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Background Report

Peer Review of the Polish Research and Innovation System

Horizon 2020 Policy Support Facility

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Directorate-General for Research & Innovation
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Peer Review of the Polish Research and Innovation System

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1 EXECUTIVE SUMMARY

The report aims to summarise evidence on the situation in the field of research, higher education and the innovation system in Poland to provide background for the Horizon 2020 Policy Support Facility Peer Review of Poland's research and innovation system. This Peer Review, requested by Poland's Ministry of Science and Higher Education, is being implemented by a panel of independent experts and national peers in 2017.

Twenty-eight years after an historical socio-economic experiment and transformation into the market economy, and 13 years after joining the European Union (EU), Poland is recognised as one of the most successful examples of the economic transition in the region. Between 1990 and 2015, Polish gross domestic product (GDP) per capita increased more than seven times – from USD 1731 (in current prices) to USD 12 500. This was the most impressive growth of any of the Organisation of Economic Co-operation and Development (OECD) and EU countries[1]. Moreover, during the last global crisis, Poland was the only EU economy to show continued growth in its GDP.

Despite being an indisputable economic success, this growth was not based on innovation and technology, but on better productivity and the restructuring of an ineffective post-socialism economy. However, this development – which relies on drivers characteristic of the early stages of a transformation process towards a market-driven economy – has its limits, and research and innovation are increasingly being regarded as engines of long-term growth in Poland. Although several waves of reform were implemented in the research, higher education and innovation system, following changes in this system, many challenges remain. The quality of science and innovation outputs remains significantly below EU standards. Despite recent efforts, according to the latest European Innovation Scoreboard (EIS) 2016, Poland is a moderate innovator[2]. Compared to 2008, its performance has increased marginally. Developments in the higher education system achieved widely appreciated success, measured in its accessibility to and number of students. However, quality and relevance are often more questionable. In international rankings, e.g. the Shanghai Ranking, the best Polish universities are placed in the 401 to 500 range. Supported by public financing and the significant role of the EU Structural Funds, R&D investment has gradually increased. According to recent data, Gross Domestic Expenditure on R&D (GERD) accounted for 1 % of GDP in 2015. However, the business sector still spends less than half of GERD.

The second chapter provides a snapshot of Poland's economy and a more detailed statistical picture of its R&D, higher education and innovation activities.

The third chapter presents the rather complex system of governance in research and higher education. Although the establishment – for the first time in Poland – of the inter-ministerial Council for Innovation is a big step forward, the challenge of the different ministries' sectoral perspective persists. The most important strategic documents are described, including the latest strategies from the Minister of Science and Higher Education (Gowin's Strategy). However, it should be noted that several different strategy documents covering different timelines have created multiple priorities and smart specialisation areas. The legal framework for higher education is based on the Act on Higher Education, whereas science is regulated under the Act on Principles of Financing Sciences and four other associated acts. Over the last two decades, a legal framework has developed from several waves of reform. However, the mainly incremental character of the changes has had a rather limited impact on the system. In addition, an extensive presentation of many policymaking and policy-implementation structures focuses on two implementing agencies, the National Science Centre (NCN) and the National Centre for Research and Development (NCBiR).

The fourth chapter introduces Poland's higher-education and research-performing organisations. It characterises the various taxonomies in Poland's universities, as well as different public research organisations (PROs) (i.e. university institutes, Polish Academy of Sciences, and research institutes). Although all three major types of PROs have been reformed several times over the last two decades, there have been no significant improvements in their performance. Previous reforms

[1] https://www.obserwatorfinansowy.pl/tematyka/makroekonomia/polska-z-najwiekszym-w-oecd-i-europie-wzrostem-pkb-na-glowe-mieszkanca/ based on the World Bank data.

[2] EIS 2016 Country Profile Poland http://ec.europa.eu/DocsRoom/documents/17851

in higher education institute (HEIs) and PRO legislation have made it more complex and over-regulated. In addition, links between PROs and the business sector and the regional socio-economic environment are weak. As requested by the Polish authorities, the review includes a detailed overview of the quality-assurance system for evaluating higher education and research institutions. Overall, there is broad consensus that the research institution evaluation overestimates the bibliometric and complex parametrisation and makes limited use of peer-review methods.

The fifth chapter presents the rather complex financing mechanism in HEIs and research organisations. It describes the basic subsidy mechanism for teaching activities in public universities, based on algorithms, and how most higher education funds are distributed, alongside many other subsidies available to public and non-public universities. Overall, the perception is that the financing of higher education teaching activities does not support quality to an extent which could stimulate significant change in the system. It should also be acknowledged that a new funding formula was introduced in January 2017. In the research field, seven major financing streams (non-competitive and competitive) are presented. Although GERD reached an historical maximum of 1 % GDP, it is acknowledged that this level and its present structure are inappropriate and inadequate for ambitious development plans. Furthermore, the statutory financing of R&D activity in PROs is inadequate to support excellence.

The sixth chapter covers different aspects of human resources in R&D and higher education activities. Following a general overview of human resources in the system, there is a concise presentation of the studies, career paths in research and HE, and mobility issues. The main challenges identified here are related to: the low level of R&D staff per 1000 citizens, in particular in business sectors; the age structure of R&D staff, especially in institutes in the Polish Academy of Sciences (PAN) and research institutes (IB); and rigid career path rules which limit inter-, sectoral, institutional or international mobility.

The seventh chapter presents different aspects of commercialisation activities. Legal, tax and financial framework conditions are defined and the institutional capacity of different intermediary institutions is presented. Recent developments (first Act on Innovativeness) and future plans are described, and there is a critical overview of the commercialisation output. Several specific challenges are addressed in this chapter. Despite recent reforms, weak linkages between the business sector and academia continue to challenge the Polish R&I system. Quantifiable outcomes of science and industry co-operation are very limited, including low numbers of joint private-public co-publications and co-patents. It has also been noted that few enterprises actually declare their co-operation with scientific organisations, and the share of R&D expenditure in public science (HEIs and PROs) funded by business enterprises is very low. The number of research projects carried out by public HEIs and PROs contracted by industry remains persistently low (with business funding for research by academia amounting to 0.02 % of GDP in 2015, one of the lowest values in the EU-28).

Chapter eight summarises international cooperation in research, focusing on Polish participation in Horizon 2020, while the ninth chapter describes Poland’s bibliometric and patent indicators.

The sources referred to in the report are listed in Annex 1, with several recent publications providing a solid foundation for the study. The two most important sources used extensively throughout are the RIO Country Report 2016 by K. Klincewicz, K. Szkuta and M. Marczewska (EC JRC 2017) and the EURYDICE Country Pages for Poland.

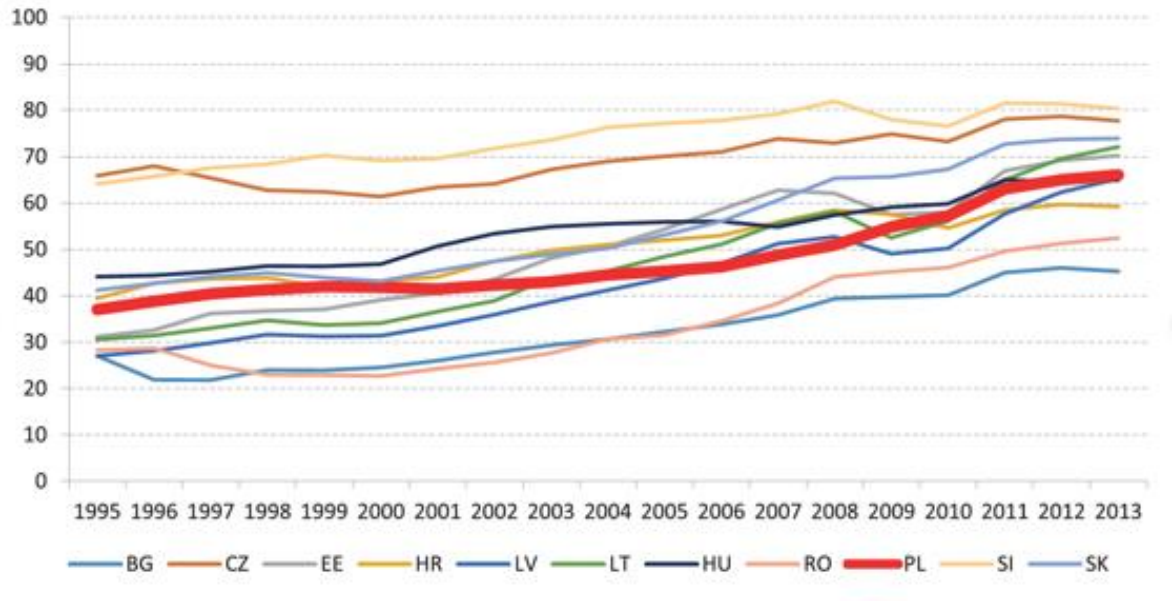
2 INTRODUCTION

2.1 Economy snapshot[3]

Poland is an EU Member State with 37.9 million inhabitants as of 2016, totalling 7.4 % of the EU-28 population. Poland's GDP per capita expressed in purchasing power standards reached 68.5 % of the EU average in 2015. In 2014 and 2015, in real terms GDP growth was positive at 3.3 % and 3.6 %, respectively (Eurostat, 2016). Poland is Europe's growth champion. Since 1989, it has more than doubled its GDP per capita, beating all its European peers. It was the only EU economy to avoid the 2008-2009 global financial crisis (World Bank, 2015a).

As shown in Figure 1, Poland recorded an upward trend in GDP (PPS) during the period 1995-2013 and is ranked sixth in Central Eastern Europe, behind Slovenia, Slovakia, the Czech Republic, Lithuania and Estonia.

Figure 1: GDP (PPS) per capita (as percentage of the EU-15 average)



Source: World Bank Staff estimates using Eurostat data

According to the preliminary estimate made in January 2017 by the Central Statistical Office (GUS), the increase in real GDP in 2016 was 2.8 % against 3.9 % in 2015 (constant average prices of the previous year).

Table 1 gives an overview of the main economic indicators.

Table 1: Main economic indicators

Indicator	2010	2014	2015 (when available)
GDP per capita in EUR	9400	10 700	11 100
GDP growth rate	3.6 %	3.3 %	3.9 %
Budget deficit as % of GDP	-7.5 %	-3.4 %	-2.6 %
Government debt as % of GDP	53.1 %	50.2 %	51.1 %
Unemployment rate as percentage of the labour force	9.7 %	9 %	7.5 %
Value added of services as share of the total value added	63.7 9 %	64.61 %	NA
Value added of manufacturing as share of total value added	17.65 %	18.62 %	NA

[3] Chapter based on the EC JRC 2017 with updated statistical data, where possible.

Indicator	2010	2014	2015 (when available)
Value added of knowledge-intensive services as share of total value	29.91 %	30.09 %	NA
Value added of high- and medium-tech manufacturing as share of total value added	5.11 %	5.39 %	NA
Employment in knowledge-intensive service sectors as share of total employment	29.04 %	30.45 %	30.03 %
Employment in high- and medium-high tech manufacturing sectors as share of total employment	4.56 %	5.13 %	NA
Employment in manufacturing as share of total employment	18.58 %	19.1 %	19.3 %
Employment in services as share of total employment	56.88 %	58.3 %	58.33 %
Share of foreign-controlled enterprises in the total number of enterprises	0.42 %	NA	NA
Business structure of the economy: share of enterprises by size class 250 persons employed or more From 50 to 249 persons employed From 20 to 49 persons employed From 10 to 19 persons employed From 0 to 9 persons employed	 0.21 % 1.04 % 1.56 % 1.81 % 95.38 %	 0.2 % 0.94 % 1.49 % 2.2 % 95.17 %	NA
Entrepreneurship performance indicator: Firm birth rate Firm death rate Firms survival (three-year threshold)	 13.81 10.58 58.84	NA	NA
Labour productivity (Index, 2010=100)	100	109.4	111.6
Innovation output indicator	NA	20	NA
Summary Innovation Index	Rank: 28 Score: 0.3	Rank: 30 Score: 0.29	Rank: 29 Score: 0.29

Source: Eurostat, 2016

2.1.1 Business structure

The Polish economy is dominated by small and medium-sized enterprises (SMEs) (employing up to 250 people). The SMEs sector represents 99.8 % of the total number of enterprises and provides employment for 6.32 million people. Micro-enterprises (employing up to nine) represented almost 96 % of SMEs. In comparison, the share of companies employing 10-49 people was 3.2 %, while firms with between 50-249 employees constituted less than 1 % of the total number of enterprises. In 2014, the number of active enterprises in Poland reached 1.84 million (Eurostat 2016). The role of foreign capital enterprises (including multinationals) in the Polish economy and the innovation system is substantial, although its relative importance has declined over the last two decades. Since 2009, the number of entities with foreign capital has continued to grow from 22 176 to 26 464 in 2014 (GUS, 2015g).

Poland is characterised by relatively low labour productivity compared to other EU-28 countries. However, its productivity has recorded constant growth since 2008. According to Eurostat, Poland's nominal labour productivity per person increased from 61.2 % of the EU average in 2008 to 74.3 % in 2015. The latest available data shows the growth in real labour productivity per person accounted for 2.2 % in 2015 (Eurostat, 2016). Overall, continuous growth in total factor productivity (TFP) may suggest that Poland is slowly improving its relative competitive position among other European countries.

2.1.2 Sectoral structure

The basic measures within the structure of the economy are individual industries' shares in value added and employment. However, in the context of this report, the sectoral breakdown of business R&D expenditures (BERD) should also be considered.

From 2010 to 2014, the total value added of Poland's manufacturing sector gradually increased, from 17.65 % to 18.62 %. In the same period, the value added of high-technology industries also rose slightly, from 5.11 % in 2010 to 5.39 % in 2014.

Manufacturing and services (in particular, wholesale, retail trade and repair in the automotive industry) contribute substantially to the total gross value added (GVA) compared to other sectors. Important sectors with a relatively high contribution to GVA include construction, public

administration and defence, professional, scientific and technical activities and real estate activities. Nevertheless, construction and real estate activities are not important in terms of BERD (GUS, 2016c, 2016a). As regards manufacturing, in 2014, the top four sectors in terms of GVA included the manufacturing of: food, beverage and tobacco products; fabricated metal products except machinery and equipment; motor vehicles, trailers and semi-trailers; and rubber and plastic products (GUS, 2016c, 2016a).

When measuring the structure of the economy by individual sectors' share of total employment, manufacturing has a relatively high and stable share (19.3 % in 2015). In the service sector, the highest shares in employment were noted in wholesale and retail trade, transport, accommodation and food service activities (22.5 % in 2015) and in public administration, defence, education, human health and social work activities (20.4 % in 2015) (Eurostat, 2016).

Manufacturing and services jointly represent around 95 % of the BERD, funded mainly by the private sector. The manufacture of motor vehicles and basic pharmaceutical products and pharmaceutical preparations are the leading manufacturing sectors in Poland in R&D spending. Among the top sectors in services, R&D spending includes: information and communication services, professional, scientific and technical activities and wholesale and retail trade, and repair of motor vehicles and motorcycles. Since 2011, these service branches have become increasingly important (GUS, 2015d).

A comparison of sectoral structures broken down by BERD and GVA shows that R&D-intensive sectors make a limited contribution to the GVA. This supports the conclusion that sectors characterised by relatively lower technology intensity still dominate the structure of Poland's economy.

Poland is strongly embedded in global value chains (GVC) in supply, manufacturing and logistics activities, as well as shared service centres. In particular, this refers to the chains created and managed by German, British and French companies (NBP, 2016c). Poland reported considerable upgrading in GVC due to its stronger and greater participation as a buyer of foreign value added rather than a seller of value added (World Bank, 2015b). According to the World Bank, the ICT and aerospace service sectors show the potential to support economic upgrading in GVCs. In terms of integration in GVCs, Poland's advantages include good language skills and attractiveness for higher-skilled service jobs (World Bank, 2015b). Investment cycles in the country appear to have shortened in recent years. Having fallen in 2012-2013, investment activity rebounded strongly in 2014-2015 before dropping back again in 2016. These swings were driven by a combination of factors, including changes in the overall macroeconomic conditions and outlook, and in the perception of uncertainty and risks, and peaks and troughs in EU Structural Funds use. Investment is expected to recover from 2017, although its pace remains uncertain. Public investment is also expected to rebound more strongly as the perspective of the EU funding programming calendar puts pressure on Poland to accelerate spending. In contrast, the rebound of private investment will hinge on how expectations concerning macroeconomic stability and the policy and regulatory environment develop (EC, 2017).

Poland's performance in terms of digital infrastructure and services is below the EU average (EC, 2016b; MIR, ERDF, 2014). Its overall score in the 2016 Digital Economy and Society Index (DESI) is 0.43. It is ranked 22nd in the EU-28, putting it in the "falling behind" cluster along with Bulgaria, Cyprus, Czech Republic, Greece, France, Hungary and Slovakia (EC, 2016a). On the one hand, fixed broadband coverage value in Poland is the lowest in the EU, at 86 % of the EU average, while the use of mobile broadband is ranked sixth in the EU-28 (EC, 2016b). In terms of business digitalisation, including the use of cloud services, social media, data hosting, CRM and accounting software, Poland still ranks below the EU average with only 12 % of ICT specialists employed and 10 % of companies selling online (EC, 2016b).

The annual World Bank report 'Doing Business 2016', which measures the ease of doing business in 189 economies, has ranked Poland in 25th position, with 11 EU Member States ranked higher (World Bank, 2016a). This is a major improvement since 2009 when it was ranked 76th with Greece being the only EU Member State below it. Compared to last year's report (2015), Poland has moved up three places in the ranking.

