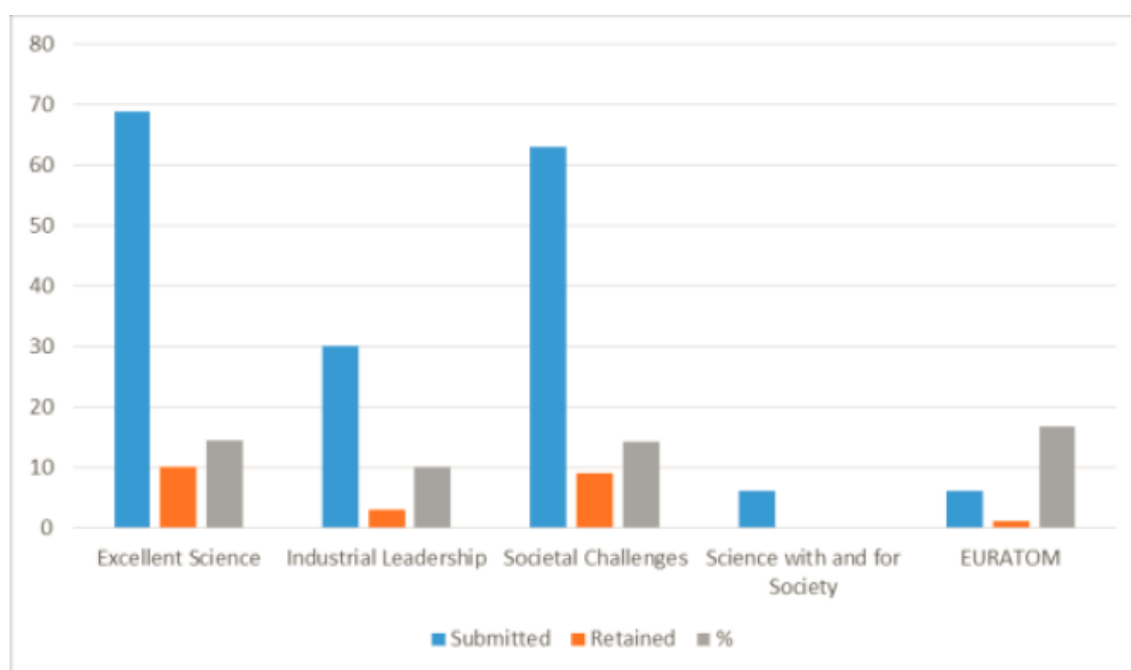


Figure 27: Success rate of submitted UA proposals by HORIZON 2020 pillars¹⁸²

181 Olena Melnyk, Olena Koval: „Progress Report on monitoring of Ukraine participation in FP7 and Horizon 2020, p.6, 2015, Deliverable 2.18 in BILAT-UKR*AINA project, p.31

182 Ibid., p.32

8.2. Bilateral R&D cooperation between Ukraine and EU Member States

Since its independence in 1991, Ukraine opened up its national research system towards the international research community. In the early 2000s and, especially, since Russia interfered on Ukraine's territory in 2014, Ukraine made efforts to leave behind the politically hemisphere influenced by Russia and shifted its interest towards the EU.

In line with the fostered collaboration with the EU in general are also Ukraine's activities in R&D cooperation with single European member states. According to data from 2014, 25 intergovernmental agreements on S&T cooperation between Ukraine and EU MS and countries associated (AC) to HORIZON 2020 are in effect. These cooperation partners are (in alphabetical order)¹⁸³

- EU MS: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, The Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain
- AC to HORIZON 2020: FYROM, Moldova, Turkey

The activities carried out under such bilateral S&T agreements are usually scientific events (conferences and workshops), exchange of researchers and experts, exchange of knowledge and implementation of joint research projects. Weaknesses are mainly found on the side of finances and politics, as the budgetary situation in Ukraine for national R&D as well as international R&D cooperation is unstable and as Ukraine faces serious re-organisations on its governmental level.

To illustrate the bilateral agreements in more detail, a few examples are featured.¹⁸⁴

The Austrian-Ukrainian partnership in S&T is primarily managed within the "Scientific-Technological Cooperation Agreement" (Wissenschaftliche-Technische Zusammenarbeit – WTZ), which is financed by the Austrian Federal Ministry of Science, Research and Economy.¹⁸⁵ The first WTZ came into force in 2004. Currently the new application period for projects running between 2017 and 2018 is open with the aim to intensify the international scientific cooperation of Austrian and Ukrainian scientists. **Based on the joint foci both countries share in basic research**, applications for projects shall prioritise the following fields: High-energy Physics, Ecology, Biotechnology, ICT, Nanophysics and Nanotechnologies plus Humanities and Social Sciences.

The French-Ukrainian S&T partnership has an even longer tradition. The agreement on cultural and S&T cooperation was first adopted in 1995. The National Centre for Scientific Research (CNRS) is in charge for this agreement, which operates under the Ministry of Higher Education and Research in France. **The focus within this collaboration is on the fields of physics and chemistry.** The agreement is divided into three main sub-agreements: One between CNRS and NASU (signed in 2004), one between CNRS and the State Fund for Fundamental Research (SFFR) (signed in 2007) and a trilateral one between CNRS, NASU and SFFR (signed in 2009 and renewed in 2012).

The S&T partnership between Germany and Ukraine is based on two main agreements; firstly on the intergovernmental agreement on scientific and technological cooperation, which was concluded in 1987 with the USSR. In 1993 then, Germany and Ukraine as a sovereign state adopted the joint declaration on S&T cooperation. As part of this agreement a joint working group of S&T experts from both countries was established. The last meeting of this working group took place in June 2014 in Kyiv.¹⁸⁶ Furthermore, in 2009 the Germany Ministry for Education and Research and MESU signed a **Memorandum of Understanding (MoU) on joint funding of STI collaboration.** The MoU foresees to establish regular calls for proposals for both sides funded by the two ministries. Other players in charge of promoting and supporting German-Ukrainian research cooperation are the German Academic Exchange Service (DAAD), the German Research Foundation (DFG), the Alexander von Humboldt Foundation (AvH),

183 Erich Rathske: "Comparative Analysis of EU MS/AC policies and programmes towards Ukraine", Deliverable 1.5 in the frame of BILAT-UKR*AINA project, 2014, p. 13

184 If not stated otherwise, all examples taken from Rathske : Comparative Analysis of EU MS/AC policies and programmes towards Ukraine, 2014

185 http://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2004_III_135/COO_2026_100_2_147460.pdf : accessed on 2 May 2016.

186 <https://www.bmbf.de/de/ukraine-368.html> : accessed on 2 May 2016.

the Max Planck Society (MPG) and the German Rectors' Conference (HRK). Each of them maintains specific agreements and/or programmes targeting the cooperation with Ukraine.

The first **Turkish-Ukrainian efforts to channel bilateral partnership in S&T** date back to 1997 when the International Laboratory for High Technology was launched. The laboratory was in operation for 15 years and fed the politically high-level "Joint Action Plan of enhanced cooperation in S&T". The second pillar in S&T cooperation are specific cooperation programmes, which are jointly executed between the Scientific and Technological Research Council of Turkey (TÜBİTAK) and its Ukrainian partners NASU and SASSI (State Agency on Science, Innovation and Informatisation¹⁸⁷). The thematic fields covered within these programmes are not determined and shall be reviewed based on common research priorities.

Ukraine furthermore concluded S&T agreements with 10 Eastern European and Central Asian Countries. Agreements have also been signed with Russia, and several countries in North and Latin America, the Asia-Pacific Region, the Middle East and Africa.

One of the most active roles in international R&D cooperation has the Ukrainian National Academy of Sciences (NASU), which concluded more than 110 bilateral agreements with more than 50 countries in the world. Most of these agreements are signed with other National Academies of Sciences, such as those of Austria, Bulgaria, Germany, Poland, Romania etc. Looking at the number of joint projects with these partner institutions from 2012, Figure 28 shows a high level of bilateral inter-academy activities with Poland, France, Hungary, the Slovak Republic and the Czech Republic.

Country	Number of joint projects
AS Poland	50
CNRS (France)	27
AS Hungary	24
AS Slovak Republic	22
AS Czech Republic	21
AS Bulgaria	13
AS Austria	5
AS Romania	4
Scientific and Technological Research Council of Turkey (TÜBİTAK)	11
AS Serbia	4
AS Montenegro	2

Figure 28: Number of projects jointly supported by NASU and research and/or funding bodies in selected EU MS/AC and other countries; source = BILAT-UKR*AINA deliverable, p.15

187 ... whose operations have been recently transferred back to the Ministry of Education and Research of Ukraine.