2.2 R&D snapshot[4]

GERD amounted to EUR 4.31 billion in 2015, rising by 11.7 % and 54.5 % compared to 2014 and 2011, respectively. R&D intensity measured as the share of GDP amounted to 1 % in 2015 compared to 0.75 % in 2011 (see Table 2). In 2014, Poland ranked 20th among the EU Member States regarding R&D intensity, which was two times lower than the score for the whole EU.

In 2015, the number of people employed in R&D in Poland was 157 900, including 118 500 researchers. Employment in R&D measured in full-time equivalents reached 109 200 FTEs, including 82 600 FTEs for researchers.

In the same year, 6.8 per 1000 people employed (in FTE) were involved in R&D activities. This indicator was almost two times lower than for the whole EU in 2014 (13.0). In 2014, Poland was 23rd among the EU Member States regarding employment in R&D (in FTE) per 1000 people employed and 22nd for researchers (in FTE) per 1000 people employed. Expenditure on R&D per employee was PLN/FTE 165 300.

In 2015, there were 8.3 million people in human resources in science and technology (HRST). The most important group within the HRST core, i.e. individuals who have successfully completed tertiary education and are employed in a science and technology occupation, totalled 3.5 million.

Table 2: Main R&D indicators

Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2014)
GERD (as % of GDP)[1]	0.72 %	0.88 %	0.94 %	1	2.04 %
GERD in national currency (PLN million)	10 416 2	14 352 9	16 168 2	18 060 7	NA
R&D funded by abroad % of GDP	0.09 %	0.12 %	0.13 %	0.17 %	NA
R&D funded by EC (% of GDP)	0.06 %	0.10 %	0.1 %	NA	NA

Source: Eurostat, 2016

[1] Polish objective for GERD declared in response to the EU 2020 strategy is 1.7 % of GDP in 2020

2.2.1 Government R&D

The public sector remains an important R&D performer, with key HEIs – 109 entities – and many other PROs. In 2015, other PROs included as many as 309 R&D performers (GUS, 2016b) divided into distinctive groups with differentiated research interests. The Polish Academy of Sciences institutes – 70 entities – concentrate on basic research (69.6 % of R&D expenditure in 2015), with limited activity in applied research and experimental development (30.4 %), while research institutes – 116 entities – were less involved in basic research (18.4 %) but carried out more applied research and experimental development (81.6 %) (GUS, 2016b).

In 2015, the Polish Academy of Sciences incurred PLN 1.68 billion (EUR 394.2 million) of R&D expenditure and employed 8100 R&D personnel, while research institutes invested PLN 2.57 billion (EUR 603 million) and employed 17 700 R&D personnel (GUS, 2016b). All scientific organisations in Poland are subject to regular institutional evaluations, categorising them according to their R&D performance (for details, see Chapter 3.5). Only four research institutes are in the highest ("A+") category, 41 are ranked as "A" and 67 as "B", while 13 institutes in the Polish Academy of Sciences are designated "A+", with 43 in the "A" category and 14 in "B" (MNiSW, 2016c). Table 3 below gives an overview of the main R&D indicators in the government sector.

[4] Chapter based on GUS, 2016b. See also European Semester Country Report – Poland, 2017 for more detailed information, https://ec.europa.eu/info/sites/info/files/2017-european-semester-country-report-poland-en.pdf

Table 3: Main R&D indicators – government

Indicator/inputs and outputs	2010	2012	2014	2015	EU average (2014)
GBAORD in national currency (PLN million)	5 247 4	5 733 6	7 396 9	5 460	NA
GBAORD as % of GDP	0.36 %	0.35 %	0.43 %	0.31 %	0.67 %
R&D funded by GOV (% of GDP)	0.44 %	0.45 %	0.43 %	0.42 %	0.66 %
R&D performed by GOV (% of GDP)	0.26 %	0.25 %	0.23 %	0.25 %	0.25 %

Source: Eurostat, 2016.

2.2.2 Academia R&D

In 2015, Poland's higher education sector incurred expenditure of PLN 5.22 billion (EUR 1.12 billion) on R&D (HERD), an increase of 21.7 % between 2010 and 2014 (GUS, 2015c: 59). The sector employed approximately 82 300 R&D personnel in 2015 (GUS, 2016b).

Only 109 public HEIs stated they carried out R&D activities in 2015 (GUS, 2016b), even though the total count of public HEIs in that year was 132 (GUS, 2016d). Among 283 non-public HEIs (GUS, 2016d), only a few carry out larger-scale R&D projects, although in 2015 as many as 102 organisations declared R&D expenditure (GUS, 2016b). Although the overall number of HEIs fell from 460 in 2010 to 415 in 2016 (GUS, 2016d), it remains relatively high. Average R&D expenditure by public HEI was PLN 44.77 million (EUR 10.5 million), and by non-public HEI just PLN 3.2 million (EUR 0.75 million) (GUS, 2016b).

HEIs depend primarily on the government to fund their R&D activities (66.9 % of HERD in 2015), although they also use foreign sources including the European Commission (23.1 %) and their own sector financing (7.2 %). Domestic business enterprises fund 2.6 % of R&D expenditure in the higher education sector, and private non-public organisations just 0.2 % (GUS, 2016b).

Table 4 below presents the main R&D indicators in academia.

Table 4: Main R&D indicators – academia

Indicator/inputs and outputs	2010	2012	2014	2015	EU average (2014)
R&D performed by HES and funded by GOV (% of GDP)	0.2 %	0.22 %	0.2 %	0.19 %	0.37 % (2013)
R&D performed by HES and funded by private BES+ PNP (% of GDP)	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
International scientific co-publications per million population	173.61	199.19	235.23	251.17	438
Scientific publications among the top 10 % most-cited publications worldwide as % of the country's total scientific publications	3.88	4.26	5.0[1]	NA	NA
Research excellence composite indicator (rank)[2]	NA	20	NA	NA	NA
ERC success rate (granted over evaluated)	0.1	0.04	NA	0.04	NA

Source: Eurostat, 2016; Scopus, 2016

[1] The latest available data is for 2013
[2] Overall scores and scores for each of its four components: highly cited publications per total publications, PCT patents per population, sum of ERC grants per public R&D, top universities and PROs per GERD

Compared to other public science organisations, public HEIs registered the lowest levels of R&D expenditure per one R&D employee: only PLN 118 100 (EUR 27 700) in 2015, compared to PLN 178 700 (EUR 42 000) for research institutes and PLN 229 600 (EUR 53 900) for Polish Academy of Sciences institutes (GUS, 2016b).

HEIs benefited from a substantial increase in the value of their research equipment between 2010 and 2014 (83.51 %), compared to 64.03 % increase among PROs. It should also be noted that, by the end of 2014, the overall value of research equipment in the HEI sector was only 66.12 % of the comparable assets in research institutes and the Polish Academy of Sciences (GUS, 2015d).

HEIs focus on fundamental research (68 % of HERD in 2015), with less emphasis on applied research and experimental development (32 %) (GUS, 2016b). Interestingly, HEIs outperform business enterprises and PROs in patenting their research outputs: 28.8 % of HEIs performing R&D filed patent applications in 2015, compared to 16.7 % of PROs and 12.3 % of companies (GUS, 2016b). However, these volumes of academic patent applications include inventions that might not be commercially viable, but are patented as they are incentivised by modalities for awarding institutional funding alongside, among others, scientific publications and technology transfer revenues.

The thematic focus of HEIs' research and teaching activities is presented in Table 5, highlighting substantial teaching workloads in humanities and social and economic sciences compared to the most intensive R&D activities in engineering, technical and natural sciences.

Table 5: Thematic concentration of HEIs' R&D and teaching activities in Poland (2014)

Field of research	Share of HEIs' R&D expenditure (2014)	Share of R&D personnel employed by HEIs (headcount, 2014)	Share of students (all study cycles, 2014)
Natural sciences	27.6 %	18.3 %	3.9 %
Engineering and technical sciences	32.3 %	21.7 %	24.8 %
Medical and health sciences	11.8 %	16.8 %	18.0 %
Agriculture	6.0 %	5.7 %	1.7 %
Social and economic sciences	11.5 %	22.0 %	34.1 %
Humanities	10.8 %	15.5 %	17.5 %

Sources: GUS 2015d; GUS 2015e.

2.2.3 Business R&D

Business sector R&D expenditure has increased substantially in the last five years, from PLN 2.77 billion (EUR 662 million) in 2010 to PLN 7.53 billion (EUR 1.79 million) in 2014 (GUS, 2015c). R&D personnel in business enterprises numbered approximately 43 185 (GUS, 2015d). In 2015, BERD rose to PLN 8.41 billion (EUR 2.01 billion) (GUS, 2016b), and R&D personnel reached 49 000 employees (GUS, 2016b). Altogether, 2814 companies declared R&D expenditure in 2014 (GUS, 2015d). The average intramural R&D expenditure incurred by an enterprise was approximately PLN 2.6 million (EUR 0.62 million) (GUS, 2015c). In 2014, 66.74 % of all business expenditure on R&D was incurred by large enterprises, with 250 or more employees (GUS, 2015d), although many SMEs are likely to refrain from reporting R&D expenditure, limiting the reliability of the BERD statistics is limited. Business R&D activities were highly concentrated in some parts of the country, with the highest ratio of BERD to the regional GDP in the south-eastern region of Podkarpackie (0.99 %) and the central region of Mazowieckie, with the capital Warsaw (0.65 %) (GUS, 2015c). Relevant indicators are summarised in Table 6.

The Polish government addressed the issue of low BERD in a series of legislative measures. As from January 2016, a new system of R&D tax incentives has increased the deduction rates for labour and other R&D costs. As of 1 January 2017, a further significant change has been made to the design of R&D tax credits, increasing their availability and size (according to the first Act on Innovativeness), extending the deduction period, a proposal for new eligible cost categories, and proposed additional incentives for start-ups, like cash refunds for those conducting R&D activities. A second innovation law is now being prepared based on the White Paper on Innovation, proposing more attractive tax incentives as from 1 January 2018. To date, the more R&D-friendly tax regulations have already been welcomed by the business sector and are expected to trigger proportional increases in BERD (EC, 2017). See Section 7.2 for more details.

The primary source of financing R&D activities was business enterprises' own financial sources (79.4 % of BERD), accompanied by government funding (11.5 %) and foreign sources (9.0 %), including the European Commission (GUS, 2015c). Only 16.6 % of companies performing R&D resorted to foreign sources of funding (GUS, 2015c). Business enterprises are not particularly active in applying to the Horizon 2020 programme, with only 171 private for-profit organisations participating in 186 projects (38 of which as project coordinators). Based on the first 274 calls, the EC contribution accounted for EUR 46.4 million. While only 13 companies were awarded more than one project, the most successful private company – ITTI Ltd – was granted six projects (KPK, 2017). At the same time, COSME, another EC Framework Programme, has a very good uptake in Poland, which is one of the most successful beneficiary countries in terms of COSME budget

absorption, owing to the activity of several financial intermediaries that secured funding for guarantees and loans to be offered to the SME sector.

Particularly active among R&D performers were companies controlled by foreign capital (fully owned by foreign investors or companies in which these investors held more than 50 % of shares). They accounted for 19.1 % of all R&D-active firms although, at the same time, for a disproportionately high share of BERD (57.3 %) (GUS, 2015c). However, only 5.1 % of these foreign-controlled firms carrying out R&D activities filed patent applications in Poland, while patenting activities were more important for domestically owned companies – 9.9 % of all companies registering R&D expenditure in 2014 filed patent applications (GUS, 2015c).

In 2015, business enterprises' R&D activities were dominated by experimental development (76.6 % of expenditures) and applied research (18 %), while fundamental research played an insignificant role (5.4 %) (GUS, 2016b). Only 730 companies (out of 2814 R&D performers) declared they had dedicated research equipment (GUS, 2015d).

The largest Polish start-up association estimated the population of active start-ups at 2423 in 2015 (Skala et al., 2015). Among 423 start-up companies surveyed, over 60 % used exclusively private financing from their founders (Skala et al., 2015). In the period 2007-2013, over 1000 start-up companies benefited from R&I grants based on the EU Structural Funds, including a specific measure dedicated to innovative ICT and internet companies. Using Leontief's inter-sectoral input-output model, the consulting company Deloitte estimated that, by 2023, start-ups in Poland could generate PLN 2.24 billion (EUR 536.3 million) of added value and create 50 252 jobs (both direct and indirect) (Deloitte, 2016).

High-technology companies account for only 2.3 % of all firms in Poland, 5.3 % of sales revenues and 7.6 % of export sales, while medium-high-technology companies total 13.5 % of all firms, 27.3 % of sales revenues and 40.3 % of exports (GUS, 2015c).

Several large companies established Public-Private Partnerships with the National R&D Centre (NCBiR), and co-funded R&D programmes designed to develop new technologies in selected areas. Calls were open to companies or scientists, and intellectual property rights staying with the creators. The companies benefit from the availability of specified technologies and local suppliers-beneficiaries in the programme, and outsource programme management to NCBiR. Examples of such joint initiatives include: KGHM (metal mining company), Synthos (chemical company), GDDKiA (managing road and motorways) and ARP (with a programme focused on shale-gas technologies), while an initiative with PKP PLK (railway company) is under preparation. Several large companies maintain corporate venture programmes (investing in start-ups, with a view to capitalising on these investments, for example KGHM, media group TVN) or corporate foundations (subsidies for public science or students, perceived as charitable activities, e.g. foundations of two leading Polish pharmaceutical companies Polpharma and Adamed, as well as a sizeable financial award for the most innovative Polish chemist, offered by Synthos). Some of the largest companies in Poland, including ICT firms, invest substantial funds in sports teams or other activities, but their social responsibility activities do not target R&D performers, and there are hardly any private endowments for Polish HEIs (with a notable exception of funding received by the University of Warsaw from Google to pursue research projects related to the digital economy).

Innovative enterprises, responding to the Polish edition of the Community Innovation Survey for 2012-2014, had more co-operation experiences with research institutes (manufacturing companies, 14.3 %; service companies, 6.0 %) than with the Polish Academy of Sciences (manufacturing companies, 1.9 %; service companies: 1.0 %) (GUS, 2015a). These shares are lower than corporate cooperation with HEIs. Some companies also work with PROs from abroad (manufacturing companies, 0.6 %; service companies: 3.7 %) (GUS, 2015a). In particular, the international collaboration among service companies might suggest a lack of certain skills or knowledge, required by the industry, among PROs in Poland. In this context, it is important to mention the 2015 NIK report which pointed to the poor performance of research institutes. The report's conclusions are discussed in Section 7.1. In terms of public-private scientific co-publications, which can be used to measure the link between business and academia, with 3.7 co-publications per million population in 2014, Poland trails its regional peers, such as the Czech Republic (13.8) or Hungary (23.3), and is way below the EU-28 average (33.8) (data from CWTS based on Web of Science).

Table 6: Main R&D indicators – business

Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2014)
BERD as % GDP	0.19 %	0.33 %	0.44 %	0.47 %	1.3 %
R&D funded by BES (% of GDP)	0.18 %	0.28 %	0.37 %	0.39 %	1.13 %
R&D performed by BES (% of GDP)	0.18 %	0.28 %	0.37 %	NA	1.12 % (2013)
R&D performed by BES (% of GDP) funded by GOV	0.03 %	0.04 %	0.05 %	NA	NA
Turnover from innovation as % of total turnover	8 %	6.3 %	NA	NA	11.9 % (2012)
SMEs introducing product or process innovations/marketing or organisational innovations	NA	18.9 %	NA	NA	25.4 % (2012)
World share of PCT applications	0.16 %	0.16 %	0.17 %	NA	26.09 %

Source: Eurostat, 2016; WIPO, 2016.

2.3 Higher education institutions[5]

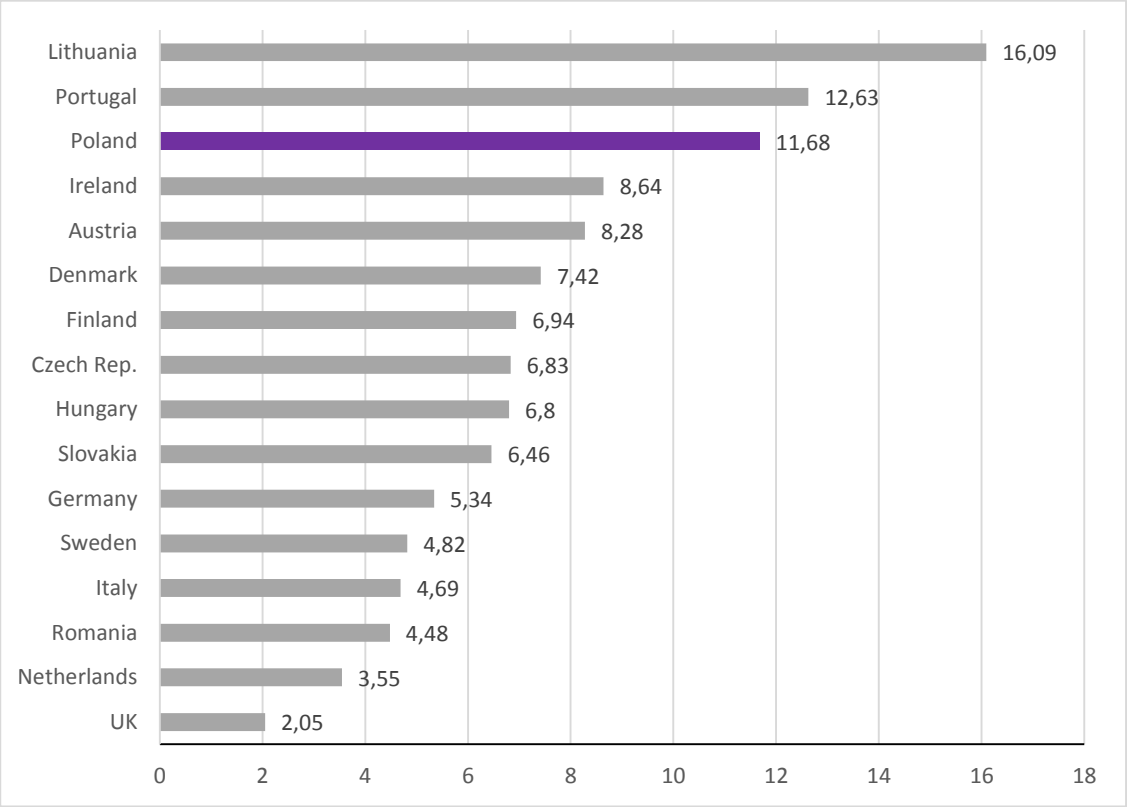
The higher education system in Poland constitutes both public and private entities. Numerous and diverse HEIs provide a broad scale of educational services for many students. In the nineties, dynamic growth began in the educational system which has lasted for several years. Until 2005, expansion of the educational system was characterised by an increase in the number of different fields of study (degree courses) and by constant growth in the number of students enrolled.