8.3. International mobility of Ukrainian research personnel

On the individual level, international mobility of researchers is a crucial prerequisite for increasing the cooperation with other countries and/or regions. By exchanging researchers bi- and multilaterally, not only a knowledge transfer happens but also new joint ideas and knowledge are developed.

In Ukraine, international mobility of researchers is mainly stimulated through international projects, schemes and exchange programmes. Since 2011, the Ukrainian Ministry of Education and Science (MESU) **runs a state mobility programme** promoting the education and training of students and post-graduate students as well as internships for scientific and pedagogical staff.¹⁸⁸

The European Commission supports a wide range of external policy activities aimed at enhancing cooperation in higher education between the EU and third countries. Activities in this field are mainly subsumed under the **Erasmus Mundus programme**¹⁸⁹. Whereas Erasmus Mundus aims to intensify cooperation between EU organisations and higher education institutions from third countries, the **Tempus programme**¹⁹⁰ is dedicated to modernising the higher education sector in third countries by supporting its alignment to the Bologna goals. In both of the programmes Ukraine is an active member and eligible to apply for available funding. The Tempus programme doubtlessly facilitated the internationalisation of Ukrainian higher education institutions and contributed to the initiation of several new research projects and exchange programmes.

Based on data from 2012, Ukraine received funding for 52 scholarships within the Erasmus Mundus Action 1 calls (focussing on individual mobility, scholarships for students, doctoral candidates and scholars).¹⁹¹ This is the historically highest number of awarded scholarships for the country.

Ukraine has also a comparatively high share of awarded Marie Skłodowska-Curie (MCA) projects both in FP7 and Horizon 2020. Only excellent researchers are awarded with such funds. Among all non-EU countries and countries associated to FP7 respectively Horizon 2020, Ukraine is one of the leading countries in terms of participation in MCA. Based on findings of the "BILAT-UKR*AINA" project¹⁹², 107 Ukrainian researchers were funded under the MCA scheme with a financial allocation of about €4m between 2007-2012.¹⁹³ The largest share of funding was allocated to researchers from the fields of nano-sciences and high-tech.

9. FRAMEWORK CONDITIONS FOR R&I AND SCIENCE-BUSINESS OPERATIONS

The level of R&D expenditure (GERD – Gross domestic expenditure on R&D) in Ukraine represented 0.75% of the national Gross Domestic Product (GDP) in 2012 (GERD/GDP), which is less than 37% of the EU-27 ratio at that time. In 2013, the level slightly increased to 0.77%. Also the private expenditure on R&D is considerably low and an outcome of the specific structure of the Ukrainian economy: 2/3 of the Business enterprise expenditure on R&D (BERD) is concentrated in machine-building industries, which re part of the heavy industries sector of Ukraine. Together with other heavy industries like ferrous metallurgy, production of basic chemicals or coal-mining they formed the backbone of the Ukrainian economy. Common to all is a low R&D intensity.¹⁹⁴

9.1. Innovation orientation of the Ukrainian society and economy

The outcome of innovation is notoriously difficult to measure in Eastern European Countries, because they do not participate in the Community Innovation Survey (CIS), although Ukraine does conduct

188 Olena Koval, Vadym Yashenkov et al.: "Overview of the internationalisation of Ukraine in RTDI including recent trends and developments", Policy Brief in BILAT-UKR*AINA project, 2012

189 http://eacea.ec.europa.eu/erasmus_mundus/: accessed on 2 May 2016.

190 <http://eacea.ec.europa.eu/tempus/>: accessed on 2 May 2016.

191 Koval et al.: Overview of the internationalisation of Ukraine in RTDI including trends and developments, p.7

192 <http://www.bilat-ukraina.eu/>: accessed on 2 May 2016.

193 Koval et al.: Overview of the internationalisation of Ukraine in RTDI including trends and developments, p.6

194 UNESCO Science Report 2015, p.336

surveys itself every 2-3 years which are based on the CIS methodology¹⁹⁵, despite difficulties in addressing the business community.

According to the most recent data from the World Economic Forum, Ukraine's "innovation performance" improved compared to past years.¹⁹⁶ Against the backdrop of the general economic environment and business situation of Ukraine today (see chapter 2. on the economic situation for more details), this is a positively surprising fact.

The following table 8 gives an overview on all indicators in the field of innovation as stipulated by the Global Competitiveness Index of the WEF.

Ukraine's performance in the GCI based on the factor "innovation"	GCI 2012-2013: ranking and grade (1-7)	GCI 2013-2014: ranking and grade (1-7)	GCI 2014-2015: ranking and grade (1-7)	GCI 2015-2016: ranking and grade (1-7)
General innovation performance (overall)	71 / 3.2	93 / 3.0	81 / 3.2	54 / 3.4
Capacity for innovation	58 / 3.3	100 / 3.2	82 / 3.6	52 / 4.2
Quality of scientific research institutions	64 / 3.7	69 / 3.6	67 / 3.8	43 / 4.2
Company spending on R&D	104 / 2.7	112 / 2.7	66 / 3.1	54 / 3.4
University-industry collaboration in R&D	69 / 3.6	77 / 3.4	74 / 3.5	74 / 3.5
Governmental procurement of advanced technological products	97 / 3.2	118 / 3.0	123 / 2.9	98 / 3.0
Availability of scientists and engineers	25 / 4.8	46 / 4.5	48 / 4.3	29 / 4.7
PCT patent applications per mln. inhabitants	51 / 2.1	52 / 2.9	52 / 3.2	50 / 3.6

Table 8: Ukraine's performance in the field of innovation, given by indicators stipulated for the field; source = WEF Global Competitiveness Reports 2012 to 2016

According to Table 8 Ukraine progressed mostly in the area of "capacities for innovation". Compared to the ranking for 2014-2015, in which Ukraine occupied the 82nd position, the country ranks 52nd in the current statistics. Hence, Ukraine overtook 30 countries/positions just within a two years development. The progress in "Governmental procurement of advanced technological products" (from 123rd to 98th position) is mainly the result of the on-going anti-corruption policies set in place by the government. However, the statistics of the WEF have to be treated with care, since they often depict great leaps, which are not always comprehensible.