However, in recent years, demographic pressure has increased because of a fall in population numbers in the age group (19-24 years). In the period 2013-2015, the total number of universities (including public schools of higher vocational education – PWSZ) in Poland dropped from 467 to 452 due to a reduction in the number of private HEIs. Although private universities (318) continue to dominate the HEIs, more than three-quarters of students acquire their education at public universities (134). The highest numbers of HEIs operate in the Masovian region (voivodship) (106). The largest HEIs belong to the public sector and the University of Warsaw remains the biggest university in Poland with almost 43 000 students in the academic year 2015/16 (OPI, 2016) (for more regional details see chapter 3.1). With such a large number of universities, Poland leads the EU statistics in number of universities per 1 million inhabitants, behind Lithuania and Portugal (see

[5] if there is no other reference, data presented are based on GUS, 2016d.

Figure 2).

Figure 2: Number of universities per 1 million inhabitants in selected European countries in 2015



Source: OPI, 2016.

Since the gross enrolment ratio has gradually started to fall, Poland's position in the corresponding international rankings has dropped slightly. While some 60 % of undergraduate students continue to enrol in graduate studies, it is important to note that the popularity of studies in technical sciences has increased among women. Poland is among the European leaders in terms of the percentage of women enrolled in technical science studies, the leader being Croatia by just one percentage point. However, at the same time, among all the different kinds of studies, Polish female students are the least likely to choose technical science studies (OPI, 2016).

In the 2015/2016 academic year, there were 1 405 100 students in HEIs, i.e. 4.4 % less than in the previous academic year. This was the 18th successive year in which a decline in student numbers was recorded, which was influenced by demographic changes. Among ISCED-F 2013 fields of education, business and administration, engineering and engineering trades as well as social sciences were the sub-groups chosen most often.

The number of foreign students in Polish higher schools is increasing. In the 2015/2016 academic year, they numbered 57 100, i.e. 4.1 % of all students. Most came from Europe (47 600 in total) the majority from Ukraine (30 600) and Belarus (4600).

The number of graduates in the 2014/2015 academic year totalled 395 200, down by nearly 29 400 compared to the 2013/2014 academic year. The number of students in postgraduate studies in the 2015/2016 academic year rose by 1800 in relation to the previous year, to reach 151 600. Females made up 72.2 % of all postgraduate students.

In the 2014/2015 academic year, the number of students attending PhD studies conducted by tertiary education institutions, such as research institutes, scientific units of the Polish Academy of Sciences, and the Medical Centre of Postgraduate Education amounted to 43 100, 0.5 % less than the year before (for more details, see chapter 5.1.3).

In 2015, 96 100 academic teachers were employed in HEIs (counted as FTE), of whom only 2000 were foreigners. There were almost 15 students per one academic teacher, as in the previous year.

2.4 Innovation activity and knowledge commercialisation

In 2015, net revenues from the sales of products in enterprises classified under the high- and medium-high-technology sections of the Polish Classification of Activities constituted 34.2 % of net revenues from the sales of products in manufacturing (where high-technology revenues represented 5.4 % of revenues). Net revenues from product sales in the activities classified into knowledge-intensive services constituted 57.1 % of total sales.

In 2015, 36.6 % of people employed were hired in manufacturing, classified into high- and medium-high technology as well as knowledge-intensive services, 3.2 % of which were in high-tech sectors.

In the same year, expenditure on innovation activities in Polish industrial enterprises amounted to PLN 31.1 billion and was concentrated primarily in enterprises employing more than 49 people (constituting 27.2 % of the population surveyed) – 93.0%. This expenditure amounted to PLN 12.6 billion in service-sector enterprises, 93.8 % of which was in enterprises employing more than 49 people (16.7 % of the population surveyed). The concentration of expenditure in innovation activities is even higher in enterprises hiring more than 499 people – in industry, 62.4 % of expenditure was incurred by 2.1 % of entities, and in services, 67.8 % of expenditure by 1.1 % of entities.

The highest expenditure in industry was incurred by fixed assets – PLN 24 billion (77.3 % of total expenditure on innovation), most of which was spent on purchasing machinery and technical tools, means of transport, tools, devices, movables and equipment (51.2 %). The industry incurred PLN 5.1 billion (16.5%) on innovation which originated from R&D. In services, the highest expenditure was on purchasing fixed assets – PLN 4.9 billion (38.5 %) and R&D – PLN 4.1 billion (32.7 %).

In 2015, the purchase of licences was the most common form of technology transfer among industrial enterprises in Poland. Licences were purchased by 2.8 % of industrial enterprises, and R&D by 1.2 %. As with expenditure on innovations, these phenomena were concentrated in enterprises employing more than 49 people – 6.4 % purchased licences and 3.2 % purchased R&D, while in the case of enterprises employing over 499 people, the figures were 18.5 % and 11.7 %, respectively. In 2015, revenues from sales of licences (excluding licences for standard software) amounted to PLN 1 982 000 for each industrial enterprise making such sales.

In 2015, some 4676 resident patent applications were submitted to the Republic of Poland Patent Office and 2404 patents were granted for resident inventions. Only 10.5 % of innovative companies report co-operating with HEIs while the number of joint patent applications and co-publications is insignificant. Moreover, as presented in Table 7, patent activity among all PROs is quite moderate. Surprisingly, the dynamic for patents granted from 2009 to 2015 is significantly higher for HEIs and the Polish Academy of Science (PAS) institutes, 140 % and 190 %, respectively, than for research institutes, at only 30 %; these institutes are expected to be the most applied-research oriented.

Table 7: Number of patents granted in the period 2009-2015

Research organisation	2009	2010	2011	2012	2013	2014	2015	Total 2009-2015
HEIs	450	459	773	809	1022	990	1087	5590
Research institutes	282	246	321	331	399	433	367	2379
PAS institutes	32	28	50	55	44	85	94	388

Source: Own calculations based on the Polish Patent Office 2016 data

2.5 Rankings[6]

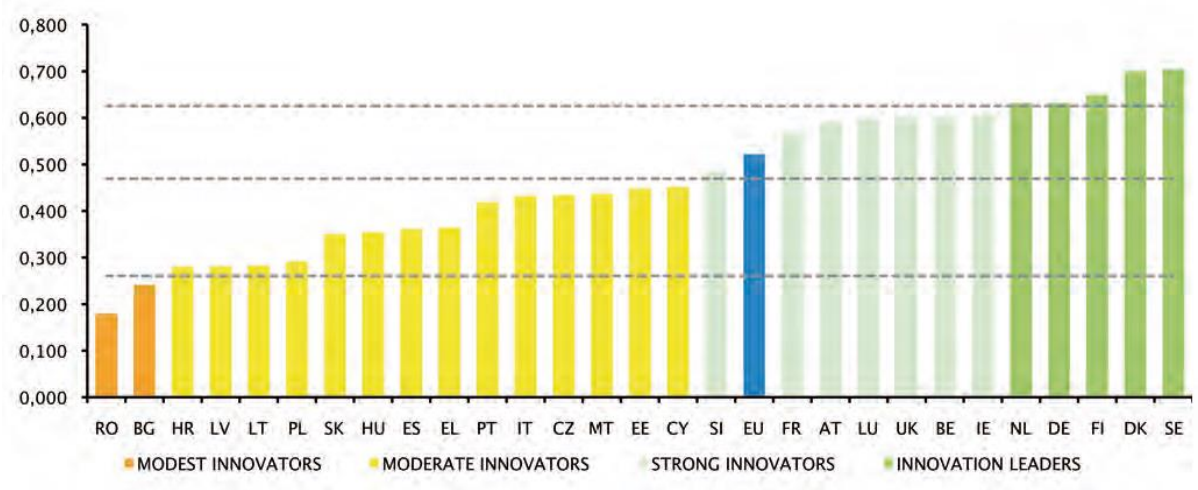
Despite recent efforts, according to the European Innovation Scoreboard (EIS) 2016, Poland is a moderate innovator[7]. Innovation performance has been somewhat volatile within a relatively narrow range. Compared to 2008, performance has increased marginally, although the relative performance declined from 59 % in 2009 to 56 % in 2015. Poland is performing below the EU average in all dimensions, particularly in 'linkages and entrepreneurship' and 'open, excellent and attractive research systems'. Performance is also below the EU average for most indicators, with the largest relative weaknesses in 'non-EU doctorate students', 'public-private co-publications', 'PCT patent applications' (in societal challenges) and 'licence and patent revenues from abroad'.

Relative strengths are in 'non-R&D innovation expenditures' and 'community designs'.

Performance is better for most dimensions and indicators. High growth is observed for R&D expenditure in the business sector (15 %) and licence and patent revenues from abroad (15 %). A significant decline in performance has been observed in innovative SMEs collaborating with others (-12 %) and SMEs with marketing or organisational innovations (-9.7 %).

Provisional CIS 2014 data show an improved performance for four indicators and a worse performance for two. The overall impact on the innovation index is expected to be positive with the index possibly rising from 0.292 to 0.305, assuming that the performance for the other indicators does not change.

Figure 3: EU Member States' innovation performance, EIS 2016



Source: European Innovation Scoreboard, 2016

Two Polish universities – Jagiellonian University from Cracow and the University of Warsaw – were included in the 2016 ARWU World University Ranking of the 500 best universities (Shanghai Ranking, 2015) ranked between 401-500.

In the international citations ranking (based on citations in Google Scholar) – Transparent Ranking[8] third edition 2016, the University of Warsaw was awarded the highest position, although it ranked only 698th among nearly 76 000 citations.

[6] The country-based infographics 2016 highlighting the strengths and weaknesses of the Polish research and innovation system can be downloaded from the following link: https://rio.jrc.ec.europa.eu/node/34619

[7] EIS 2016 Country Profile Poland http://ec.europa.eu/DocsRoom/documents/17851

[8] The ranking has been prepared by the Spanish research institution, Cybermetrics Lab, which prepares the Webometrics Ranking of World Universities.

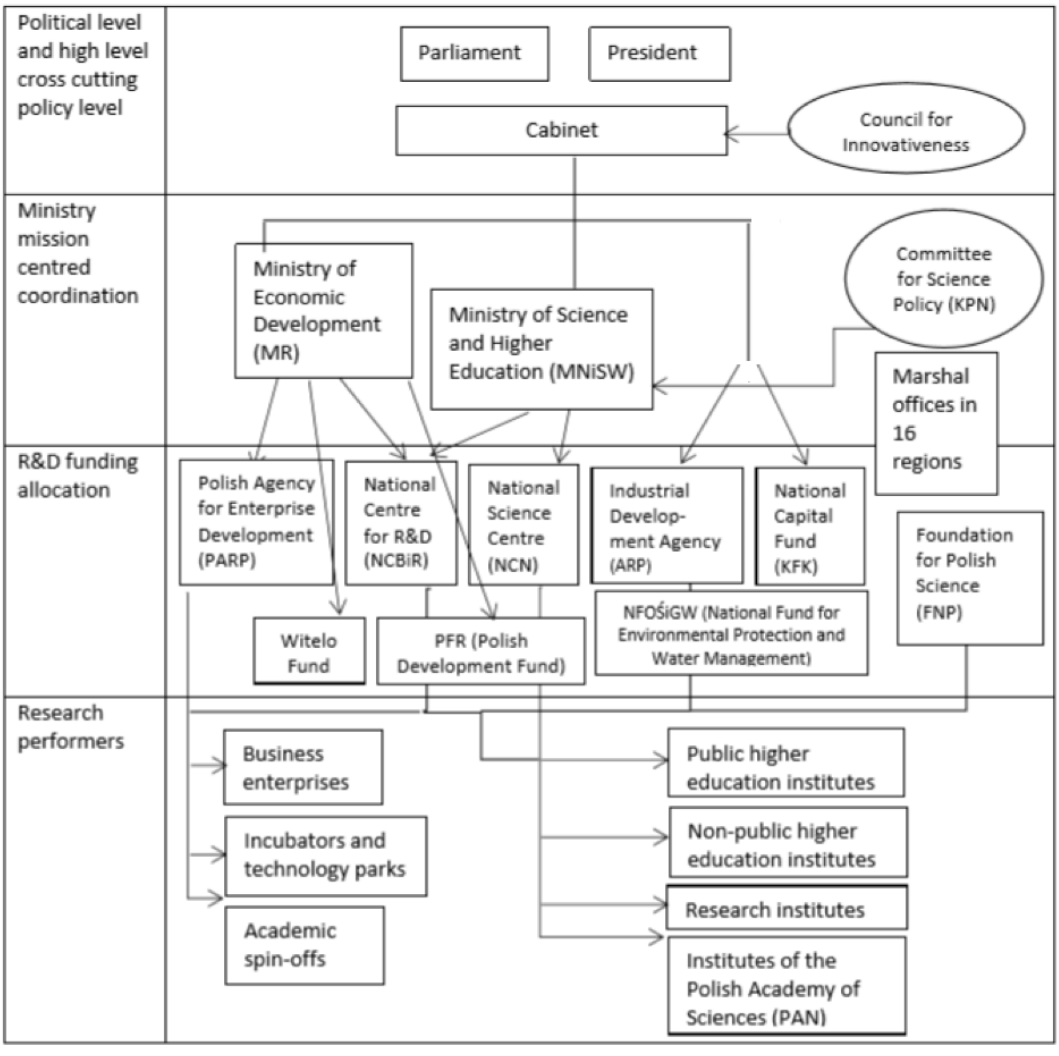
3 GOVERNANCE OF THE RESEARCH AND HIGHER EDUCATION SYSTEM

Main challenges

- Although the establishment for the first time in Poland of an inter-ministerial Council for Innovation is a big step forward, the sectoral perspective of different ministries persists.
- Several different types of strategy documents and timelines have resulted in multiple priorities and Smart specialisation areas.
- Over the last two decades, a legal framework has evolved from several waves of reforms, although their mainly incremental characteristics have resulted in a rather limited impact on the system.
- Although implementation of EU Structural Funds has driven evaluation culture mainly at project and programme level, it lacks a well-defined element embedded in the R&D&I policymaking system.

Poland's R&I system is predominantly centralised, with the national government defining policy directions and allocating funding through its agencies. Figure 4 presents the most important R&I policymakers, funders and performers in Poland.

Figure 4: Governance structure of the Polish research and innovation system



Source: EC JRC, 2017 updated

The Parliament is the legislative body, and the Council of Ministers (the Cabinet) has the executive power to set the relevant national policies, as well as the ability to start legislative initiatives or amendments of legal acts. The President can also submit proposals for new legal acts and accept the legislation adopted by the Parliament. In addition, a group of Members of Parliament can initiate new legislation without interfering with the government's standard legislative procedure (e.g. no obligation for impact assessment).

In January 2016, the government established an inter-ministerial Council for Innovativeness headed by the Minister of Economic Development, with the participation of Ministers of: Science and Higher Education, Culture and National Heritage, Digitalisation, Health and National Education. This was the first time in Poland's history that R&I policies had been given such a prominent position on the government's agenda, with all three Deputy Prime Ministers being members of the Council.

3.1 Strategic and legal framework

This chapter aims to provide a broader picture of the strategic and legal framework for research, development, innovation and higher education activity in Poland. Several documents will be presented from the most recent to the most dated, but still binding.

3.1.1 Strategic framework

Responsible Development Strategy (SOR) (MR, 2017)

In February 2017, the government adopted the Strategy for Responsible Development (*Startegia na rzecz Odpowiedzialnego Rozwoju*) outlining new directions for Poland's economic and social policies. It will be implemented by strategic and flagship projects indicated in the document. There are currently around 185 projects listed in the strategy, in the field of legislative solutions as well as specific investments. Many are already in progress, having been implemented in parallel with the strategy's formal approval process.

The Electromobility programme could be seen as an example of a flagship project. Its goal is to start the design and production of electric vehicles and to develop the infrastructure required for this type of car, including introducing environmentally friendly public transport in Polish cities (projects: E-bus and electric car). Similar programmes are dedicated to the renewal and modernisation of the shipbuilding sector (Batory project), developing services based on drones (projects Żwirko and Wigura), and the development of innovative solutions for health – modern medical equipment (including a Polish medical robot), and advanced generics and biosimilars (Project Development Centre for Biotechnology).