195 Ibid., p.316

196 Schwab: The global competitiveness report 2015-2016. WEF, 2015, p.354

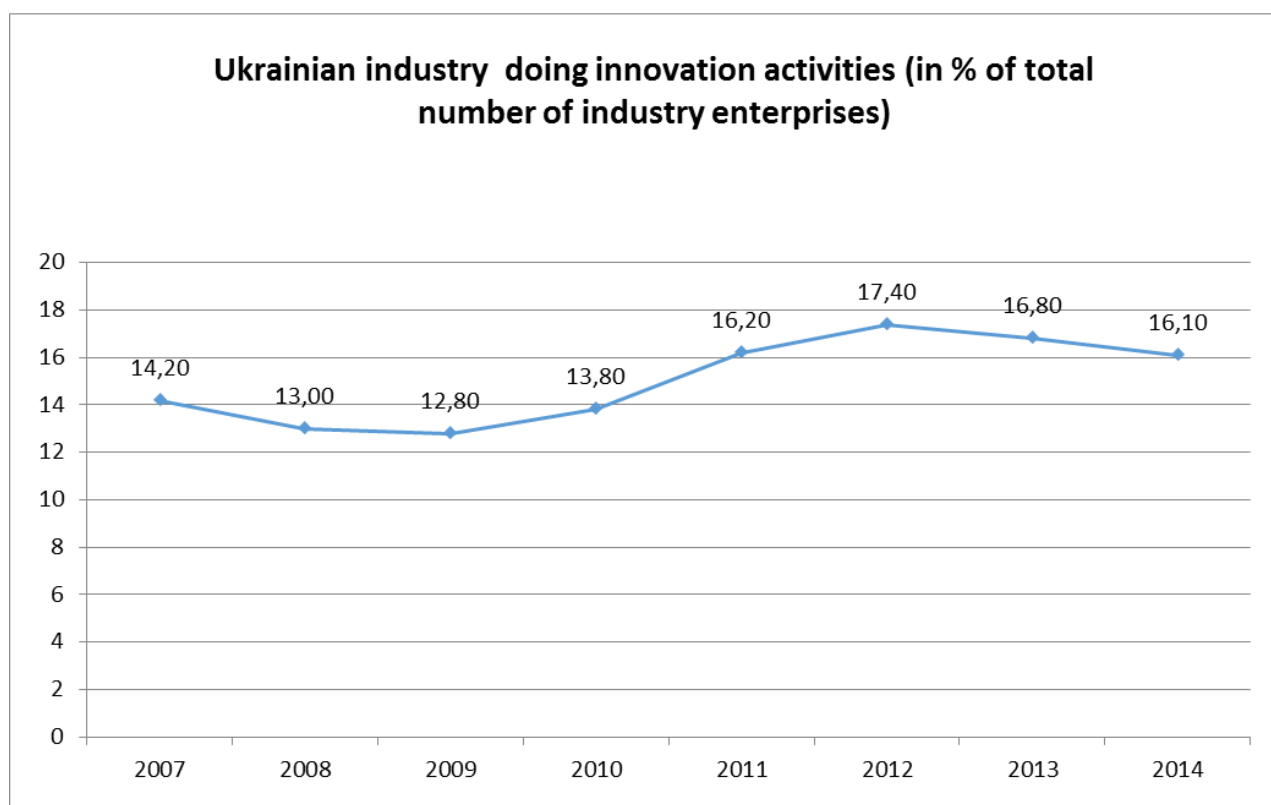


Figure 29: Ukraine's industry enterprises conducting innovative activities, share in % of total number of enterprises; source = Self-assessment report: SCIENTIFIC AND TECHNOLOGICAL SPHERE OF UKRAINE, MESU

Based on the most recent data available from the Ukrainian Ministry of Education and Science, 1,609¹⁹⁷ industrial enterprises were engaged in innovative activities in 2014. This represents a share of 16.10% of the number of industry enterprises, as depicted in Figure 29 above (see also footnote 198). Ukraine experienced a continuous increase in the share of innovative enterprises from 2009 until 2012. Since 2012, the share of innovative enterprises, however, decreased.¹⁹⁸

Out of the 1,609 innovative enterprises in 2014, 1,208 (75.1%) were successful innovators, meaning they introduced innovative products and/or processes. Moreover, 137 of these companies introduced new products to the market, 504 introduced products new to the companies themselves and 164 launched new types of machinery, equipment, appliances, apparatus etc.¹⁹⁹ The total spending on innovation activities by Ukrainian industrial enterprises in 2014 was 7,695,900,000 UAH or 0.5% of the GDP (in 2013 total spending was 9,562,630,000 UAH). The high-tech sector has a significantly higher spending on innovation activities (4.48%) than the mid-tech sector (1.59%).²⁰⁰

Table 9 below provides data on innovation spending in Ukraine from 2000 to 2014 (data are missing for 2001, 2002, 2003, 2004 and 2006). It gives an overview on the total spending on innovation distributed by sources. Furthermore, the relation to GDP is given.

197 According to information provided by Professor Igor Yegorov on 23 May 2016, these enterprises are selected from a sample of approximately 10,000 enterprises. The sample comprises all large and almost all medium-sized companies. The total number of industrial enterprises in Ukraine is approximately 30,000.

198 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p.25

199 Ibid.

200 Ibid., p.27

Spending on innovation in Ukraine	2000	2005	2007	2008	2009	2010	2011	2012	2013	2014
Total funding of innovation, in mio. UAH (rounded)	1,757	5,751	1,082	1,199	7,949	8,045	14,334	11,481	9,562	7,695
in % to GDP	1	1.3	1.5	1.3	0.9	0.7	1.1	0.8	0.7	0.5
including (in % to total funding):										
Self-financing of enterprises	79.6	87.7	73.7	60.6	65.0	59.3	52.9	63.9	72.9	85.0
state budget	0.4	0.5	1.3	2.8	1.6	1.1	1.0	2.0	0.3	4.5
local budgets	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.2	1.6	0.1
extra-budgetary funds	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
national investors	2.8	1.4	0.2	1.4	0.4	0.4	0.3	1.3	1.3	0.1
foreign investors	7.6	2.7	3.0	1.0	19.0	30.0	0.4	8.6	13.1	1.8
loans	6.3	7.1	18.5	33.7	11.8	7.8	38.3	21.0	6.6	7.3
other sources	1.3	0.3	3.2	0.4	2.1	1.3	6.9	3.0	4.2	0.8

Table 9: Spending on innovation in Ukraine, total numbers as % of GDP and per source; source = Self-assessment report: Scientific and technological sphere of Ukraine, MESU

According to the Ukrainian Ministry of Education and Science, the largest share of innovative activities seems to occur in the food production sector. This sector accounts for 17.1% of the total number of innovative enterprises. The machinery and machinery equipment production sector accounts for 9.6%, the sector for the fabrication of metal products accounts for 5.4% and the sector for manufacturing of chemicals and chemical products accounts for 4.7%.²⁰¹

The share of innovation related activities in technology-producing enterprises is much higher than on average level. The share in the high-tech sector is 37.6%, and in the mid-tech sector 21.1%. The average level based on the overall industry sector is 16.10%, as previously shown in Figure 29. Within the technology-producing sector, the following industries show the highest innovation shares: aircraft, spacecraft and related equipment (56.7%), arms and ammunition (50.0%) and basic pharmaceutical products plus pharmaceutical drugs (38.2%).²⁰²

A similar picture is shown in terms of innovation funding received per industrial sector, as presented in Figure 30. Also in attaining money for innovation activities, the food production sector (as a single sector) ranks first in 2014. It received 24.20% of the total innovation funding spent on industries in Ukraine in this year. Second ranks the production of machinery and related equipment with 14.40% of total funding received in 2014. Least innovation funding went to the metallurgical industry (4.40%).²⁰³

201 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p.26

202 Ibid., p.27

203 Ibid., p.30

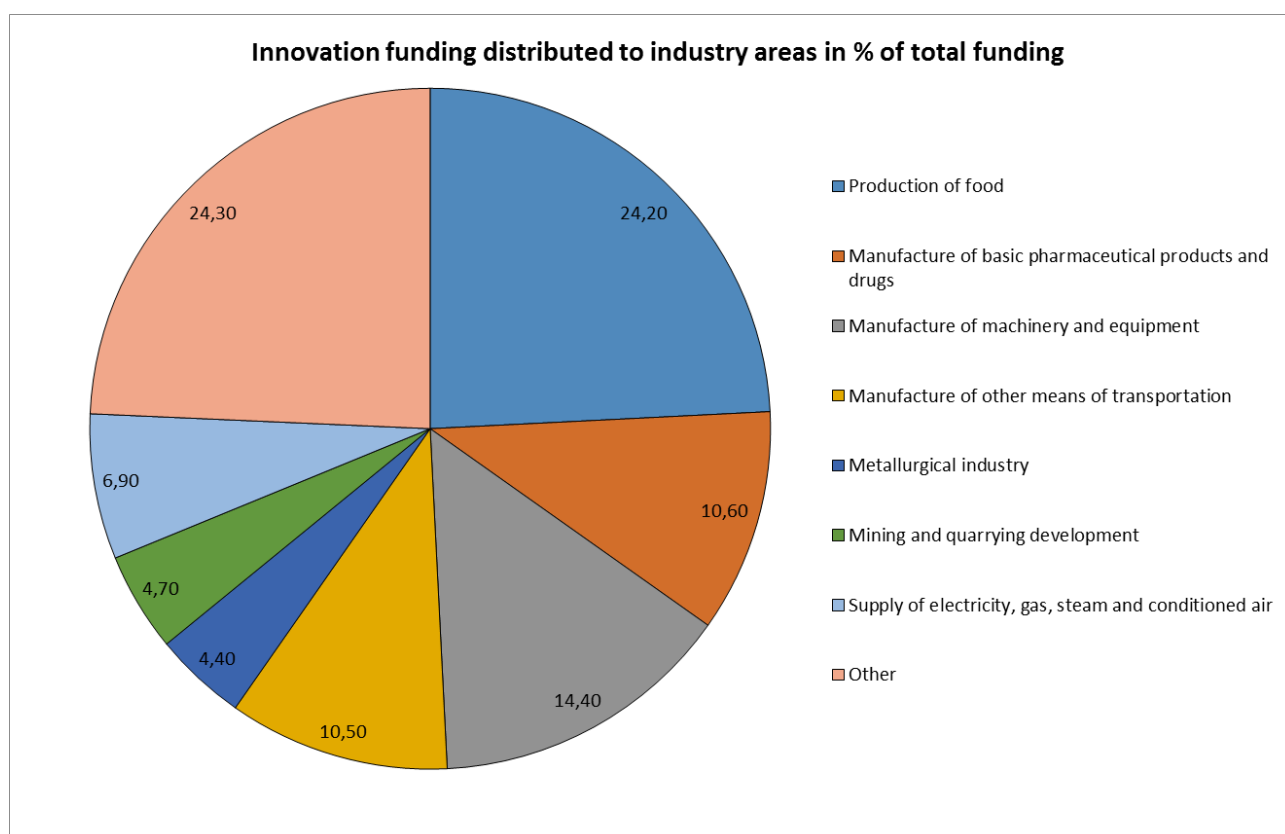


Figure 30: Innovation funding in Ukraine in 2014, distributed to industrial sectors and given in % share of total innovation funding; source = Self-assessment report: Scientific and technological sphere of Ukraine, MESU

9.2. General policy environment for business and access to finance

Ukraine's state policies aim at strengthening the hardly effective interaction within the research sector itself (universities with public research organisations such as NASU institutes) and between the research sector and industries. Among all launched strategies (development of research infrastructures for common use by different research organisations, creation of special organisations to exploit research results for technology transfer, introduction of grants to promote R&D cooperation between universities and PROs etc.), the establishment of so-called "techno-parks" was considered to be the most successful. However, among the techno-parks solely two of them can be labelled as "innovative". One is the Paton Institute of Electric Welding, the other the Institute of Mono-crystals. Between 2000 and 2011 they together covered more than 95% of all innovative production triggered by Ukrainian techno-parks.²⁰⁴

Despite the fact that Ukraine has created and operates specific entities entitled to carry out innovation activities, the effectiveness of most of these entities (with the exceptions of the already mentioned two techno parks) remains rather low. To put it into numbers, over the course of the last years Ukraine has established 12 technology parks, 17 science parks, 28 business incubators, 25 innovation centres, 9 centres for science, innovation and information, several operating units on IP at higher education institutions and a dedicated Ukrainian institute of scientific and technical expertise and information.²⁰⁵ Even if the quantity of innovative institutions seems fairly sufficient, there is still much space for improvement on the performance level.

One of the drivers to stimulate innovation (innovative products, technologies, technical solutions etc.) is a vivid cooperation within the so-called **"knowledge triangle" between universities – PROs – business**.²⁰⁶ Simply said, the more these three sectors cooperate in exchanging both tangible (products,

204 Yegorov, ERAWATCH Country Reports 2012: Ukraine, 2013, p.22

205 Self-assessment report: Scientific and technological sphere of Ukraine, MESU, 2016, p.32

206 Yegorov, ERAWATCH Country Reports 2012: Ukraine, 2013, p.4

technologies, applications etc.) and intangible goods (knowledge, behaviour), the higher is the chance that somewhere in this circular flow innovation will happen. The exclusive focus of the Ukrainian government on state-owned entities within the knowledge triangle seems however problematic. The tradition to support only state-owned institutions is kept alive. Direct state support goes to the six national academies of sciences, state-owned companies and state-owned universities. It is evident that such policies have no or only minimal impact on Ukrainian private companies conducting R&D. Neither supported are multinational companies, which tend to bring innovative knowledge to the local Ukrainian market and with whose support innovation activities in Ukraine could be enhanced. The consequences in practice are that Ukrainian researchers are working for private foreign or domestic clients on contracts which are not officially registered by their employers.²⁰⁷

Regarding the policy environment for business and innovation, the main concern is the lack of coordination between research policies and economic promotion policy. Whereas research policies solely focus on the quality of (state-) academic research, economic policies until very recently targeted the Ukrainian market and localisation conditions only. A lack of coordination is also evident when looking at the **interplay between Ukraine's federal government and its regional bodies**. At the regional level, no comprehensive governance system for R&D exists. While few of the regional governance bodies have created special departments for STI policies, the majority however is lagging behind in this aspect. No data, however, are available as regards the performance of the regional R&D support departments.²⁰⁸

Financial frictions are particularly detrimental for start-ups, SMEs and firms in the service sector, which face difficulties collateralizing investments and innovation activities.²⁰⁹ These particularly affect domestically owned firms that depend on the domestic financial system. In Ukraine, around 40% of business founders report difficulties in accessing finance. While substantial, this is around half the level in Azerbaijan, Mongolia, Turkey, Georgia, Kazakhstan and Kyrgyzstan.²¹⁰ The funding gap is even more pronounced for R&D performing companies in transition economies. In Ukraine, around 80% of companies surveyed said that inadequate own finances limited their innovation activities, while 54% identified inadequate state financial support.²¹¹

In Ukraine, the majority of funds for innovation activities come from the enterprises' own resources. In 2011, enterprises contributed 53% of innovation expenditures, although this was much lower than the 72% average over the period 1998-2011, and sharply down from a peak of 88% of innovation expenditures in 2005. The decline in the share of own resources for innovation activities was accompanied by increases in financing from foreign sources and banks. The average contribution of banks to innovation financing over 1998-2011 stood at 14% but has been highly variable – as high as 38% in 2011, but only 7.8% in 2010, for example. Foreign investors financed a substantial share of innovation expenditures in 2009 and 2010, corresponding to large investment inflows in the chemical sector. The low share of state and local budgets (around 1-2%) is remarkable by international standards, and shows very limited public support for innovation financing.

Despite the financial crisis which severely affected the banking system in Ukraine, there is evidence that finance is less of a constraint for enterprises compared to other features of the Ukrainian business environment (e.g. corruption, access to land, tax administration). Ukraine ranked in 23rd position for "Getting Credit" in the World Bank's Doing Business survey in both 2012 and 2013.²¹² However, this is at the aggregate level, and may mask significantly different conditions for start-ups and SMEs.

While the bulk of SME financing in Ukraine comes from banks, credit unions and pawnshops, there are government supported credit guarantee schemes in place targeting energy efficiency and competitiveness, which are open to SMEs. Specifically for SMEs are national programmes of support

207 Yegorov, ERAWATCH Country Reports 2012: Ukraine, 2013, p.23

208 Ibid., p.31

209 D. Czarnitzki and H.L. Binz (2008), R&D Investment and Financing Constraints of Small and Medium-Sized Firm, ZEW Discussion Papers 08-047, ZEW – Zentrum für Europäische Wirtschaftsforschung / Center for European Economic Research, Mannheim.

210 See E. Nikolova, F. Ricka, D. Simroth (2012), Entrepreneurship in the transition region: an analysis based on the Life in Transition Survey, EBRD Working Paper No. 141, London.

211 I. Yegorov, Innovation Policy and Problems of Creation and Development of the National Innovation System in Ukraine, Centre for S&T Potential and Science History Studies, National Academy of Sciences of Ukraine, paper presented to second session of the UNECE Team of Specialists on Innovation and Competitiveness Policies, Geneva, 14-15 February 2008, quoted from UNECE Innovation Performance Review Ukraine (2013).

212 <http://www.doingbusiness.org/data/exploretopics/getting-credit> : accessed on 2 May 2016.

implemented by the State Export-Import Bank of Ukraine (Ukreximbank), including preferential financial support provided by the Ukrainian Fund for Entrepreneurship Support (UFES). The Law on Mandatory State Social Unemployment Insurance provides a lump sum allowance for unemployed members of the workforce starting their own business.²¹³ At present (april 2016), however, there is no public institution with a specific mandate to support innovative enterprises or start-ups in Ukraine.²¹⁴ The absence of dedicated support to innovative SMEs can be explained by the ongoing fiscal consolidation drive, together with general reluctance to commit resources to this area given problems with past schemes (including corruption). The not anymore existing State Agency for Science, Innovation and Informatization was leading work to secure the authorized capital for a Fund to support small innovative businesses.²¹⁵

SMEs access to finance has been and continues to be an area of focus for major international financial institutions, including the International Finance Corporation (IFC), the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD). Typically, resources are provided to local banks for on-lending to SMEs under different programmes in areas of importance for Ukraine's economic catch-up.²¹⁶

Based on various sources (data from official sources as well as from the Ukrainian Association of Investment Business (UAIB), specific survey and case studies), there are estimated to be around 700 venture funds in Ukraine.²¹⁷ Total assets in these funds were slightly less than €2 billion in 2009. Analysing the structure of target companies – mostly brokers, consultancies, construction, and trade – reveals that these venture capital funds (VCs) are overwhelmingly vehicles for acquiring or managing equity stakes in companies. However, closer analysis reveals some evidence of real venture capital flows,²¹⁸ although venture funds supporting innovation tend to be of foreign origin, with domestic funds predominantly focused on real estate and related areas. However, figures on investments are scarce, with detailed documentation and analysis even scarcer.