The key solution to ensuring better coordination towards promoting investments (e.g. PARP, ARP, PAIiIZ, Export Credit Insurance Corporation and BGK) is the establishment of the Polish Development Fund (PFR). This will play an umbrella role for the group of agencies and funds participating in the implementation of development projects (e.g. START Programme in Poland, Polish International Expansion Programme, Enterprises Guarantee Programme for SMEs, Development Programme, Capital Programme House + programme, Electromobility).

It is also foreseen to set up the National Institute of Technology (NIT) – the institution conducting mainly applied research, with the aim of transferring knowledge to the economy. The initial concept of the NIT is based on the German Fraunhofer-Gesellschaft. In practice, a new entity will be created by merging most of the existing industrial research institutes.

Another initiative worth mentioning in the context of the R&D&I policies is the Start-in-Poland programme with an approximate budget of PLN 3000 million, which aims to support start-ups and their co-operation with large enterprises, including state-owned companies.

Implementation of all the strategy's development goals will require substantial public funding (domestic and foreign/European) and private, estimated for 2020 at around PLN 1.5 trillion from public resources and more than PLN 0.6 trillion of private investment.

The strategy's main effects are expected to increase citizens' wealth and reduce the number of people at risk of poverty and social exclusion. The most important goal will be to raise the average household income to 76-80 % of the EU average by 2020 and close to the EU average by 2030. The percentage of people at risk of poverty and social exclusion will fall to 20 % in 2020 (17 % in

2030). The aim is also to increase GDP per capita to 75-78 % of the EU average in 2020 (95 % in 2030). To ensure high and sustainable growth, the following targets have been set until 2020:

- increase in investment to 25 % of GDP;
- increase GERD to 1.7 % of GDP;
- 7.2 % average annual growth rate in exports of goods; and
- 10 % share of export of high-technology products in total exports.

Gowin's Strategy (Strategia Gowina)

In September 2016, Jarosław Gowin, the Minister of Science and Higher Education presented his ministry's strategic directions, called 'Gowin's Strategy'. This strategy was developed in parallel with the SOR and positioned as complementary to it. It comprises three pillars: 'Constitution for Science' (reform of HEIs), 'Innovations for Economy' (support for commercialisation of R&D results) and 'Science for You' (promotion of science and strengthening the social responsibility of science). The major initiatives announced by Minister Gowin are outlined below:

In the 'Constitution for Science' pillar:

- Deregulation of different aspects of academic activity (short-term goal – new legislation simplifying existing Higher Education Act – in place since October 2016)[9];
- 'Ustawa 2.0' – Law 2.0 – systemic approach to new legal framework for research and HE activity focusing on quality of research, new category of research universities, new financial modalities for PRO and universities, etc.;
- The National Academic Cooperation Agency (NAWA) – a new agency responsible for standardisation of scholarship programmes and encouraging foreign students and researchers to study and work in Poland.

In the 'Innovations for Economy' pillar:

- New law for innovation activities:
    - short-term 'First Innovation Act' with many small improvements to existing regulations (e.g. more attractive tax incentives, etc.), already in force from the beginning of 2017;
    - long-term – 'Second Innovation Act' based on the discussion initiated in the White Paper on Innovation[10] expected to come into force by the end of 2017.
- Strengthening the role of the NCBiR – higher budget, new programmes, a new model for programme management, simplification of rules and procedures, etc.;
- PZU Vitello Programme – new model of public-private co-financing for the research and development activity, with a budget of PLN 500 million. (PZU is large public insurance company with dominant state ownership);
- The National Institute of Technology – a new research organisation focusing on applied research and commercialisation of knowledge created by merging most of the existing industrial research institutes and supervised by different ministries.

[9] Major elements of the deregulation: simplification of PKA's accreditation process, fewer reporting and information obligations for HEIs in their contacts with the ministry, simplification of approach to hiring academic staff, simplification in evaluation procedures for academic staff, more flexibility in the design of new curricula, simplification of criteria to start new practical direction of study at the first stage, simplification of student access to financial support, simplification of procedures for students loans, easier access to scholarships for PhD students, full autonomy for HEIs in the design of postgraduate curricula, free access to a unified antiplagiarism system, simplification of student access to the second and next directions.

[10] White Paper on Innovation (*Biała Księga Innowacji*) outlining more detailed areas for public intervention and regulatory changes, intended to promote innovativeness in the economy (see also chapter 7.7 of this report).

In the 'Science for You' pillar:

- University for Young Explorers – educational programmes for children from 6 to 16 years run by universities and PROs;
- ScienceBus Programme – special buses with small labs and science exhibitions to reach small cities, villages and remote areas, putting children from 400 schools in contact with live science and discoveries;
- Strengthening and popularising the Universities of the Third Age – a social phenomenon which has existed in Poland for many years, whereby elderly people can participate in special courses provided by universities or university staff.

Smart Specialisation Strategies

National Smart Specialisation (NSS) was prepared as a part of the Enterprise Development Programme, which was one of nine strategies integrated under the Strategy for Innovation and Economic Efficiency 'Dynamic Poland' (SIEE) and accepted by the Council of Ministries on 8 April 2014[11]. With later updates, it is a list of 20 technology concentration areas grouped in five thematic sectors:

HEALTHY SOCIETY

1. Medical engineering technologies, including medical biotechnologies
2. Diagnosis and treatment of civilisation diseases and personalised medicine
3. Production of medicinal products

AGRI-FOOD, FORESTRY-TIMBER AND ENVIRONMENTAL BIOECONOMY

4. Innovative technologies, processes and products of the agri-food and forestry-timber industry
5. Healthy food (high quality and organic production)
6. Biotechnological processes and products of household chemistry and environmental engineering

SUSTAINABLE ENERGY

7. High efficiency, low-emission and integrated energy production, storage, transmission and distribution systems
8. Smart and energy efficient construction
9. Environmentally friendly transport solutions

NATURAL RESOURCES AND WASTE MANAGEMENT

10. Modern technologies for sourcing, processing and use of natural resources and production of substitutes thereof
11. Minimising waste, including waste unfit for processing and use of waste for material and energy purposes (recycling and other recovery methods)
12. Innovative technologies for processing and recovery of water and reducing its consumption

INNOVATIVE TECHNOLOGIES AND INDUSTRIAL PROCESSES (IN HORIZONTAL APPROACH)

13. Multifunctional materials and composites with advanced properties, including nano-processes and nano-products
14. Sensors (including biosensors) and smart sensor networks
15. Smart grids and geo-information technologies
16. Electronics based on conducting polymers

[11] Two documents referred to in the text put the fundamentals for all operational programmes financed from the European funds in the financial perspective 2014-2020.

17. Automation and robotics for technological processes

18. Optoelectronic systems and materials

19. Intelligent Creative technologies

20. Innovative marine technologies for specialised vessels, marine and costal structures, and logistics based on maritime transport and inland waterways.

In addition, each of 16 Polish regions (voivodships) developed and adopted its own Regional Smart Specialisation strategy (RIS3). NSS with 20 broad thematic concentrations related to industrial R&D with Regional Smart Specialisations which differ in each of the 16 Polish regions, and with varying levels of technological detail, created a blurred and poorly structured priority framework.

In 2016, the complexity was expanded even further. To narrow down the list of 20 national specialities defined by the NSS and combine them with the specialities of 16 regions, the NCBiR generated an even longer list of 26 RANBs (Regional Science-Research Agendas). In another attempt, the Responsible Development Strategy (SOR) listed eight out of 20 NSS as more important than others, deserving dedicated 'fast-track programmes'. Moreover, the SOR included several other sets of priorities, identifying strategic sectors, horizontal technologies, sectors for international promotion, as well as strategic and flagship projects in some technological areas, whilst also declaring plans to continue further prioritisation. Furthermore, there are no visible monitoring systems in place, and the Economic Observatory established in 2015 to continuously analyse Poland's smart specialisations seems to be inactive.

National Research Programme (NRP – KPB)

The National Research Programme (NRP – KPB in Polish) was established by Resolution of the Council of Ministers dated 16 August 2011. The NRP sets the thematic strategic directions for the state's research and development activities. The strategic directions of R&D are defined as an undertaking to tackle important socio-economy-technology problems, with defined goals and objectives, influencing medium- and long-term national policies in the field. They were chosen by considering the long-term needs of the Polish economy, predictions of future niche markets for high-tech products, as well as the quality and concentration of the research potential and priorities of the European research programmes. Strategic directions provide a basis for the NCBiR to formulate and finance strategic research and development programmes. Strategic directions for research and development should be implemented for a period of 10-15 years, and strategic programmes over a period of 3-7 years. The NRP defines seven strategic interdisciplinary directions for R&D activity, proposing almost 70 research topics:

1. New technologies in the field of energy

2. Civilisation diseases, new drugs and regenerative medicine

3. Advanced information technologies, telecommunication and mechatronics

4. Modern materials technologies

5. Environment, agriculture and forestry

6. Social and economic development of Poland in an increasingly global world

7. Security and defence.

Although the NRP was adopted several years ago, thanks to its general and horizontal nature it still provides a valid framework for ongoing and new research programmes. An update of the document is expected to be harmonised with the recent development strategy SOR.

Higher Education and Science Development Programme for 2015-2030

The programme was prepared by a group of experts, based on a background analysis by the Science Policy Committee and adopted by the government in September 2015. It focuses on higher education and research activities associated with universities. Its main objectives and operational activities are:

1. Improving the quality of higher education and strengthening links with social and economic needs:

    - Improving the competence of teachers
    - Improving the human resources policy in universities
    - Improving the quality of doctorates and the doctoral level
    - Improving the quality of habilitation
    - Changes in the nature of studies in I and II degrees
    - Adapting education to the diverse abilities of students
    - Universities as a main subject of accreditation, qualifications and evaluation
    - Evaluation of higher education based on the effects
    - Enhancing the role of teaching achievements in the evaluation and promotion of academic staff
    - The internationalisation of higher education and scientific institutions.

2. Improving the quality of research conducted in Polish research institutions:

    - Increasing the number of prestigious scientific achievements
    - Increasing the commercialisation effects of science
    - Creating new types of scientific institutions
    - Support for the best research organisations
    - Improving the selection of reviewers
    - Strengthening cooperation with Polish scientists conducting research abroad.

3. Improving the higher education and science systems in Poland through changes in organisation, management and financing:

    - Reducing the bureaucratic burden
    - Strategic planning in defining research priorities
    - Changing the system of financing universities and research organisations
    - Differentiation of universities
    - Diversity of academic career paths and adjustment of personal evaluation system

4. Increasing the social, economic and international impact of Polish science:

    - Diversification of science promotion activities
    - Strengthening science–business cooperation
    - Fiscal incentives for R&D investments
    - Lifelong Learning Programme.

After the change of government, the Programme was neither declared, nor dismissed nor continued. Hence, inspiration for several activities proposed in Gowin's Strategy is rather obvious.

Internationalisation of the Higher Education Programme

The programme prepared and adopted by the Ministry of Science and Higher Education in 2015 aims to increase the competitiveness of Polish universities in the international market by raising the quality of teaching and research, increasing the role of science and higher education in the country's economic growth, and strengthening Poland's role by improving the attractiveness of universities as centres of science and education.

Proposed actions are divided into two groups of tasks for universities and for the ministry:

- Tasks for the universities:
    - Create curricula which is attractive for foreign students
    - Adjust university service to the needs of foreign students and strengthen the skills of academic staff
    - Create a system supporting the participation of academic staff in international scientific programmes
    - Supporting students and academic staff on travel abroad and returns to Poland.
- Tasks for the Ministry of Science and Higher Education:
    - Definition of scholarship policy
    - Organisational and legal changes in the system
    - Support for changes at universities
    - Promotion on foreign markets.

Like the Higher Education and Science Development Programme, following the change of government, the Internationalisation of the Higher Education in Poland Programme was never declared, or dismissed or continued. Hence, the inspiration for several activities proposed in Gowin's Strategy is quite clear.

Polish Roadmap for Research Infrastructures

The Polish Roadmap for Research Infrastructures, developed by the Ministry of Science and Higher Education in 2011, covered 33 domestic and international projects in various fields of science. The updated version from 2014 includes 53 project proposals. The inclusion of an investment project proposal in the roadmap does not constitute a commitment to project financing. The latest change in the Act on the Principles of Financing Science from 2015 forced the ministry to review and update the roadmap with new evaluation criteria and the financial feasibility of the projects.

Lifelong Learning Strategy

An Intersectoral Task Force for Lifelong Learning, including the National Qualifications Framework (NQF), led the development of a document entitled 'The Lifelong Learning Perspective', which was adopted by the government in September 2013.

Key objectives for the lifelong learning (LLL) policy based on the above-mentioned document are:

- Creativity and innovation
- Integrated national qualifications system
- Increasing participation rates in early childhood education and care
- Adaptation of education and training to labour market and social needs
- A new approach to adult learning based on the recognition of the value of learning in the workplace and as part of structured social engagement.

Lifelong Learning is a shared responsibility of the Ministry of Education and Ministry of Science and Higher Education. In the light of reforms already introduced and planned by the Ministry of Education, continuation of the strategy is under review.

Smart Growth Operational Programme 2014-2020 (full text available in English)

The programme aims to boost the innovativeness and competitiveness of the Polish economy by increasing business expenditure on R&D and improving cooperation between all participants in the innovation life cycle. The funding will be used nationwide to strengthen research activities and improve the links between science and business in the 16 Polish regions. The support should enable the development of innovative ideas into concrete, marketable new products and technologies, thereby increasing the position of Polish enterprises in the global value chain.

The programme will support applied research and development in enterprises. Financial instruments, such as guarantees and equity investments, will play a key role in achieving the objectives, together with investments in R&D infrastructure in private enterprises and public research institutes. Further measures will support productive investments, improve the quality of public research and strengthen the incentives for companies and research institutes to co-operate. Ultimately, the programme should galvanise the ongoing transition of the Polish economy model towards an innovation-based one, enabling it to better compete in a globalised world.

It is structured around four priority axes with specific priorities:

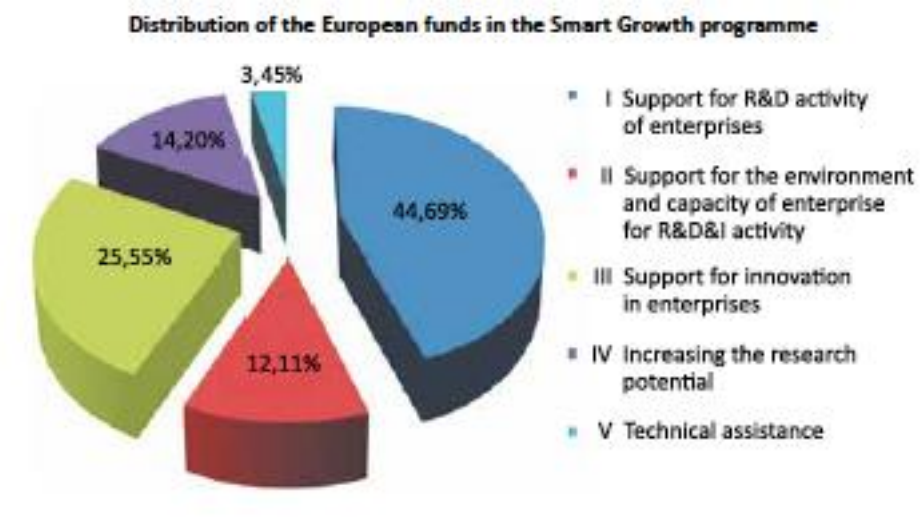
- Priority axis I: Support for the R&D activity in enterprises – with a priority to increase the number and quality of research and development projects carried out by enterprises.
- Priority axis II: Support for the environment and capacity of enterprises for R&D&I activity – with a priority to improve the institutional conditions enabling enterprises to engage in R&D activities and enhancing their potential for R&D.
- Priority axis III: Support for innovations in enterprises – with a priority to support innovation in enterprises, in particular by providing financial instruments for innovative investments and assisting innovative exporting companies from key sectors in further internationalisation.
- Priority axis IV: Increasing the research potential – with a priority to enhance the links between public research, business and the needs of the economy by investing in strategic public R&D infrastructure and research programmes with the highest potential for the Polish economy.

The key results expected from the programme include:

- Increasing business R&D expenditure in relation to GDP to almost 1 %;
- Almost doubling the share of high-technology products among Polish exports to 13.0 %;
- Increasing the share of applied R&D to 72.6 %;
- Supporting more than 12 000 companies in conducting research and implementing innovation;
- Leveraging an additional EUR 4.4 billion of private funding for research and innovation;
- Creating 20 500 new jobs; and
- Developing the use of financial instruments in supporting research-based business ventures.

The total budget allocated to the programme is about EUR 10.19 billion with the EC contribution through the European Regional and Development Fund of EUR 8.61 billion. The distribution of EU funds in the programme is presented in Figure 5.

Figure 5: Distribution of EU funds in the Smart Growth Operational Programme 2014-20



Source: 'From Idea to Market' Smart Growth Programme 2014-2020 brochure: https://www.poir.gov.pl/media/10296/POIR_broszura_ang_082015.pdf

More detailed examples of specific measures available under the Smart Growth Programme are presented below:

Which SG OP measures provide support for research and development?

Name of measure/sub-measure	Who is it for?
Sub-measure 1.1.1 **Industrial research and development work implemented by enterprises** (competition projects)	Enterprises
Sub-measure 1.1.2 **R&D work related to manufacturing a pilot/demonstration installation** (competition projects)	Enterprises
Measure 1.2 **Sectoral R&D programmes** (competition projects)	Enterprises, consortia of enterprises

Which SG OP measures provide support for implementing the results of R&D work?