Development of the Ukrainian VC infrastructure is held back by an incomplete legal framework, for example in relation to taking minority stakes in businesses or the introduction of option schemes. Consequently, a number of funds and even enterprises that received VC investments are registered abroad. Besides these VC specific issues, more general difficulties of doing business in Ukraine increase the risk of failure for start-ups.²¹⁹

9.3. Knowledge markets and knowledge and technology transfer

Ukraine is associated to all international key agreements on IPR (Intellectual Property Rights). A state agency on IP²²⁰ is in force, which collects patent data. This agency SIPS (State Intellectual Property Service of Ukraine) is entitled as a copyright and industrial copyright office for patent registrations. The second industrial copyright office is the Ukrainian Intellectual Property Institute²²¹. Some universities and state-sponsored academies of sciences also have own offices for the commercialisation of knowledge.

Figure 31 shows the number of total patent applications in Ukraine from 2000 to 2014, based on data from the World Intellectual Property Organisation (WIPO).²²² The numbers cover only those patent applications, which were made to the Ukrainian patent registration offices. Thus, they do not give any information on those Ukrainian patent applications, which were filed in a foreign patent office. Most patent applications were filed in 2001 (8,818 patent applications were made in total). In 2002 and 2003 Ukraine faced a noticeably decrease in national patent applications. The reasons for this are unclear.

213 EU, ETF, EBRD, OECD (2012), SME Policy Index Eastern Partner Countries 2012: Progress in the Implementation of the Small Business Act, quoted from UNECE Innovation Performance Review Ukraine (2013).

214 This seems to change during 2016.

215 UNECE Innovation Performance Review Ukraine (2013).

216 UNECE Innovation Performance Review Ukraine (2013).

217 O. Krasovska (2012), Does venture capital in Ukraine really support high technology investments?, International Journal of Economics and Law Vol. 2, No. 4, pages 55-59, quoted from UNECE Innovation Performance Review Ukraine (2013).

218 Ibid.

219 UNECE Innovation Performance Review Ukraine (2013).

220 State Intellectual Property Service of Ukraine: <http://sips.gov.ua/en> : accessed on 2 May 2016.

221 <http://www.uipv.org/en/> : accessed on 2 May 2016.

222 http://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=UA : accessed on 2 May 2016.

From 2004 onwards patent applications evened out somewhere between 5,000 and 6,000 applications/year roughly.

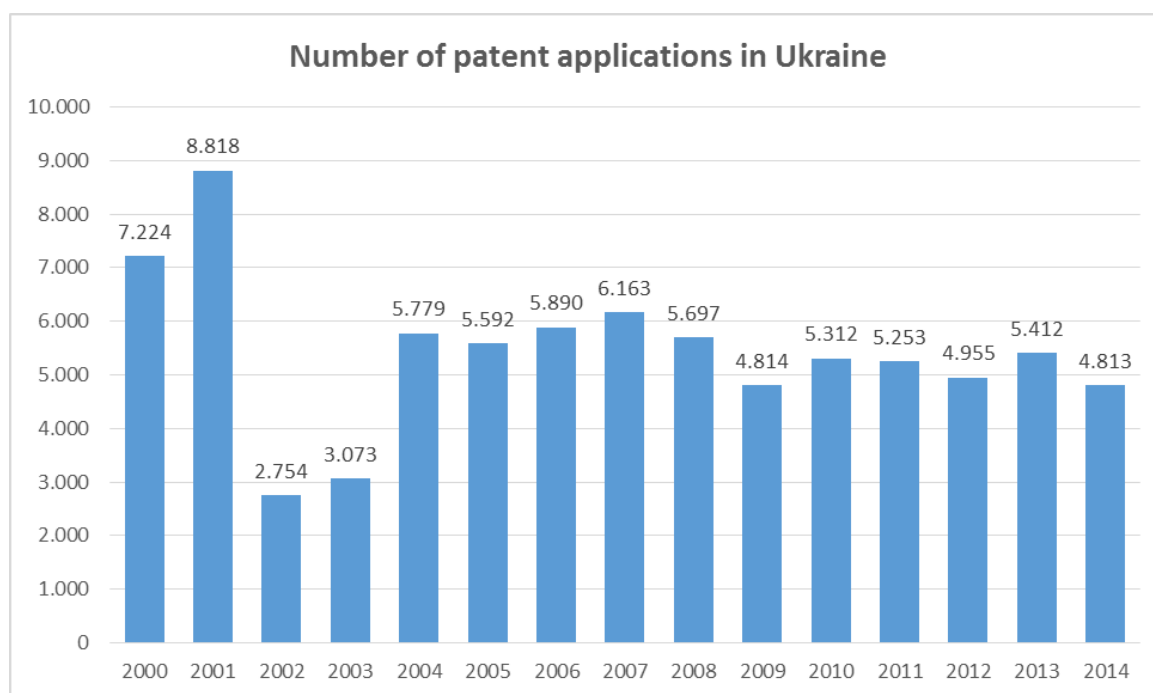


Figure 31: Total number of patent applications (in thsd.) in Ukraine from 2000 - 2014; source = WIPO (World Intellectual Property Organisation)

The difference between national and international patent applications, shown in the next two figures, must be explained more in detail. In the world of patents the major difference on the scope of application validity and protection varies with the format of intellectual protection. First option is to make a patent application to a national patent filling office. These applications are called “**nationally filed patent applications**”. A nationally filed and granted patent is protected only in the country to which the application was made. Figure 32 below shows such data on patent applications by Ukrainian inventors to national patent filling offices worldwide. From the figure excluded are Russia and Ukraine itself, as the number of patent applications to their respective offices is proportionally much higher, what, at the other end, would distort the overview below. Therefore, the patent applications to Russia and Ukraine follow separately.

By combining Figure 32 (patent applications to national offices worldwide excluding Russia and Ukraine from 2003-2013) and Figure 33 (patent applications to national offices in Russia and Ukraine only from 2003-2013), the following results can be obtained (all data is gained from EPO PATSTAT online database²²³): Most nationally filed patent applications from Ukraine-based inventors were made to the patent authorities in their home country, summing up to 12.879 applications in total. With Russia (2.100) comes a country next, whose economic, political and cultural ties historically are very much connected to Ukraine. Also the common use of Russian is probably a push-factor for Ukrainian applicants. Moving more westwards, third most applications were made to the US (223). The list of the top-5 countries is completed by South Korea (136) and Poland (68).

223 <https://data.epo.org/expert-services/index-2-2-6.html> : accessed on 3 May 2016.

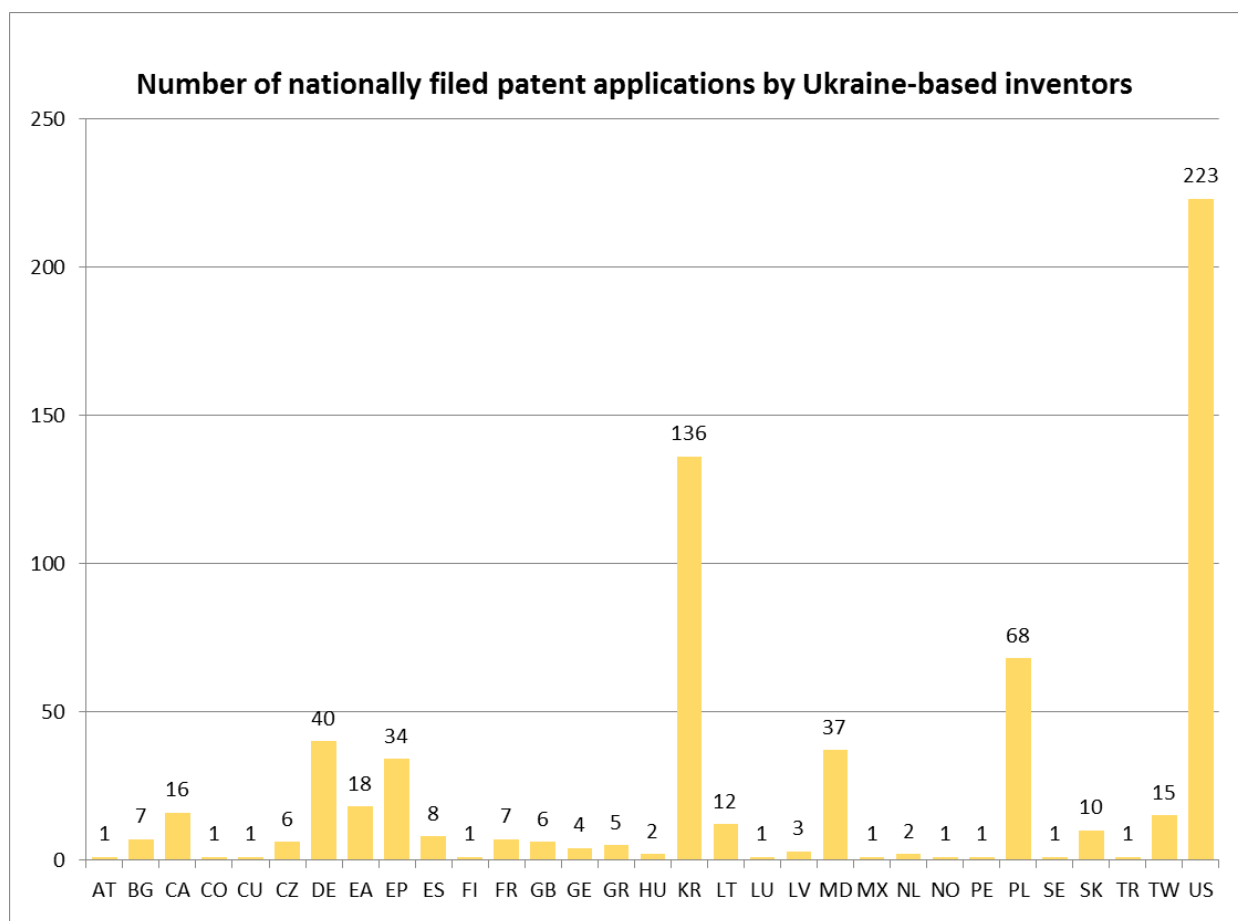


Figure 32: Total number of nationally filed patent applications worldwide by Ukraine-based inventors from 2003-2013; source = PATSTAT by EPO (European Patent Office)

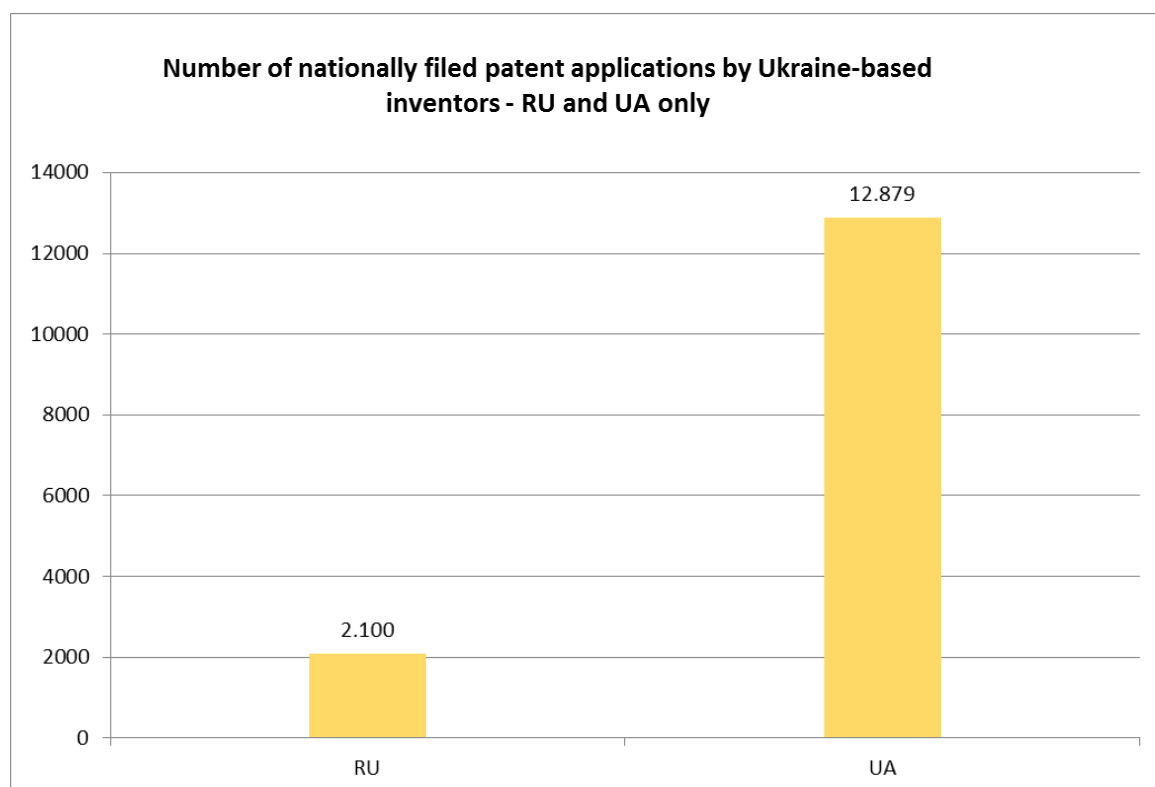


Figure 33: Total number of nationally filed patent applications in Russia and Ukraine only by Ukraine-based inventors from 2003-2013; source = PATSTAT by EPO

Apart from nationally filed patent applications, an inventor can also apply for an international protection for his or her invention. These applications are usually made under the Patent Cooperation Treaty (PCT), introduced and executed by the World Intellectual Property Organisation (WIPO).²²⁴ Such applications are called “**PCT filed patent applications**”.

Currently 148 countries are contractual partners within the PCT. Ukraine is a member since 1991. When applying for a PCT protection, an inventor must decide in how many of the 148 countries he or she seeks protection. The underlying conditions applicable to this process are simple: The higher the number of countries in which the invention shall be protected, the more has to be paid. Figure 34 below shows the number of patent applications under the PCT by Ukraine based inventors from 2003 to 2013. It illustrates in which countries Ukraine based inventors applied for a PCT protection for their invention. Unfortunately, no data are provided on the number of countries the Ukrainian inventors sought for protection when applying for a PCT filed patent.

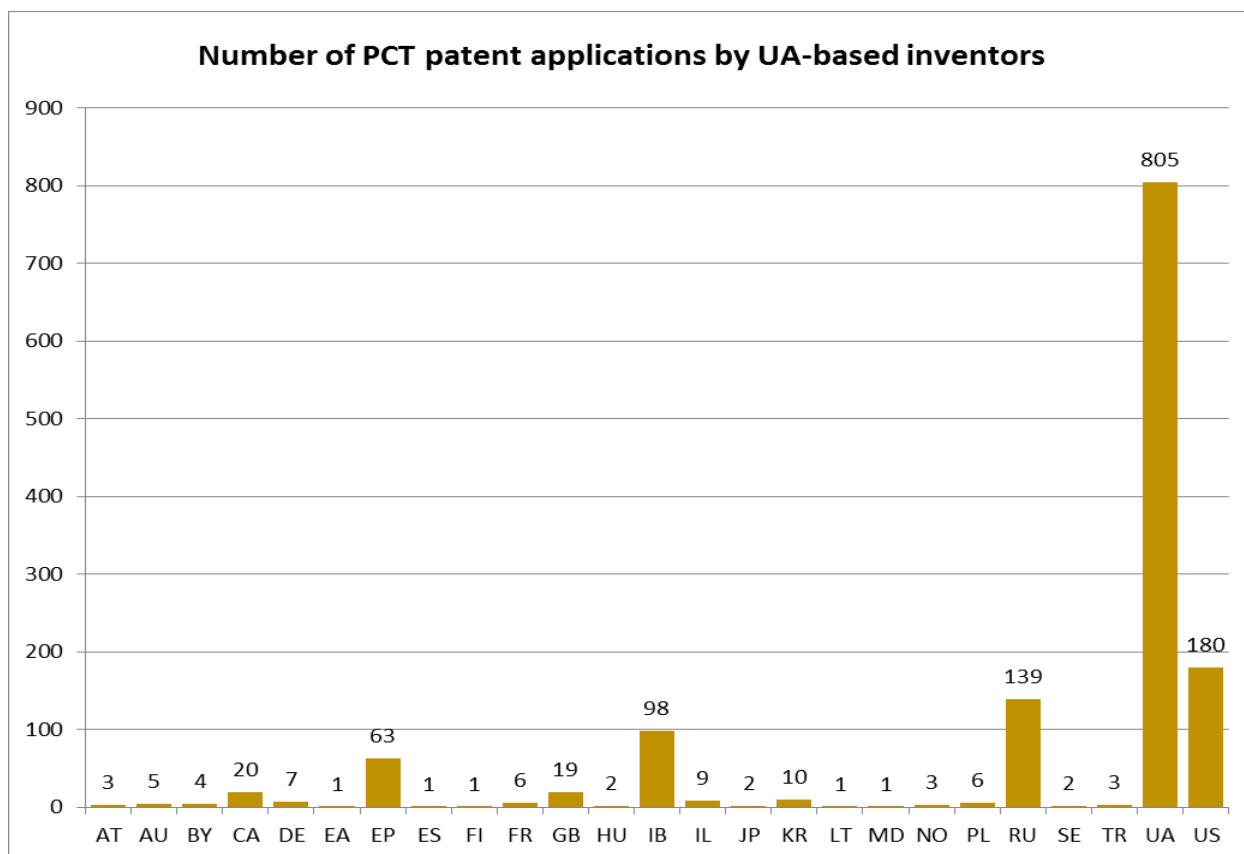


Figure 34: Number of PCT patent applications by UA-based inventors from 2003 to 2013, distributed by countries; source = PATSTAT by EPO