Name of measure/sub-measure	Who is it for?
Sub-measure 3.2.1 **Research for the market** (competition projects)	Micro, small and medium-sized enterprises
Sub-measure 3.2.2 **Technology innovation credit** (competition projects)	Micro, small and medium-sized enterprises
Sub-measure 3.2.3 **Guarantee fund to support innovative enterprises** (financial instrument)	Micro, small and medium-sized enterprises*

Which SG OP measures provide support for purchase of research infrastructure?

Name of measure/sub-measure	Who is it for?
Measure 2.1 **Support for investments in R&D infrastructure of enterprises** (competition projects)	Enterprises
Measure 4.2 **Development of modern research infrastructure of the science sector** (competition projects)	Scientific entities, consortia of scientific entities, consortia of scientific entities and enterprises

Which SG OP measures support the provision of pro-innovation services?

Name of measure/sub-measure	Who is it for?
Sub-measure 2.3.1 **Pro-innovation BEI* services for SMEs** (competition projects)	Micro, small and medium-sized enterprises
Sub-measure 2.3.2 **Innovation vouchers for SMEs** (competition projects)	Micro, small and medium-sized enterprises
Sub-measure 2.3.3 **Internationalisation of Key National Clusters** (competition projects)	Coordinators of Key National Clusters, Members of Key National Clusters
Sub-measure 2.3.4 **Protection of industrial property** (competition projects)	Micro, small and medium-sized enterprises

*BEI – business environment institutions

Which SG OP measures provide support for technology transfer?

Name of measure/sub-measure	Who is it for?*
Measure 2.2 **Open innovation – support for technology transfer** (non-competition project; financial instrument)	Micro, small and medium-sized enterprises

* Final recipients of support

Which SG OP measures provide support for export and international promotion?

Name of measure/sub-measure	Who is it for?
Sub-measure 3.3.1 **Polish tech-bridges** (non-competition projects)	Micro, small and medium-sized enterprises*
Sub-measure 3.3.3 **Support for SMEs in the promotion of Polish product brands – Go to Brand** (competition projects)	Micro, small and medium-sized enterprises

* Final recipients of support

Which SG OP measure supports personnel development?

Name of measure/sub-measure	Who is it for?*
Measure 4.4 **Increasing the human potential in R&D sector** (non-competition project)	scientific entities, entrepreneurs, scientists, students, PhD students, special purpose entities, academic technology transfer centres

* Final recipients of support

Which OP OP measures will finance the International Research Agendas?

Name of measure/sub-measure	Who is it for?*
Measure 4.3 **International Research Agendas** (non-competition project)	Scientific entities, scientists

Which SG OP measures finance the activity of enterprises at early stages of their development?

Name of measure/sub-measure	Who is it for?*
Sub-measure 1.3.1 **Support for development of undertakings from the science sector at the seed stage – BRIdge Alfa** (financial instrument)	Originators, research teams
Sub-measure 1.3.2 **Public-private support for R&D work with capital fund participation – BRIdge VC** (financial instrument)	Micro, small and medium-sized enterprises
Measure 2.2 **Open innovation – support for technology transfer** (financial instrument)	Micro, small and medium-sized enterprises
Sub-measure 3.1.1 **Investments in innovative start-ups – Starter** (financial instrument)	Micro, small and medium-sized enterprises
Sub-measure 3.1.2 **Business angels' group investments in SMEs – Biznest** (financial instrument)	Micro, small and medium-sized enterprises
Sub-measure 3.1.3 **Innovation Loan Fund** (financial instrument)	Micro, small and medium-sized enterprises (which have an investor)
Sub-measure 3.1.4 **Competitive Nationwide Fund of Innovative Funds** (financial instrument)	Micro, small and medium-sized enterprises
Sub-measure 3.1.5 **Support for SMEs to access the capital market – 4 Stock** (competition projects)	Micro, small and medium-sized enterprises

Source: 'From Idea to Market' Smart Growth Programme 2014-2020 brochure: https://www.poir.gov.pl/media/10296/POIR_broszura_ang_082015.pdf

Knowledge Education Development Operational Programme 2014-2020 (full text available in English)

This programme aims to help address the key challenges Poland is facing in employment, social inclusion, health, education and public administration**.** It totals EUR 4.689 billion, of which EUR 4.436 billion is from the EU budget, including EUR 252 million from the Youth Employment Initiative.

This Operational Programme will support measures in line with the Europe 2020 Strategy priorities to ensure smart, sustainable and inclusive growth. Furthermore, it will directly support interventions addressing the challenges outlined in the Country-Specific Recommendations. This will ensure investments, in particular, in the integration of young people in the labour market, vocational education and training, and the participation of women in the labour market.

Investments will cover the following main areas:

- Promoting sustainable and quality employment and supporting labour mobility;
- Promoting social inclusion and combating poverty;
- Investing in education, skills and lifelong learning; and
- Enhancing institutional capacity and efficient public administration.

The main beneficiaries include central government bodies, territorial self-government bodies and municipalities, courts and judiciary institutions, social partners and relevant civil sector organisations.

Activities related to innovation and higher education are located mainly in two axes of the programme:

Axis III: Higher education for economy and development with specific objectives:

1. Increasing the competences of people participating in higher education to match the needs of the economy, labour market and society;

2. Improving education quality and efficiency of PhD studies;

3. Improving accessibility of international education programmes for Poles and foreigners participating in higher education;

4. Support for organisational changes and increasing the competences of staff in the higher education system.

Axis IV: Social innovation and transnational cooperation with specific objective to increase the use of social innovation in order to improve the efficiency of selected aspects of public policies in the area of the impact of the ESF.

Projects implemented under Priority Axis III will create a base for implementation of the Gowin Strategy and, in particular, changes and improvements to the system resulting from implementation of Law 2.0.

3.1.2 Legal framework

The legal system for scientific activity and higher education in Poland is rather complex and based on several legal Acts. Two fundamental acts set the general rules for the system: the Act on the Principles of Financing Science and the Act on Higher Education. They are accompanied by several acts forming different institutions (agencies or PROs) and providing a framework for a system of scientific degrees and titles. The characteristics of major legal acts are summarised below.

Act on the Principles of Financing Science

The Act on the Principles of Financing Science, adopted in 2010 (with subsequent changes), introduced a funding allocation based on excellence and a system for the comprehensive evaluation of scientific units' quality of scientific or research and development activities. The Act defines all types of activities recognised as research or research related (e.g. promotion of science), including investments in infrastructure or scholarships, as well as different types of competitive and non-competitive projects eligible for public support. The competences relating to the financing of fundamental research and applied research and development have been transferred from the Minister for Science and Higher Education to the National Science Centre (NCN) and the National Centre for Research and Development (NCBiR), respectively. The Act also creates advisory bodies to the minister – the Committee for Science Policy (KPN) and the Committee for Evaluation of Scientific Units (KEJN) – and rules for setting up other expert panels. More detailed information on policymaking structures is presented in Section 3.2.

Act on Higher Education

The 2005 Act on Higher Education repealed the Higher Education Act of 12 September 1990, the Act on Schools of Higher Vocational Education of 26 June 1997, and the Act on Military Higher Education of 31 March 1965. It applies to public and non-public higher education institutions (HEIs) and defines:

1. The basic terms used in HE, including a higher education institution, a public and non-public HEI, university-type and non-university HEIs, degrees, first-cycle, second-cycle and third-cycle programmes, non-degree postgraduate programmes, full-time and part-time programmes, fields and macro-fields of study, interdisciplinary programmes, etc.;

2. The requirements HEIs must fulfil in order to use the following names: "university", "technical university", "university of applied sciences", "university" with another adjective, and "academy";

3. Basic HEI tasks.

It specifies the main national-level institutions and bodies in the higher education system (the General Council for Higher Education, the Polish Accreditation Committee – formerly the State Accreditation Committee – and Rectors' Conferences) together with their main responsibilities and general organisational arrangements.

It lays down arrangements for:

- The establishment and liquidation of public and non-public HEIs;
- Supervision over HEIs;
- International cooperation of HEIs in the area of education and research;
- System of governance of HEIs;
- The internal structure of HEIs;
- The organisation of degree programmes and doctoral programmes;
- Rights and duties of students and doctoral students;
- Procedures for financial support of students and doctoral students;
- Operating rules for student and doctoral student self-government bodies; and
- Arrangements for order and security on the premises of HEIs.

The Act is considered to be extremely complicated and over-regulated. Critical assessment of this, as well as the Act on the Principles of Financing Science, was a major driver for Minister Gowin to propose his concept of "Law 2.0" – a new constitution for higher education and science.

Act on the National Research & Development Centre (NCBiR)

The 2010 Act on the National Research & Development Centre (NCBiR) stipulates the rules of governance and main funding agency tasks. The science reform adopted in autumn 2010 gave the Centre more freedom to manage its financial assets, within the scope of a strategic research programme. Subsequent changes in the Act extended the Centre's activities: as of 2011, it became the intermediary institution in three Operational Programmes: Human Capital, Innovative Economy and Infrastructure and Environment.

Act on the National Science Centre (NCN)

The 2010 Act on the National Science Centre (NCN) established the Centre as a government agency, supervised by the Ministry of Science and Higher Education to support basic research in Poland. The Act stipulates the role of the funding agency, its governance, tasks and financing.

Act on Research Institutes

The Act on Research Institutes from 2010 creates a legal basis for operating a specific type of PRO focused on applied research and co-operation with industry. It sets operational goals, rules for internal organisation and governance, as well as financial management. It also defines rules on ministerial supervision, and widely describes staff obligations and privileges.

Act on the Academic Degrees and Title, and on the Degrees and Title in the field of Art

The 2003 Act (with further amendments) defines doctor (*doktor*) and habilitation (*doktor habilitowany*) as academic degrees and professor (*profesor*) as an academic title. It indicates precisely the process of awarding academic degrees and title of professor, including the reviewer's role and duties.

3.2 Policymaking structures

Polish R&I policies are coordinated by the inter-ministerial Council for Innovativeness headed by the Minister of Economic Development who sets the overall directions for the economy's economic development and innovativeness. The Ministry of Economic Development (MR) supervises about 50 research institutes. Following recent changes and liquidation of the Ministry of Treasury, MR also supervises several state-owned companies and the Polish Development Fund (PFR) – an umbrella structure for most of the state-owned or state-support investment funds. The Ministry of Science and Higher Education (MNiSW) defines policies on science and higher education. MNiSW is expected to rely on the advice of the KPN, which represents the key stakeholders from HEIs and PROs.

Ministry of Science and Higher Education (MNiSW)

MNiSW shapes the national science and higher education policy, manages the science budget and supervises two key funding agencies: the NCN which finances basic science projects and the NCBiR which finances applied research and innovative development, including R&D projects in business enterprises. It supports the development of Polish universities, research institutes and research institutes of the Polish Academy of Sciences.

The Minister responsible for Higher Education supervises HEIs' activities as regards their compliance with the law, their statutes and the permit granted for the establishment of a non-public HEI, and proper use of public funds. The minister may request information and clarification from the bodies of an HEI and the founder of a non-public HEI, and may conduct inspections of HEIs.

Committee for Science Policy (KPN)

KPN is an advisory body of the Ministry of Science and Higher Education. It operates under the provisions of the 2010 Act on the Principles of Science Financing. The committee's major tasks are:

- To help the minister in developing the policy and strategy documents relating to research and innovation policies;
- Assistance to the minister in drafting the state budget and financial plan;
- Opinions on the plans and assessment of reports of the NCN and the NCBiR;
- Opinions on draft normative acts for research and innovation;
- Preparing opinions and assessments on the request of the minister or on its own initiative;
- Assisting the minister in developing the priorities of domestic and foreign investment in the context of medium-term plans and the available resources;
- Analysis of the costs of maintenance and efficient use of large research infrastructures;
- Developing proposals for linking Polish research infrastructure with European research infrastructure.

Committee members are appointed by the minister who selects them from candidates who meet the formal requirements, guided by the rules to ensure representation of the different scientific fields, various types of research units, as well as various areas of socio-economic development.

Central Council of Science and Higher Education (RGNiSW)

The Central Council of Science and Higher Education is an elective representative body of science and higher education which interacts with the Ministry of Science and Higher Education and other authorities to set the higher education policy. Operating under the provisions of the 2005 Act on Higher Education, it comprises 14 academic teachers, 5 representatives of the Polish Academy of Sciences, 4 representatives of research institutes, 4 students, 2 graduate students, and 3 representatives of employers. Its primary tasks cover:

- Expressing on its own initiative, opinions on all matters concerning higher education, science, culture and education; it may also address these matters to the public authorities,

scientific institutions and universities, including explanations and information, notifying the Ministers for Higher Education, for Science, and other ministers;

- Providing opinions on matters presented by the Ministers for Higher Education, for Science and other authorities and public administration or on its own initiative;
- Preparing opinions on draft regulations on higher education and research and innovation, as well as international agreements on higher education and science;
- Expressing opinions on the draft state budget for the part for which the minister responsible for higher education and the minister responsible for science dispose of regarding rules for allocating universities grants from the state budget, as well as opinions on measures for science and higher education provided for in parts of the state budget;
- Evaluating plans and reports on the activities of the NCN and the NCBiR;
- Examining applications for funding investments in large infrastructure research and reporting on its use, taking into account the relationships between Polish research infrastructure and European infrastructure;
- Expressing opinions on education standards;
- Making proposals to the minister responsible for higher education on standard descriptions of learning outcomes for individual fields of study, with the education level and profile assigned to the respective areas of education.

Committee for Evaluation of Scientific Units (KEJN)

The Committee for Evaluation of Scientific Units is an advisory body to the Minister of Science and Higher Education. It operates under the provisions of the Act of 30 April 2010 on the principles of science financing. It comprises 30 members appointed by the minister from candidates proposed by the scientific and economic communities. Half of the members are replaced every two years.

The Committee's main task is to draw out the parameters and criteria for the comprehensive evaluation of scientific units and to perform this evaluation at least every four years. The Committee indicates to the minister the leading scientific units, based on the quality of their scientific activity, in order to determine the level of financial support granted to fund their research potential (statutory financing).

The Polish Accreditation Committee (PKA)

The Polish Accreditation Committee was established in 2002 (as the State Accreditation Committee) based on amendments to the Higher Education Act and the Act on Schools of Higher Vocational Education then in force. Currently, it functions according to the 2005 Act on Higher Education, which defines its responsibilities and general operational rules. In addition, PKA activity is regulated by the Regulation of the Minister of Science and Higher Education of 3 October 2014 on the basic criteria and scope of programme evaluation and institutional evaluation. PKA is the only statutory body responsible for mandatory external evaluation in all HEIs. Its main responsibilities include:

- Conducting compulsory programme evaluations (first-, second- and long-cycle programmes) and presenting their findings to the Minister of Science and Higher Education (*ex-post* programme evaluation); where a negative quality rating is given by the PKA, the minister may take a decision to withdraw or suspend an authorisation of the HEI concerned to provide a given programme;
- Conducting compulsory institutional evaluations in HEI units which fulfil certain conditions (see section 'Approaches and methods of quality assurance' below) (*ex-post* institutional evaluation);
- Giving opinions to the Minister of Science and Higher Education on applications for permits to establish non-public HEIs (an advisory function in *ex-ante* institutional accreditation);
- Giving opinions to the Minister of Science and Higher Education on HEIs' applications for authorisation to provide first-, second- and long-cycle programmes in individual fields of study (in cases extending beyond the autonomy of HEIs) or for the re-granting of an authorisation (an advisory function in *ex-ante* programme accreditation).

The PKA also undertakes other activities to improve the quality of higher education. For example, it co-organises 'Quality Forum' conferences to bring together representatives from the national authorities, the academic community and employers, and produces publications promoting good practice, e.g. 'Selected good practice in managing the quality of education in Polish higher education institutions'.

The independence of the PKA was confirmed by an external review conducted in 2013 in accordance with 'The European Standards and Guidelines for Quality Assurance in the European Higher Education Area' (ESG), developed by the European Association for Quality Assurance in Higher Education (ENQA).

It is an autonomous institution financed from the state budget. Members (80 to 90) are appointed for a four-year term by the Minister of Science and Higher Education from candidates proposed by various independent institutions (e.g. the General Council for Science and Higher Education, the Conference of Rectors of Academic Schools in Poland, the Conference of Rectors of Non-University Higher Education Institutions in Poland, the Students' Parliament of the Republic of Poland, the National Representation of Doctoral Students, HEI senates, and national academic associations and employers' organisations).

The Committee has been a full member of the Central and Eastern European Network for Quality Assurance in Higher Education (CEENQA) since 2002, the European Consortium for Accreditation (ECA) since 2005, the International Network for Quality Assurance Agencies in Higher Education (INQAAHE) since 2007, and ENQA since 2009. In 2009, it was included in the European Quality Assurance Register for Higher Education (EQAR).

Central Commission for Degrees and Titles

The Central Commission for Degrees and Titles has been in operation since 1951, according to the Act of 14 March 2003 on Academic Degrees and Titles and on Degrees and Titles in Art. Its task is to grant the faculties (and other organisational units of universities, scientific institutes of the Polish Academy of Sciences, research institutes and international scientific institutes operating in Poland) rights to award degrees (degrees in arts), both doctoral and postdoctoral. Another task is to evaluate candidates without a postdoctoral degree for the position of associate (university) professor.

Conference of Rectors of Academic Schools in Poland (KRASP)

The Conference of Rectors of Academic Schools in Poland was established in 1997 by the rectors of 73 universities who were active in various types of institutions. Currently, the Conference brings together the rectors of 107 universities, including 11 private universities, with the right to confer doctoral degrees in at least one discipline. In addition, 10 schools have the status of university affiliated, and the Conference of Rectors of Public Vocational Schools (KRePSZ) has the conference associate status. Following the adoption in 2005 of the Act on Higher Education, KRASP received a "statutory mandate" and gained rights and obligations arising from the provisions of the Act.

KRASP aims to inspire and coordinate co-operation between universities and to represent the common interests of academic institutions. The Conference will take measures to establish an effective and integrated system of national education and work for the development of higher education, science and culture. In particular, in accordance with the Act on Higher Education, KRASP:

- Informs public authorities on important matters in higher education, science and culture and vital issues in academia;
- Expresses opinions on its own initiative and submit proposals on matters relating to higher education, science and culture;
- Consults principles and directions concerning the development of higher education, the system of scientific research, education and support for students and doctoral students, university management, personnel training and scientific policy and the material base of universities;
- Consults the draft state budget on the part which concerns higher education;

- Provides opinions on draft laws on higher education, science and culture, as well as the promotion of Polish science abroad;
- Provides opinions on new solutions in the education system relevant to higher education.

Conference of Rectors of Polish Universities (KRUP)

The Conference of Rectors of Polish Universities was established by the University Rectors in 1989. The aim of this autonomous congregation of rectors is to strengthen co-operation between universities in order to meet present and future challenges. KRUP develops and presents opinions and positions on issues relevant to the development of Polish science, higher education, culture and education, in co-operation with KRASP.

Conference of Rectors of Polish Technological Universities (KRPUT)

The Conference of Rectors of Polish Universities of Technology is a representative body of technical universities in Poland. It coordinates the activities and search for new forms of effective co-operation between associated technical universities, and promotes the development of technical higher education.

Conference of Rectors of Public Schools of Higher Vocational Education (KRePSZ)

The Conference of Rectors of Public Schools of Higher Vocational Education (KRePSZ) is an association of rectors representing the Public Schools of Higher Vocational Education (PWSZ). It focuses on the co-operation of these schools, looking after their interests and representation in the HEI environment, both at national and international level.

The Main Council of Research Institutes (RGIB)

The Main Council of Research Institutes is the elective representative body acting pursuant to Article 33 of the 2010 Act on research institutes. It represents the interests of the Polish research institutes to the state and local government authorities and to scientific, economic and public organisations. The Council submits opinions and requirements to the authorities and the state administration, gives opinions on ongoing science reform, and monitors the relevant regulations on the functioning of research institutes, particularly their formation, fusion, division and reorganisation.

It also aims to solve common problems among groups of institutes, and is involved in scientific development as well as improving economic innovativeness and effectiveness. It also contributes to the development of research staff and is highly supportive of young scientists.

National Representation of Doctoral Students (KRD)

The National Representation of Doctoral Students is representative body acting pursuant to Article 209 of the 2005 Act on Higher Education. KRD has the right to freedom of expression and presentation of proposals on matters relating to the community of doctoral students, including giving opinions on legislation concerning these students. It has the right to:

- Represent the interests and defend the rights of doctoral students;
- Develop self-governance of doctoral students;
- Cooperate with centres supporting the scientific activities of doctoral students;
- Support initiatives within the doctoral student community;
- Build cultural and social relationships;
- Express opinions and make proposals on matters relating to the doctoral students;
- Provide opinions on draft normative acts concerning doctoral students;
- Make legislative proposals to the competent state authorities.

Council of Young Scientists (RMN)

The Young Scientists Council is an advisory body to the Minister of Science and Higher Education. Its main purpose is to identify existing and future barriers to the career development of young scientists. Its main tasks are:

- Preparation of recommendations on the instruments supporting the careers of young researchers;
- Familiarising young scientists with funding mechanisms;
- Supporting young scientists' contacts with representatives of businesses and institutions implementing research results;
- Supporting the implementation of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers in scientific units.

Graduates Affairs Ombudsman

The Ombudsman works mainly on reducing formal barriers to graduates' access to the labour market and recommending systemic and legal solutions that will enable graduates to establish themselves more easily and quickly on the labour market.

The Citizens of Academia (Obywatele Nauki)

This bottom-up initiative by the research community aims to create a forum for dialogue among members of Poland's academic community to develop a common stance on key issues regarding the future of academia. It is an informal and non-political social movement which offers the best opportunity for a participatory, broad-based analysis of the current situation and for outlining a course for future changes.

3.3 Policy implementation

The MNiSW oversees two funding agencies: the NCN, which focuses on fundamental research and the NCBiR which primarily finances strategic research projects and applied R&D projects. NCN is a major source of funding for researchers from PROs, while NCBiR is the core source of R&D funding for business enterprises.

National Science Centre (NCN)

The NCN funds projects in arts, humanities and social sciences, life sciences and physical sciences and engineering. Its goals are to:

- Support excellent research projects in all fields of science and humanities;
- Fund doctoral scholarships and postdoctoral internships;
- Finance research projects carried out by experienced researchers aimed at implementing pioneering research important for the development of science;
- Inspire international cooperation in basic research; and
- Supervise the implementation of the research projects awarded.

To accomplish its mission, the NCN has set up 11 types of funding schemes dedicated to researchers at different stages of their career:

- OPUS: general grants
- PRELUDIUM: pre-doctoral grants
- SONATA: PhD holder grants
- SONATA BIS: PhD holder grants
- HARMONIA: international research projects
- MAESTRO: advanced grants
- SYMFONIA: interdisciplinary grants

- ETIUDA: doctoral scholarship
- FUGA: postdoctoral internships
- TANGO: proof-of-concept type grants
- POLONEZ: fellowship programme

One of the Centre's priorities is to support and develop the scientific careers of pre-doctoral and doctoral researchers embarking on a career in research. For this group, the Centre has specifically designed funding schemes such as PRELUDIUM and ETIUDA targeted at those without a PhD degree, and SONATA and FUGA , for researchers holding a doctoral degree.

National Centre for Research and Development (NCBiR)

Its mission is to help Polish scientific units and enterprises to develop their potential to create and take advantage of solutions based on results of scientific research, the aim being to give impetus to the economy.

The principal task of the NCBiR is to manage and implement the strategic programmes for scientific research and development work, which are directly translated into developing innovativeness. It supports commercialisation and other forms of transferring results of scientific research to the economy, and safeguards a conducive atmosphere for scientific staff development, especially for the participation of young scientists in research programmes. It implements international research programmes on scientists' mobility as well as other tasks commissioned by the Minister of Science and Higher Education. The Centre is financed from the state budget and EU funds.

The NCBiR currently conducts the following strategic programmes:

- Advanced technologies for energy generation;
- Interdisciplinary System for Interactive Scientific and Scientific-Technical Information;
- Integrated System for Reducing Energy Consumption in the Maintenance of Buildings;
- Modern material technologies – TECHMATSTRATEG;
- Environment, agriculture and forestry – BIOSTRATEG; and
- Prevention and treatment of civilisation diseases – STRATEGMED.

Its objective is to support the creation of new solutions and technologies to increase the innovation and competitiveness of the Polish economy. It is achieving this by developing programmes to support applied research and R&D funding for the commercialisation and transfer of results to the economy, as well as supporting the development of young scholars. Examples of such projects include:

- Technological initiative (development of new products and technologies based on Polish scientists' achievements; the project envisages cooperation between scientific institutions and enterprises);
- IniTech (co-financing of research or development work directed to an application in economic practice; implementation of research results in the economy; purchase of consulting services in the sphere of innovation);
- LIDER (for young scholars interested in creating a research team); and
- Improving safety and working conditions (working out innovative organisational and technical solutions which will limit workers' exposure to hazardous factors, work-related sicknesses and accidents at work).

In cooperation with the Minister of National Defence and Minister of the Interior, the NCBiR conducts research activities for security and defence. In competitions for specifically defined research topics for funding are projects that promise the greatest increase in real national security. The aim of the programmes and projects implemented is not only to increase the potential of Polish scientific and industrial actors, but also the desire for technological independence by creating Polish 'know-how' in the field of critical technologies in security and defence.

The NCBiR is the intermediary institution in the transfer of EU funds within the three Operational Programmes in the financial perspective for 2014-2020: Intelligent Development Programme (PO

IR) Knowledge Education Development Programme (PO WER) and the Programme for Digital Poland (OP PC). Primarily, its tasks include responsibility for the efficient payment and settlement of allocated funds, and providing substantive support to beneficiaries implementing projects with EU funds.

It also participates in international research projects, such as, *inter alia*, AAL (implementation of ICT technology), EUREKA (*inter alia*, implementations and improvements in production technologies) ERA-NET (creation of European research space) and ERA-NET plus.

Polish Agency for Enterprises Development (PARP)

The Polish Agency for Enterprises Development is supervised by the MR, but following recent developments it is now coordinated under the PFR umbrella. PARP supports non-R&D based innovations, implementation of innovations and broader R&I ecosystem services. It is involved in the implementation of national and international projects financed from the EU Structural Funds, state budget and European Commission's multi-annual programmes. As one of the key authorities responsible for creating an environment to support economic operators, the PARP actively participates in the creation and effective implementation of state policy towards enterprise, innovation and staff adaptability. Pursuant to the principle 'Think Small First' – 'SMEs above all', all the Agency's activities emphasise the needs of the SME sector. In 2016, it implemented six strategic objectives:

- Supporting the development of new ideas and business models;
- Initiating and comprehensively supporting the innovative activity of enterprises;
- Helping SMEs to enter foreign markets;
- Building links and supporting cooperation among enterprises and their environment;
- Assisting public authorities in the creation of an innovation policy; and
- Creating and promoting innovative solutions in the public sector.

The Foundation for Polish Science (FNP)

The FNP has existed since 1991 as a non-profit organisation specialising in supporting science. It is the biggest – independent from the state budget – source for financing science in Poland. Its goals are to support eminent scholars and research teams, take action to transfer scientific output into the economy, as well as supporting various investment initiatives for the benefit of science in Poland.

The Foundation awards individual prizes and scholarships to scientists, supports the modernisation of laboratories and implementation of scientific output in economy practice. It is involved in supporting international scientific cooperation, actions facilitating scientific thought exchange as well as boosting the scientific independence of younger generation scientists.

Every year it awards prizes for achievements and scientific discoveries which contribute to the progress of civilisation and increase the significance of Polish science in the world (FNP Prize – Polish 'Nobel Prize').

In 2016, FNP offered a variety of programmes and scholarships (some EU-funded), such as:

- New FNP programmes
    - INTERNATIONAL RESEARCH AGENDAS Programme 11 TEAM Programme
    - TEAM-TECH Programme
    - FIRST TEAM Programme
    - HOMING Programme
    - POWROTY/REINTEGRATION Programme
- Prizes and stipends
    - The FNP Prize

- START Programme
- Leszek Kołakowski Honorary Fellowship
- Sabbatical fellowships for MISTRZ/MASTER winners
- IDEAS FOR POLAND Programme

- International cooperation
  - Polish-American Scientific Award
  - Polish-German Scientific Award COPERNICUS
  - Alexander von Humboldt Polish Honorary Research Fellowship
- Publications
  - MONOGRAPHS Programme
  - MONOGRAPHS Programme – EDITING/ADIUSTACJE competition

Foundation for the Development of the Education System (FRSE)

The FRSE has been appointed the Polish National Agency of the Erasmus+ Programme implemented in the period 2014-2020. Its main aim is support, in the broad sense, for activities helping to develop education in Poland. It achieves by coordinating EU educational programmes, among others. The programmes include children, young people and adults – from pre-school to senior citizens.

4 HIGHER EDUCATION AND PUBLIC RESEARCH ORGANISATIONS

Main challenges
• Although all three major types of PROs have undergone reforms several times during the last two decades, no significant improvement has been observed in their performance;
• The cumulative effects of previous reforms on PRO legislation are complexity and over-regulation;
• Weak links between PROs, the business sector and socio-economic regional environment;
• Research institution evaluation overestimates bibliometric and complex parametrisation with a limited use of peer-review methods.

The public sector remains an important R&D performer, with a key role for research institutes belonging to the HEIs and many PROs, comprising two groups: institutes of the Polish Academy of Sciences (PAN) and research institutes' former industrial R&D units (JBR).

4.1 Higher education institutions

Until 2005, HEIs were divided into higher education schools (*szkoła wyższa*) and schools of higher vocational education (*wyższa szkoła zawodowa*). They were established and operated according to separate legislation (1990 Higher Education Act, and 1997 Act on Schools of Higher Vocational Education, respectively). The 2005 Act on Higher Education, which repealed the legislation

previously in force, distinguishes university HEIs (*uczelnia akademicka*) and non-university HEIs (*uczelnia zawodowa*).

A university-type HEI is an institution in which at least one organisational unit (e.g. faculty) is authorised to award doctoral degrees (*doktor*). It may provide first-cycle programmes leading to a Bachelor's degree (*licencjat or inżynier*) (ISCED 6) and/or second-cycle or long-cycle programmes leading to a Master's degree (*magister*) (ISCED 7), and doctoral programmes (ISCED 8).

A non-university HEI is an institution which, like a university-type HEI, provides first-cycle, second-cycle and/or long-cycle programmes but is not authorised to award doctoral degrees (*doktor*) or provide doctoral (third-cycle) programmes. This type of institution includes HEIs referred to as schools of higher vocational education (*wyższa szkoła zawodowa*) which are authorised to provide only first-cycle degree programmes.

For authorisation to provide first-, second- and/or long-cycle programmes, university-type and non-university, HEIs must comply with the same requirements laid down in the Regulation of the Minister of Science and Higher Education of 26 September 2016 on the conditions for the provision of degree programmes. This regulation sets out:

- Requirements concerning a programme of study;
- Requirements to be fulfilled by HEIs' organisational units to provide degree programmes in a given field, at a given level of study and of a given orientation/profile;
- Fields of study in which HEIs offer long-cycle programmes and second-cycle programmes and may offer long-cycle programmes; and
- Detailed requirements concerning the establishment and operation of HEIs' branch campuses and their basic organisational units in other locations.

The so-called minimum staff resources are defined either for individual or groups of fields of study. The ratios of academic staff to students are defined for individual fields of study. At present, the ratio of academic staff included in the minimum staff resources to students in each field may not be lower than 1:60; as exceptions, it may not be lower than:

- 1:50 in the fields of study related to foreign languages;
- 1:40 in the fields of medicine and dentistry.

Second-cycle and long-cycle programmes may be provided by organisational units of university-type and non-university HEIs which comply with the requirements listed above for first-cycle programmes and conduct research in the discipline or area related to a given field of study. However, the minimum staff resources for second-cycle and long-cycle programmes should include a larger number of academic staff holding a professorial title and a postdoctoral or doctoral degree than defined for first-cycle programmes. The required ratios of academic staff to students are the same as for first-cycle programmes (see above).

In addition, minimum staff resources for a given second-cycle or long-cycle programme in an HEI's basic organisational unit can include: academic staff for whom the HEI to which the unit belongs is the place of their primary employment, or academic staff employed in the HEI concerned for whom a research institute of the Polish Academy of Sciences is the place of primary employment.

To provide doctoral programmes, organisational units of university-type HEIs should be authorised to award either postdoctoral degrees or doctoral degrees in at least two different disciplines of a given field of science. Such authorisations are granted by the Central Commission for Degrees and Titles based on the quality of research and the number of staff with a professorial title or a postdoctoral degree, after consultation with the General Council for Science and Higher Education. An organisational unit of a university-type HEI must have 8 or 12 staff with a professorial title or a postdoctoral degree to be authorised to award doctoral or postdoctoral degrees, respectively.

Based on the Act on Higher Education, the following types of HEIs may be distinguished:

- University-type HEI – an institution which carries out academic research and where at least one organisational unit is authorised to award a doctoral degree;
- Non-university HEI – an institution which provides first-cycle, second-cycle and/or long-cycle programmes, but is not authorised to award doctoral degrees;
- Military HEI – supervised by the minister responsible for national defence;

- State service HEI – supervised by the minister responsible for internal affairs;
- HEI of art studies – supervised by the minister responsible for culture and national heritage;
- Medical HEIs – supervised by the minister responsible for health; and
- HEI of maritime studies – supervised by the minister responsible for maritime affairs.

In the academic year 2014/15, there were 434 HEIs in Poland, including 132 public institutions. The following types of HEIs may be distinguished (according to the Central Statistical Office):

- Universities (*uniwersytety*) (19);
- Technical HEIs (*wyższe szkoły techniczne*) (25);
- Agricultural HEIs (*wyższe szkoły rolnicze*) (7);
- HEIs for economics (*wyższe szkoły ekonomiczne*) (70);
- Pedagogical HEIs (*wyższe szkoły pedagogiczne*) (15);
- Medical universities/academies (*akademie medyczne*) (9);
- Schools/universities of maritime studies (*wyższe szkoły morskie*) (2);
- Universities/academies of physical education (*akademie wychowania fizycznego*) (6);
- Schools/academies of art studies (*wyższe szkoły artystyczne*) (23);
- Theological HEIs (15); and
- HEIs supervised by the Ministers for National Defence and Internal Affairs (7).

Around 70 % of public HEIs are university-type institutions which provide first-, second (or long-) cycle and third-cycle (doctoral) programmes, while the remainder (ca. 30 %) are non-university HEIs providing only first- and second- (or long-) cycle programmes.