As Figure 34 above shows, Ukraine itself is the most popular country for PCT patent applications among Ukraine based inventors. Both for national (under a national patent office) and international protection (under PCT), most patent applications were made to the Ukrainian patent authorities. In Ukraine exactly 805 PCT patent applications were made, followed by the US (180) and Russia (139). PCT protected applications have not only to be submitted to national patent offices: “International offices” such as the International Bureau (IB) of WIPO (World Intellectual Property Organisation) or the European Patent Office (EP) also accept PCT applications. The IB received 98 Ukrainian applications, the EP 63.²²⁵

In general, Ukraine has only very few patents recognised in the EU or in the USA compared to other, even smaller countries in the region. The major reasons for that are the weak integration of Ukrainian enterprises in global value chains and the relatively high patenting costs abroad. This is also why most PCT filed applications were not made in a foreign country but Ukraine.

224 <http://www.wipo.int/pct/en/> : accessed on 2 May 2016.

225 Data also from EPO-PATSTAT online database: <https://data.epo.org/expert-services/index-2-2-6.html> : accessed on 3 May 2016.

9.4. Young innovative companies and start-ups

Policy framework conditions are the most influential factor for a sustainable development of innovative young companies and start-ups. Only if such companies can operate in a beneficial environment and manage to establish themselves on the domestic market, they can become powerful enough to again shape those policies, relevant for them. This, on the whole, creates a circle of policy making and intervention. That is why authorities should make focused and sustained efforts to improve the legal environment for start-ups, SMEs and innovative young companies. Some call it the “chicken-egg-problem”, as a lack of innovation infrastructure or intermediaries can prevent new innovative companies from emerging, and at the same time the lack of new innovative young companies can limit the prospects for such infrastructure and intermediaries to be sustainable.²²⁶

In 2007 a law was introduced by the Ukrainian government aiming to promote the creation of spin-offs (independent small companies) by universities. Soon after the introduction of this law the economic crisis hit Ukraine in 2008/2009, causing a general cut in state budgets. Another official attempt to support the creation of new innovative companies are joint “business-start-up-centres”, which were launched as a programme by the government back in the 1990s and which ran until 2011.²²⁷ The creation of the first business-start-up-centres was stimulated with money from international donors, such as USAID or the Open Society Foundations by George Soros. In 2003 the “Ukrainian Business Incubators and Innovation Centre Association” (UBICA) was created. UBICA supported entrepreneurial development programmes with a focus on incubators, technology parks and other relevant infrastructures for innovation (among them, legislative framework for setting up start-up companies). Based on data available online, UBICA was running only from 2003 until 2005 though.²²⁸

Innovative companies and SMEs in general face particular difficulties when trying to raise finance, which remains a critical obstacle when starting a business. Support programmes for SMEs are very limited and there were no public interventions targeting start-ups in general in Ukraine until mid 2016. The limited public resources and previous unsuccessful attempts to stimulate innovation by offering financial incentives help in explaining the absence of financial mechanisms to encourage the development of innovative young enterprises. There is clear evidence that SMEs and start-ups in particular, have insufficient access to external financial resources due to the risk aversion of banks and limited presence of business angels and venture capitalists²²⁹ – a fact, which, apart from the lacking policy environment, could be seen as the second major problem for initiating the creation of start-ups in Ukraine. Additionally, bureaucracy is a more significant problem than in most transition countries, while bribery and the threat of competitors are lesser concerns for start-ups in Ukraine.²³⁰

Despite this hindering policy environment, Ukraine has some entrepreneurial talent with a relatively strong individual risk-taking attitude. The question is, whether the talent available in the country reaches a critical mass to intervene in policy making for better supporting innovative entrepreneurship. One of the sectors where start-ups are most prevalent in Ukraine is the IT sector. As a sector, where mainly young educated people work in and which often has low entry costs, this is a beneficial precondition for the unfolding of entrepreneurial talents.

The incidence of successful business start-ups is driven by two factors: the proportion of the population attempting a start-up, and their likelihood of success. While the percentage of individuals starting an enterprise in the region’s transition countries does not differ significantly from advanced economies, the likelihood of success is markedly lower. The result is a generally lower incidence of successful start-ups in transition countries when compared to a Western European average of almost 16%. In Ukraine, only around 5% of all respondents reported having successfully set up a business, ranking 25th among 29

226 UN, Innovation Performance Review Ukraine 2013, p.12

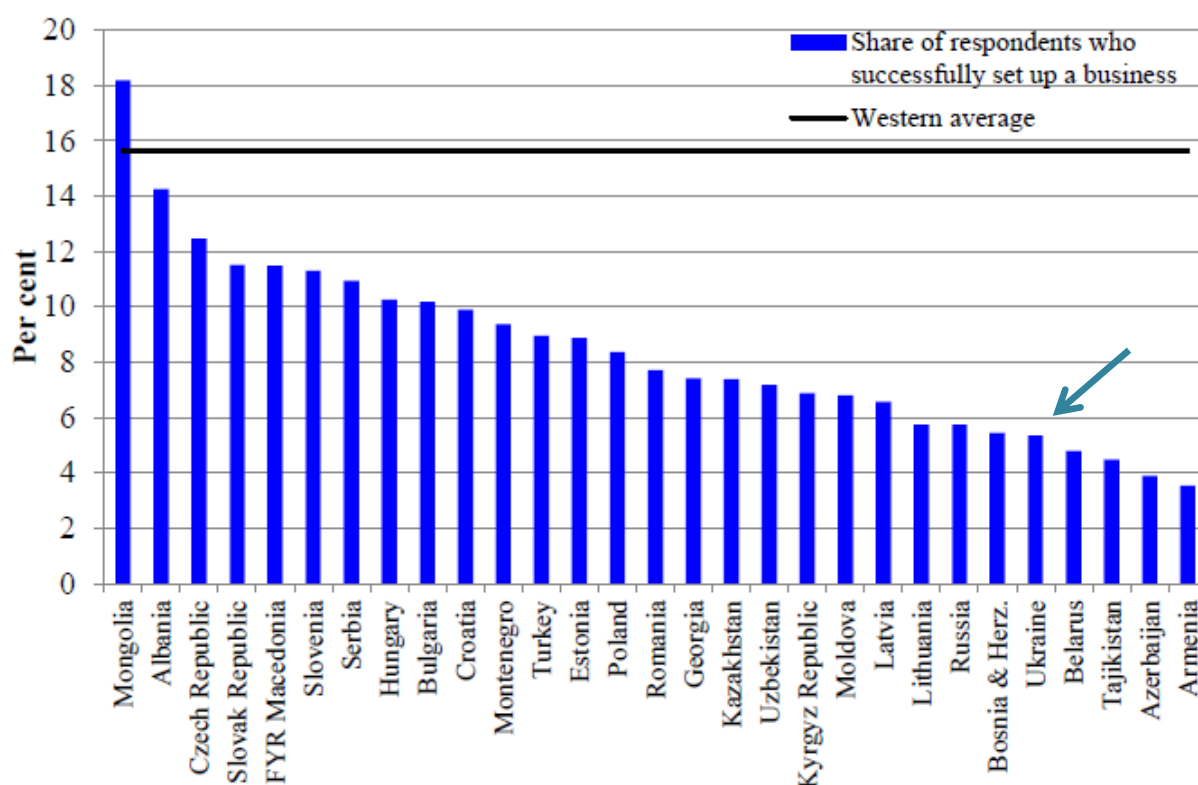
227 Breitfuss, Marinkovic, Machacova et al.: “Identifikation und Analyse der Forschungsprioritäten und der davon abgeleiteten FTE-Programme in Bosnien-Herzegowina, Mazedonien, Serbien, Türkei und Ukraine zur Ermittlung von Kooperationspotentialen für Forschung Austria Mitglieder”, Joanneum Research & ZSI – Centre for Social Innovation, Wien/Graz, 2011, p.79

228 Ibid., p.82

229 UN, Innovation Performance Review Ukraine 2013, p.80

230 See E. Nikolova, F. Ricka, D. Simroth (2012), Entrepreneurship in the transition region: an analysis based on the Life in Transition Survey, EBRD Working Paper No. 141, London, cited in: UN, Innovation Performance Review Ukraine 2013, p.80

countries.²³¹ Figure 35 below provides details on the share of respondents who successfully set up a business in Ukraine and selected other countries. When interpreting these figures it has to be noted, that the current Ukrainian legal framework facilitates entrepreneurs to register as individuals as opposed to companies, and so actual levels of successful “start-up” may be higher than the numbers would suggest.