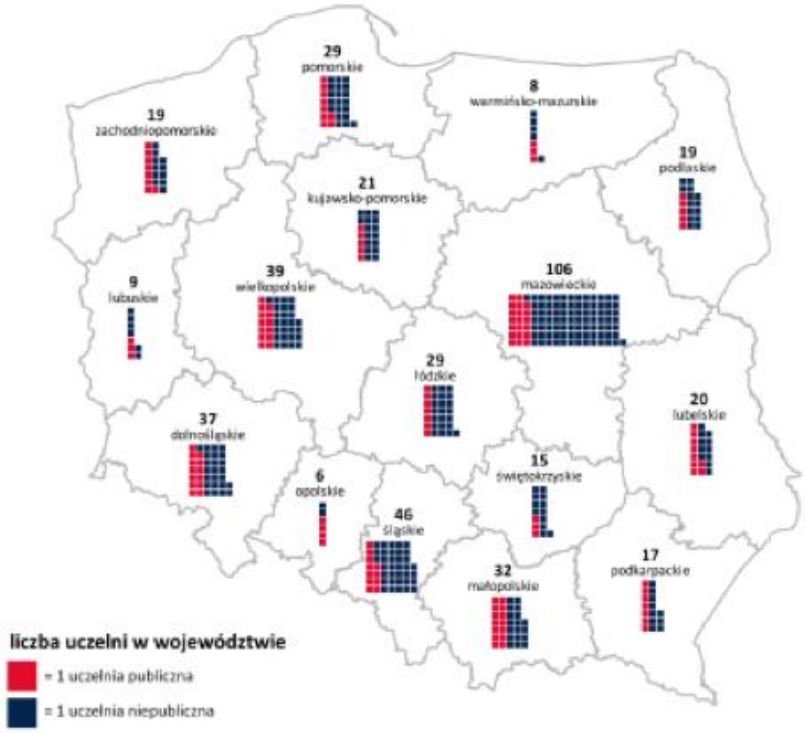
HEIs are governed by collective bodies (the senate). The HEIs' single-person authorities are rectors as well as heads of academic units who are chosen from the faculty by electoral colleges. According to the 2010 reform, HEIs can select rectors through open competitions. While the Act on Higher Education enables that opportunity, all public universities have opted for a more traditional governance system with elected leaders.

4.1.1 Regional aspects

Most universities are located in Masovia (capital) region (106 schools). Moreover, the regions with a large number of universities are: Silesia (46), Greater Poland (39) and Lower Silesia (37). In most regions, there are more private than public universities, with the exception of the Opole Region which, in 2015, operated four public HEIs and only two private ones. In the voivodships of Lubelskie, Małopolskie, Pomerania and Podkarpackie, the proportion of public and private universities is similar. The explanation for this, based on the correlation of the regional GDP per capita with the number of private HEIs, is that the number of universities is linked to the regions' socio-economic situation.

The University of Warsaw (42 380 students), which is the largest in the Masovia region, is also the largest in the country. In 2015, in the group of universities with students numbering 30 000 to 40 000, there were two others located in central Poland, namely Warsaw University of Technology (30 986) and the University of Łódź (30 799). More students than those at the Warsaw University of Technology and University of Łódź were educated in 2015 at Jagiellonian University (38 458 students), a leader in the southern Poland.

Figure 6: Number of public (red squares) and non-public (dark blue squares) HEIs in 2015 per voivodeship



Source: *OPI, 2016*

In the regional context, it is also important to mention a specific subgroup of non-university HEIs which includes public schools of higher vocational education (PWSZ) – typically classified as ISCED 5A. The first PWSZs were established in 1998 by the 1997 Act on Schools of Higher Vocational Education. This Act was the central government's answer to local governments' efforts, mostly from remote, mid-size towns – former voivodship capitals (there were 49 voivodships before the administrative reform of Poland in 1999). The most important mission of the PWSzs has been to give access to higher education to young people who, for various reasons, cannot study in academic centres. The PWSZs are recognised as an important factor in developing cultural, material and intellectual capital in local communities. They are expected to supply local and regional labour markets with relevant skills and qualifications. To strengthen this link, they are the only HEIs obliged to create bodies in the governance structure – convents – in which employers are represented. However, their links with the labour market are considered rather weak. In the academic year 2015/2016, this group comprised 37 PWSZs.

Although development of the third mission of universities is still important in the policy debate, and numerous measures have been taken to strengthen HEIs' interaction with the regional and business environment, regional authorities have no formal role in the governance of Poland's HEI system.

4.2 Public research organisations

There are two major groups of PROs, other than university research institutes: institutes of the Polish Academy of Sciences (PAN) and research institutes' (IB) former industrial R&D units (JBR).

4.2.1 Polish Academy of Sciences (PAN)

The Polish Academy of Sciences is a state scientific institution founded in Warsaw in 1952. Its mission is to work comprehensively to further the advancement of science, in the service of society and to enrich Poland's national culture, while adhering to the highest standards of research quality and ethical norms. It is an elected body of scholars, including national (ordinary and corresponding members) and foreign members. The former are limited to a maximum of 350.

New members of the Academy are chosen by the General Assembly from candidate scholars who have made outstanding contributions in their fields and command respect among the scientific community. Candidates must receive recommendations from three Academy members or from the scientific council of a research institute or university faculty that has the right to award DSc (habilitation) degrees, or from five well-recognised scientists who are professors (including one employed abroad).

The PAN's highest governing body is the General Assembly, comprising all its national members. The General Assembly directs the Academy's work and supervises its activities, making resolutions binding other PAN bodies. The General Assembly may make statements on issues of importance to the nation and the state. It is led by PAN's president who convenes sessions at least twice a year. When it is not in session, responsibility for all strategic decisions is delegated to the Presidium of the Academy (led by the president).

As a community of scientists, PAN is structured into a set of divisions, territorial branches, scientific and taskforce committees, a young academy that promotes the research and development work of outstanding young scientists, a science ethics committee, and an audit committee that oversees the Academy's financial and economic activities. The affairs of these institutions are the responsibility of the division deans, whereas the research units are overseen by the chair and deputy chair of the council of provosts for each division.

There are five divisions each grouping scholars representing a broad field of science. Each division oversees a set of research units situated throughout the country and coordinates their efforts; they represent the Polish research community in their respective fields, promote their achievements, and facilitate co-operation with centres in Poland and abroad.

PAN's basic scientific unit is the research institute, 69 of which are currently in operation. Most of them rank as leading institutions in their scientific or R&D activity. Thirteen of these institutes hold the A+ classification. Together, the heads of the research institutes make up a council of directors.

Table 8: Structures of the Polish Academy of Sciences' divisions

Divisions	National individual members	Number of institutes in division
Division I: Humanities and Social Sciences	49	14
Division II: Biological and Agricultural Sciences	69	19
Division III: Mathematics, Physics, Chemistry and Earth Sciences	89	18
Division IV: Engineering Sciences	71	13
Division V: Medical Sciences	38	5
Total	**316**	**69**

Source: Polish Academy of Sciences website www.pan.pl data for March 2016.

PAN is overseen by the prime minister, but receives budget from the Ministry of Science and Higher Education. In 2015, PAN incurred PLN 1.68 billion (EUR 394.2 million) of R&D expenditure and employed 8100 R&D personnel.

The Academy was reformed in 2010 with the aim of streamlining the management of this complex institution, facilitating better management of the scientists working there and adapting it to the principles of the European Research Area. The reforms introduced some important changes:

- Increasing the participation and importance of young researchers and; at the same time,
- Granting the status of 'senior member' to distinguished members of the Academy who are 70 years old or more;
- Establishing a clear division of tasks between the Academy, being an association of eminent scientists, and PAN's scientific institutes;
- Introducing transparent rules for managing the Academy's finances and its non-budgetary funds, and making the president of PAN responsible for the management of assets and the Academy's financial results;
- Appointing a science ethics commission as part of the Academy's structure;
- Introducing a systematic assessment of research conducted in the institutes, to be performed by an internal superintending council and the Scientific Entities Evaluation Committee acting on behalf of the Ministry;
- Allowing the Academy to actively transform – i.e. merge, divide and reorganise – its institutes, not just to create and liquidate them;
- Creating regulations facilitating research and educational cooperation between PAN, on the one side, and universities and research institutes on the other.

4.2.2 Research institutes (IB)

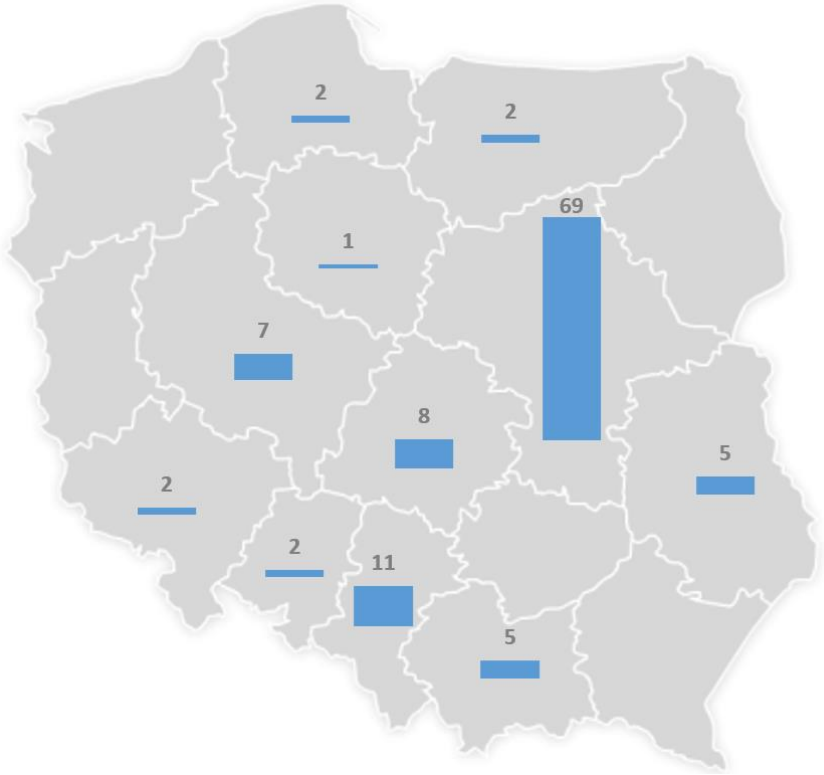
Research institutes comprise a diversified group of PROs focused on applied research and development work active in all sectors of the economy, but also supporting public administration. The first institutions of this type were established in Poland before World Word II, but their importance was visible in the 'planning economy' of the fifties and sixties in the 20th century. Communist governments assigned them a major role in supporting the technological development of economy. Their organisation closely matched the structure of the centralised economy, and the operation was directly linked to the activities of state-owned enterprises or groups of enterprises. After 1989, during the political transformation, most state-owned enterprises and even virtually all industries were privatised or liquidated. Transformation has changed not only the economy's ownership structure, but also the nature of the industry – crisis and globalisation processes – and has increased the role and influence of the services sector, in particular in heavy (traditional) industries, for which most of the research institutes worked.

Several reformative attempts were made to introduce changes in governance and adapt it to the needs of a modern economy. Essentially, there were more reactive attempts to rationalise the system, through mechanisms for liquidation or consolidation and by introducing organisational changes, quality assessment or more transparent financial management mechanisms. In the situation leading to market failure and the loss of key customers, a number of institutes led the adaptation by moving away from R&D activities towards repetitive, low-risk engineering services and manufacturing operations.

Currently, there are 114 IB which conduct research in nearly all fields of science – from social science and humanities, through engineering sciences, natural sciences, agricultural and medical. In the last parametrisation of research organisations carried out in 2013, IB covered the full scale, with four granted a rating of "A+", 40 an "A", 67 rating "B", and the other three a "C".

The institutes are located mainly in six regions in Masovia, Silesia, Łódzkie, Greater Poland, Lubelskie, and Małopolskie, while the most institutes are located in Warsaw (60). In the remaining 10 regions, there are only nine institutes.

Figure 7: Location of research institutes (IB)



Source: Own calculations based on Information System Science

IB are supervised by 16 ministers (18 in total in the government): development (36 institutes), health (16), energy (12), agriculture and rural development (10), national defence (9) infrastructure and construction (7), environment (5), digitisation (4), maritime and inland shipping (3), internal affairs and administration (3), culture and national heritage (3), family labour and social policy (2) and science and higher education, education, foreign affairs, and sport and tourism (1 each).

In 2015, IB employed approximately 42 000 people. This number accounts for total employment, including the employment in institutes supervised by the Ministry of Health which, in addition to research activities, provide medical services to operate large hospitals. In 2015, apart from the 16 institutes supervised by the Minister of Health and the two institutes in the area of health supervised by the Minister of National Defence (Military Medical Institute and Military Institute of Aviation Medicine), employment in IB totalled 21 600, of which 4100 FTEs were researchers, 10 200 were research technicians and engineering technicians, and almost 7400 others (in administration and the economic library).

In 2016, the MNiSW began preparations for a radical reform of IB and plans to establish the National Institute of Technology. At the same time, Parliament amended the relevant legislation to strengthen the ministerial oversight of some of these institutes. This change does not reflect any strategic approach to IBs but aims to better define their competences and supervising ministries.

4.3 Institutional evaluation systems

4.3.1 Quality assurance system for higher education[12]

The quality of education and quality assurance are among the key issues tackled recently in both public debates and draft strategies for the development of higher education. However, there is no single official document defining the overall objectives of the quality assurance system. The objectives behind different quality assurance arrangements are included in mission statements and tasks of the institutions directly responsible for external quality assurance.

Quality assurance arrangements have been considerably strengthened in recent years by amendments to the Act on Higher Education which came into force on 1 October 2011, and detailed regulations issued on this basis. Amended provisions in the Act place a strong emphasis on internal quality assurance systems in line with the principle adopted in the European Higher Education Area (EHEA) that HEIs themselves are primarily responsible for the quality of education. Currently, HEI rectors are responsible for supervising the implementation and further development of an internal quality assurance system; legislation defines certain compulsory elements of the internal system; and the performance of the system is a major criterion in external evaluations conducted by the Polish Accreditation Committee (PKA). Moreover, PKA's responsibilities have been extended to include institutional evaluation. The new provisions also explicitly state that the responsibilities of the Conferences of Rectors include, among others, supporting efforts related to quality assurance systems.

Furthermore, for the first time the amended Act links the quality of education with funding. The so-called pro-quality subsidy within the state budget is used by the Minister of Science and Higher Education to award additional funding to HEI organisational units awarded an outstanding quality rating by PKA following a programme evaluation. The pro-quality subsidy also provides additional funding to HEI organisational units to support implementation of their internal quality improvement systems and the National Qualifications Framework. In the former, as from 2012, the minister grants additional funding for three years to a maximum number of 25 HEI organisational units (e.g. 21 units in 2015) with an outstanding rating. Every unit receives PLN 1 million (ca. EUR 238 000) in the first year, and the amount may be indexed in the next two years. In the latter case, funding is granted through an open competition for implementation of a new or modified study programme and development of a quality improvement system.

4.3.1.1 Quality assurance approaches and methods

External quality assurance

Current arrangements in external quality assurance include:

- Procedures which may be considered a type of institutional evaluation/accreditation: assessment of applications for permits to establish non-public HEIs; and institutional evaluation carried out in units of public and non-public HEIs which fulfil certain preconditions defined in the legislation;
- Programme evaluation/accreditation: assessment of applications for authorisation to provide a programme in a given field and at a given level of study (in cases beyond HEIs' autonomy), and evaluation of programmes provided in public and non-public HEIs.

4.3.1.2 Institutional evaluation/accreditation

Ex-ante *institutional evaluation accreditation*

Current legislation does not refer to 'institutional accreditation' but lays down a mandatory procedure for granting permits to establish non-public HEIs (public HEIs are established on the basis of national legislation). The responsibility for such *ex-ante* institutional evaluation/accreditation rests with the Minister of Science and Higher Education, supported by the PKA. Applications are submitted by legal entities or individuals to the minister and subsequently

[12] Chapter based on EURYDICE, Country Pages: Poland; https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Overview

forwarded to the PKA for its opinion. Permits for the establishment of non-public HEIs are granted by the minister for an indefinite period. The minister is not required by law to take a decision in agreement with the PKA's opinion. However, in practice, the minister's decisions usually only differ from those recommended by the PKA in exceptional cases, justified by reasons other than the quality of applications (e.g. refusal to grant a permit despite the PKA's favourable opinion since there is no demand for graduates in the field of study concerned in a given region).

The PKA normally gives its opinion on an application based on documents submitted by the applicant, but its procedure provides for a site visit if justified. In assessing applications, it considers the elements discussed under '*Ex-ante* programme evaluation/accreditation' below as HEIs to be established also apply for an authorisation to provide programmes in specific fields and at specific levels of study. The criteria are published on the PKA website (http://www.pka.edu.pl).

Ex-post *institutional evaluation/accreditation*

The amended Act on Higher Education, with the relevant provisions in force as from 1 October 2011, provides the basis for the Polish Accreditation Committee to carry out *ex-post* institutional evaluation. Such evaluation does not cover an HEI as a whole but rather HEI units where a programme evaluation has already been conducted in the majority of fields of study in which first-, second- and/or long-cycle programmes are provided. It also covers those units which had not been given a negative rating in a programme evaluation in the five years preceding an institutional evaluation, or where a conditional rating was awarded, its justification did not refer to the design and functioning of the internal quality assurance system. As part of its institutional evaluation, the PKA also assesses the quality of third-cycle (doctoral) programmes and non-degree postgraduate programmes (programme evaluation covers only first-, second- and long-cycle programmes).

The *ex-post* institutional evaluation conducted by the PKA covers the following eight aspects:

- Compliance of the unit's activities with the institution's mission and development strategy;
- Functioning and enhancement of the internal system for quality assurance of education;
- Effectiveness of the human resources policy pursued by the unit;
- Measures ensuring the development of teaching/learning and research facilities in line with the unit's development strategy;
- Cooperation with the social, economic or cultural environment, and with academic and research institutions in the country and abroad;
- Functioning of the support system for students and doctoral students;
- Quality of doctoral programmes; and
- Quality of non-degree postgraduate programmes.

The criteria, together with detailed sub-criteria, are published on the PKA website.