Source: Analysis by Nikolova, Ricka, and Simroth (2012) based on EBRD Life in Transition Survey (2011).

Note: Western comparator countries taken as France, Germany, Italy, Sweden and UK.

Figure 35: Successful business start-ups (share of respondents in %); source = Snapshot from UN Innovation Performance Review Ukraine, 2013

Effective policy actions that would improve this low survival rate of start-ups in Ukraine would contribute to employment, diversification of the industrial structure and stimulation of competition. Regarding venture capital, the UN review on innovation in Ukraine makes some positive statement, in saying that Ukraine has an emerging venture capital scene, which indicates the presence of entrepreneurial opportunities in the country.²³² Venture capital is an important ingredient of the innovation system.²³³ Still, the development of the venture capital industry requires the presence of other financial intermediaries and business services.

It also has to be noted, that a business environment conducive to a thriving market economy also needs to fight corruption and the oligarchic ownership and control structures. *"No traditional STI policy initiative can expect to have a decisive impact on private sector R&D if the business environment remains largely hostile to the emergence of new enterprises and market-based challenges to existing power relations"* (UNESCO Science Report 2015, p. 29).

231 UN, Innovation Performance Review Ukraine 2013, p.75

232 Ibid., p.xvii

233 https://www.unido.org/uploads/tx_templavoila/Strategies_for_regional_innovation_systems.pdf : accessed on 3 May 2016.

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ANNEXES

Annex 1

Year	UA publications	UA int. co-publications	UA-EU28/AC co-publications
2003	7,257	2,279	1,563
2004	7,683	2,449	1,649
2005	8,232	2,627	1,745
2006	7,650	2,655	1,826
2007	7,890	2,855	1,964
2008	8,469	2,814	1,926
2009	8,302	2,870	1,883
2010	8,936	3,009	1,976
2011	9,364	3,272	2,172
2012	9,912	3,316	2,280
2013	10,440	3,549	2,394T

Development of Ukrainian publications/international co-publications(UA-EU28/AC co-publications, 2003-2013 (Source = WoS+Scopus)

Annex 2

Country	No. of co-publications with Ukraine	Average no. of countries involved	Average no. of authors involved
Germany	6,846	5.77	131.96
Russia	6,743	5.58	134.34
USA	6,684	5.79	135.71
Poland	4,872	6.48	178.93
France	3,780	7.87	227.68
Great Britain	3,176	9.02	273.59
Italy	2,359	11.65	373.93
Spain	1,917	13.20	451.15
Japan	1,448	6.53	82.05
Switzerland	1,327	15.94	631.09
South Korea	1,205	15.57	630.69
Czech Republic	1,185	14.00	520.41
Austria	1,166	14.50	595.03
Sweden	1,126	6.47	82.35
Netherlands	1,110	10.10	192.48
Belgium	1,095	15.77	624.42
Mexico	1,082	15.72	674.78
China	1,014	19.25	822.92
Finland	941	18.41	777.18
Canada	937	5.63	38.86

20 most involved countries in Ukraine's international co-publications, 2003-2013 (Source = WoS+Scopus)

Annex 3

	Physics & Astronomy	Enabling & Strategic Technologies	Engineering	Chemistry	Information & Communication Technologies	Clinical Medicine	Mathematics & Statistics	Biomedical Research	Earth & Environmental Sciences	Economics & Business	Biology
UA publications in 2003	2,200	1,315	963	897	521	324	294	274	192	10	133
UA publications in 2013	2,755	1,698	1,023	869	1,059	708	620	368	164	555	213
Growth	25.23%	29.13%	6.23%	-3.12%	103.26%	118.52%	110.88%	34.31%	-14.58%	5450.00%	60.15%
UA+EU28/AC co-publications in 2003	801	170	63	175	17	65	84	66	51	1	32
UA+EU28/AC co-publications in 2013	984	301	122	223	98	154	155	94	65	10	72
Growth	22.85%	77.06%	93.65%	27.43%	476.47%	136.92%	84.52%	42.42%	27.45%	900.00%	125.00%

Annual output and growth from 2003 to 2013 in UA publications and UA+EU/AC co-publications, 2003-2013 (Source = WoS+Scopus)

Annex 4

Science Metrix fields (most important)	UA-DE co-publications	share	UA-PL co-publications	share	UA-FR co-publications	share	UA-UK co-publications	share	UA-IT co-publications	share
Physics & Astronomy	3,629	53.40%	2,362	48.81%	1,858	49.52%	1,511	48.12%	1,474	63.26%
Chemistry	793	11.67%	530	10.95%	389	10.37%	168	5.35%	101	4.33%
Enabling & Strategic Technologies	660	9.71%	526	10.87%	402	10.71%	263	8.38%	139	5.97%
Clinical Medicine	398	5.86%	229	4.73%	264	7.04%	338	10.76%	187	8.03%
Mathematics & Statistics	318	4.68%	298	6.16%	123	3.28%	99	3.15%	105	4.51%
Engineering	268	3.94%	244	5.04%	138	3.68%	123	3.92%	71	3.05%
Biomedical Research	164	2.41%	179	3.70%	168	4.48%	205	6.53%	68	2.92%
Earth & Environmental Sciences	159	2.34%	104	2.15%	113	3.01%	77	2.45%	58	2.49%
Information & Communication Technologies	126	1.85%	92	1.90%	114	3.04%	97	3.09%	28	1.20%
Biology	113	1.66%	101	2.09%	48	1.28%	83	2.64%	39	1.67%

Top 10 Science Metrix fields of the most involved EU28/AC partner countries in UA co-publications, 2003-2013, part 1 (Source = WoS+Scopus)

Science Metrix fields (most important)	UA-ES co-publications	share	UA-CH co-publications	share	UA-CZ co-publications	share	UA-AT co-publications	share	UA-SE co-publications	share
Physics & Astronomy	1,226	64.59%	889	67.71%	731	62.27%	700	60.61%	519	46.22%
Chemistry	68	3.58%	45	3.43%	59	5.03%	40	3.46%	49	4.36%
Enabling & Strategic Technologies	131	6.90%	89	6.78%	104	8.86%	84	7.27%	89	7.93%
Clinical Medicine	133	7.01%	95	7.24%	68	5.79%	102	8.83%	128	11.40%
Mathematics & Statistics	128	6.74%	31	2.36%	38	3.24%	57	4.94%	43	3.83%
Engineering	37	1.95%	--	--	27	2.30%	29	2.51%	33	2.94%
Biomedical Research	44	2.32%	34	2.59%	42	3.58%	22	1.90%	90	8.01%
Earth & Environmental Sciences	30	1.58%	21	1.60%	16	1.36%	43	3.72%	53	4.72%
Information & Communication Technologies	--	--	20	1.52%	16	1.36%	--	--	--	--
Biology	32	1.69%	19	1.45%	42	3.58%	24	2.08%	28	2.49%

Top 10 Science Metrix fields of the most involved EU28/AC partner countries in UA co-publications, 2003-2013, part 2 (Source = WoS+Scopus)

Annex 5

	Ukraine publications average citations per field 2003-2013
Physics & Astronomy	5,72
Enabling & Strategic Technologies	2,52
Engineering	1,71
Information & Communication Tech	0,51
Chemistry	4,72
Clinical Medicine	5,51
Mathematics & Statistics	2,05
Biomedical Research	5,46
Economics & Business	0,51
Earth & Environmental Sciences	4,49
Biology	3,56
Social Sciences	0,85
Historical Studies	3,7
General Science & Technology	10,85

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It supports Member States and countries associated to Horizon 2020 in reforming their national science, technology and innovation systems.

This report summarises evidence on the situation in the field of science, technology and innovation (STI) in Ukraine and provides a background for the PSF Peer Review of Ukraine's research and innovation system, conducted in 2016 by a panel of independent experts and national peers.

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