Evaluations also take into account accreditations and certificates awarded by sectoral committees/ agencies, both national and international, conducting evaluations in selected areas of education, and by accreditation agencies registered in the EHEA or with which the PKA has concluded agreements on the recognition of accreditation decisions.

Following an evaluation, the PKA awards an outstanding rating (for eight years), a positive rating (for six years) – unless there are reasons justifying an earlier evaluation – a conditional rating (with the date set for a follow-up evaluation) – or a negative rating. Where a conditional rating is awarded, the PKA carries out a follow-up evaluation. This assesses the outcomes of remedial measures related to individual shortcomings and reservations mentioned in the first evaluation, and the relevance and implications of other changes introduced in a given unit. HEI units awarded an outstanding or positive institutional rating are exempt from programme evaluations for the period of validity. Following a negative institutional rating, the PKA will continue to conduct programme evaluations in a given unit.

Institutional evaluations are based on the same procedure as programme evaluations (see below) except that evaluation panels have more members and include not only academic experts, formal and legal compliance experts and student experts, but also doctoral student experts and employers' representatives.

4.3.1.3 Programme assessment/accreditation

Current arrangements cover both *ex-ante* and *ex-post* programme evaluation/accreditation.

Ex-ante *programme evaluation/accreditation*

Ex-ante programme evaluation conducted by the PKA involves granting authorisation to provide first-cycle, second- and long-cycle programmes in individual fields of study to basic organisational units of public and non-public HEIs. Such units are not allowed to launch programmes independently as they do not meet certain conditions in the legislation (concerning the authorisation to award postdoctoral degrees). As in the case of *ex-ante* institutional evaluation/accreditation, a decision to grant an authorisation is taken by the Minister of Science and Higher Education and supported by the PKA which gives its opinions on applications.

Again, as in the case of *ex-ante* institutional accreditation, the PKA's opinion-giving process normally only includes an analysis of documents submitted by applicant HEIs and reviews, although it may undertake a site visit where there are justified reservations about the validity of the information provided. HEIs applying for authorisation should demonstrate in their applications that they comply with the requirements in the Regulation of the Minister of Science and Higher Education of 3 October 2014 on the requirements for the provision of degree programmes in individual fields and at individual levels of study. These requirements refer to, among others, the study programme, including a description of expected learning outcomes and European Credit Transfer System (ECTS) credits, the number and qualifications of academic staff, infrastructure, and an internal quality assurance system.

In assessing applications, the PKA takes the following six elements into account:

1. Study programme(s): intended learning outcomes; study programme(s), including the process leading to the outcomes and methods for the verification of achieved outcomes; compliance with the national requirements concerning minimum staff resources and qualifications of academic staff; access to teaching and learning facilities and literature;

2. Conditions for providing distance education (where applicable);

3. Relevance of intended learning outcomes to labour market needs: use of feedback from social and business partners in the development of study programmes, and intended learning outcomes defined for student practical placements;

4. Compliance of study programmes and schedules with national standards (where these are laid down);

5. Compliance of study programmes and schedules with national standards for initial teacher training (where applicable); and

6. The internal quality assurance system; detailed criteria used by the PKA in its review of applications are available on its website.

Ex-post *programme evaluation/accreditation*

Ex-post programme evaluations are carried out by the Polish Accreditation Committee, the National Accreditation Council for Schools of Nursing and Midwifery, and peer accreditation commissions. Their approach tends to differ from one another, depending on their status and scope of activities.

4.3.1.4 Evaluations conducted by the PKA

Mandatory programme evaluation in all fields of study and all HEIs is only carried out by the PKA. Evaluations are conducted in accordance with a schedule adopted annually by the PKA, but they may also be undertaken at the request of the Minister of Science and Higher Education or the HEI concerned. The frequency of evaluations is defined in the PKA statutes, published on its website, and depends on the rating given for the previous evaluation.

The PKA awards four quality ratings: outstanding, positive, conditional and negative, thereby putting greater emphasis on quality levels than normal in evaluations leading to 'yes/no' accreditation decisions. Unless circumstances justify an earlier evaluation, a programme is re-evaluated after eight years in the case of a previous outstanding rating, and after six years in the case of a previous positive rating. Where a conditional rating has been given, the PKA defines the time frame for a follow-up evaluation on an individual basis. Programmes which receive one of these ratings are automatically considered accredited. Where a negative rating is given, the minister may suspend or withdraw the authorisation of the HEI concerned to provide a given programme. A suspended authorisation may be re-granted by the minister after consultation with the PKA; if an authorisation is withdrawn, the programme may be relaunched in accordance with a procedure in the legislation for new programmes and is subject to evaluation as a new programme according to the PKA's evaluation schedule.

Evaluations are carried out by teams of PKA members and experts appointed by it, and chaired by its members. Requirements for the composition of evaluation teams are not laid down in either national legislation or the PKA's internal regulations. However, in addition to PKA members, evaluation teams normally include:

- Academic experts: academic teachers (including, although less frequently, foreign teachers) with recognised research or artistic achievements and considerable teaching experience, proposed by the PKA's Sections for the Fields of Study;
- Student experts: students who have knowledge and experience related to the organisation of HEIs and provision of programmes, proposed by the President of the Students' Parliament of the Republic of Poland; and
- Formal and legal compliance experts (evaluating the compliance of programmes with the legislation): people with a thorough knowledge of the legal and organisational framework for HEIs, proposed by the Director of the PKA Bureau.

Experts are appointed according to the procedures and criteria published on the PKA's website and are obliged to complete relevant training. PKA members and experts are full and equal members of evaluation teams which, on behalf of the PKA, analyse self-evaluation reports from HEIs, undertake site visits and prepare evaluation reports, including their opinion on the quality of education.

The PKA conducts *ex-post* programme evaluations according to the following six criteria, which take into account the specificity of two programme orientations ('profiles'), academically-oriented and practically-oriented:

- The unit has developed a conceptual framework for education and implemented a curriculum for the programme under evaluation which enables the achievement of intended learning outcomes;
- The number and quality of research and teaching staff and the research conducted by the unit ensure the implementation of the curriculum for the programme under evaluation and the achievement of intended learning outcomes by students;
- Cooperation with the social, economic or cultural environment in the education process;
- The unit has teaching/learning and research infrastructure which enables the delivery of an academically-oriented programme/teaching/learning infrastructure which enables the delivery of a practically-oriented programme, the achievement of intended learning outcomes by students and the conduct of research (for academically-oriented programmes only);
- The unit provides support to students in the process of learning, conducting research (for academically-oriented programmes only) and entering the labour market;

- The unit has in place an effective internal system for quality assurance of education, geared towards assessing learning outcomes achieved, improving the curriculum and enhancing quality within the programme under evaluation.

The criteria, together with detailed sub-criteria, are published on the PKA website.

Internal quality assurance systems are assessed with regard to the standards defined in the above-mentioned European Standards and Guidelines. Evaluations also take into account accreditations and certificates awarded by sectoral committees/agencies, both national and international, conducting evaluations in selected areas of education, and by accreditation agencies registered in the EHEA or with which the PKA has concluded agreements on the recognition of accreditation decisions.

Where a conditional rating has been given, the PKA carries out a follow-up evaluation. This will assess the effectiveness of remedial measures related to individual shortcomings and reservations mentioned in the first evaluation and the relevance and implications of other changes introduced in a given unit. The overall assessment includes conclusions concerning the effectiveness and completeness of the changes introduced.

The evaluation procedure is based on the stages recommended in the ESG and includes: a self-evaluation report (or a report on remedial measures for a follow-up evaluation) prepared by the HEI concerned; a site visit undertaken by an evaluation team; a report prepared by the evaluation team and provided to the HEI; feedback on the report from the HEI; a rating proposed by the relevant Section for Academic Areas in the PKA; a resolution with a quality rating adopted by the PKA Presidium; and publication of the quality rating with its justification and the evaluation report.

Quality ratings given by the PKA, including negative ones, together with justifications are posted on its website and in the Public Information Bulletin. Detailed individual evaluation reports are also published obligatorily on the PKA website. Furthermore, the PKA publishes annual reports with a summary analysis of evaluations and analytical reports on individual groups of fields of study. These enable an overall evaluation of the quality of education in HEIs and provide a basis for planning quality improvement activities.

A questionnaire which may be completed by all evaluated HEIs, introduced in 2009, is designed to ensure the appropriate quality of the PKA's own evaluation procedures and criteria. It enables HEIs to assess the arrangements adopted by the PKA and to propose changes. Results of the surveys are published on the PKA website and in its annual activity reports. In line with the ESG, the PKA is also subject to external review at least every five years (the last one was in 2013). Moreover, it is supported by a consultative and advisory body, the Advisory Board, which was established in 2009 and comprises the President of the Conference of Rectors of Academic Schools in Poland (representing university-type HEIs), the Conference of Rectors of Non-University Higher Education Institutions, representatives of employers' organisations, the former PKA President and international experts.

4.3.1.5 Evaluations conducted by peer accreditation commissions

Each of the eight current peer accreditation commissions operates according to its own internal regulations which determine procedures, areas and detailed criteria of evaluation, taking into consideration the specificity of the types of HEIs and fields of study evaluated. This information is published on the websites of individual commissions. Regardless of certain differences between the approaches adopted, evaluations carried out by the peer accreditation commissions cover, among others, teaching and research carried out by evaluated HEIs; teaching staff; teaching and learning facilities; student affairs; and internal quality assurance. The accreditation procedure includes: a self-evaluation report prepared by the HEI concerned; a site visit; a report prepared by an evaluation team and provided to the HEI for feedback; the publication of information about the accredited fields of study in individual HEIs, together with the validity period of accreditation. Evaluation ends with a decision to grant or refuse accreditation, although these decisions do not entail any legal consequences as the peer accreditation commissions do not operate on the basis of the national legislation and thus do not take legally binding decisions.

4.3.1.6 Internal quality assurance

The Act on Higher Education requires that HEIs implement an internal quality assurance system and entrusts the responsibility for establishing and improving the system to the HEI's rector. HEI organisational units which establish a new programme are required to implement an internal quality assurance system from the programme start date, pursuant to the Regulation of the Minister of Science and Higher Education of 3 October 2014 on the requirements for the provision of degree programmes in individual fields and at individual levels of study. An internal quality assurance system should cover the entire education process. This includes methods for verifying learning outcomes, arrangements for using findings from student assessment of teachers' performance, the assessment of achieved learning outcomes, the use of findings from graduate career monitoring, and measures undertaken to prevent and detect plagiarism.

The Act also obliges HEIs to assess the performance of academic staff at least every two years, or every four years for teachers holding a professorial title who are employed by an HEI on an appointment basis. The assessment is conducted by a body specified in the HEI's statutes and covers the performance of statutory duties as well as observance of intellectual and industrial property rights by the academic teacher concerned. The assessment presented by students, including doctoral students, must be taken into account.

Detailed internal quality assurance arrangements are adopted by individual HEIs in their statutes and other internal regulations. They are taken into consideration in mandatory external evaluations conducted by the Polish Accreditation Committee and the National Accreditation Council for Schools of Nursing and Midwifery, as well as in evaluations carried out by peer accreditation committees.

4.3.1.7 Summary reports on quality in higher education

At national level, the PKA's annual reports are the main source of summary information on the quality of higher education. These reports include statistical data on applications reviewed as part of *ex-ante* assessment/accreditation and *ex-post* evaluation/accreditation and more detailed analyses of institutional and programme evaluations. The latter are broken down by academic areas or groups of fields of study. In analytical chapters, the PKA discusses, among others, strengths and weaknesses of HEIs, changes and trends, and the impact of its own activities on improving quality. Reports are sent to the competent ministers, the Parliament, Rectors' Conferences and the General Council for Science and Higher Education, among others, and are published on the PKA website. Findings are used to inform policy decisions relating to quality assurance in higher education, as well as by PKA itself to improve its procedures.

4.3.2 Research institution evaluation

Poland introduced performance-based funding models in 2008. Organisational funding is divided according to the outcomes of nation-wide organisational assessments which take place every four years, using criteria defined by the Committee for Evaluation of Scientific Research Institutions (KEJN). Evaluation is regulated by the Act on the Principles of Financing Science adopted in 2010 and is obligatory for all research organisations defined therein. In addition, detailed criteria and mechanisms are described in the Ministry Ordinance.

Detailed assessments include: numbers of publications taking into account the impact factors of specific academic journals, patents, revenues from industry co-operation and external R&D funding, normalised by the number of R&D employees in an organisation, researchers' scientific awards, number of PhD degrees awarded, patents, and financial results of the commercialisation of research results. In 2013, the evaluation criteria were substantially modified to further promote organisations conducting world-class research, and the evaluation process is now performed using a central IT system POL-on to eliminate the risks of human error or duplication of records for researchers working at more than one scientific organisation. The first assessment was carried out in 2013.

Research organisations are evaluated (by comparison and rankings) within the so-called Common Evaluation Groups (GWO) defined by the KEJN separately for each research field, with reference to size, type and specific profiles. Evaluation is carried out by the KEJN's evaluation teams nominated by its chairmen. Evaluation teams rate research organisations scores separately for achievements in each of the following four criteria:

- Research and creative results (outcomes);
- Scientific potential;
- Tangible (mostly financial) results of scientific activity; and
- Other effects of scientific activity.

To determine the categories that may be granted to individual research organisations, each GWO introduces two reference (model, virtual) units: reference unit for category A and reference unit for category B. These model units are defined to set a rating according to each of the four above-mentioned criteria. Based on the experts' recommendations, the minister grants one of the following category (levels) to a research organisation:

- A+ – leading;
- A – very good;
- B – satisfactory, with a recommendation to strengthen research, development or commercialisation activity; and
- C – unsatisfactory, which results in basic research funding (statutory funding) cut to just six months.

In 2017, an assessment will be carried out according to the updated methodology prepared after consultations with stakeholders. The most important changes stem from including the MNiSW's strategic objectives, such as quality, innovation, interdisciplinarity as well as openness and the internationalisation of Polish science. More points will be granted for participation in international research projects with an emphasis on Horizon 2020, receiving the HR Excellence in Research logos, while the indicator on economic benefits from commercialisation has been complemented with an assessment of the usefulness of the solution for the Polish economy. Changes also include specific publication patterns in the social sciences and humanities.

5 FINANCING HEIS AND RESEARCH ORGANISATIONS

Main challenges
• Although GERD reached an historical high of 1 % GDP, there is a common understanding that the level and structure is both inappropriate and inadequate for ambitious development plans;
• Financing of higher education teaching activities does not support quality to the level which could stimulate significant change in the system;
• System of statutory financing of R&D activity at PROs does not support excellence adequately.

5.1 Financing higher education teaching activity[13]

Revenues from teaching activities are the most important income among universities' financial revenues, but their share is shrinking year on year. Although the so-called teaching revenue per student is rising, the pace of growth is greater in the group of public universities. Moreover, in the public sector, revenues from research activities per employee are four times higher than corresponding revenues in the private sector.

The public universities' payroll costs account for about 56 % of the operational costs and 52 % of operation costs of private universities. The average annual gross salary is higher at public universities. There are no relevant differences in salaries between private and public universities, including medical schools and polytechnics.

5.1.1 Public HEIs

Teaching activity in HEIs is financed from state budget subsidies. HEIs receive a subsidy for their statutory tasks set by law, such as:

- Tasks related to the education of students enrolled in full-time programmes, full-time doctoral students and research staff; the maintenance of HEIs, including renovation of premises ('basic grant');
- Tasks related to non-refundable financial support for students and doctoral students, which can also be used for the renovation of student dormitories and canteens;
- Co-financing and financing of investment projects; and
- Tasks concerning the provision of appropriate conditions for the full participation of disabled students and doctoral students in the learning process.

Moreover, a pro-quality subsidy is set aside within the state budget and allocated as a grant to the best HEI organisational units for quality-related tasks, including top-ups for salaries and scholarships.

Subsidies/grants can be divided into the following types:

- Specific-purpose grants: funding to cover or contribute towards the cost of investment projects and of purchasing tangible assets for the training of disabled students and doctoral students;
- Grants for specific institutions: other types of funding.

[13] Chapter based on EURYDICE, Country Pages: Poland; https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Overview

Grants are financed from the part of the state budget managed by the Minister for Higher Education. HEIs covering military, the arts, maritime studies, medical, and public services, as well as those training staff for civil aviation are co-financed from the part of the state budget administered by the minister supervising these HEIs. The state budget also funds some investment projects in HEIs within the framework of multi-annual programmes.

HEIs can receive other funds from the state budget (including EU Structural Funds and research funding) and from the budgets of local government units or their associations, although in the latter case, the co-financed task must be linked to local government units' own tasks. Public HEIs in Poland pursue their own financial policy based on activity and financial plans approved by their senates. The plan must meet the requirements set out in the Council of Ministers Regulation of 18 December 2012 on detailed rules for financial management in public HEIs.

The rector of a public HEI:

- Devises a strategic development plan for the institution, to be adopted by the collegial body indicated in its statutes;
- Takes decisions concerning the institution's assets and financial management, including the sale or encumbrance of assets, and oversees its administration and business operations;
- Takes decisions on all matters concerning the institution, except for those reserved by law or statutes for the remit of other bodies.

In a public HEI, the head of finance and administration (*kanclerz*) is responsible for managing its administrative and business affairs insofar as this is provided for by the statutes and the rector. The bursar (*kwestor*) of a public HEI is the chief accountant and is the deputy of the head of finance and administration.

Basic subsidy

The mechanism for financing teaching activities in HEIs is divided into two stages.

The total amount of funding to be distributed among all HEIs is established annually in the Budgetary Act. Pursuant to the Act, state-budget expenditure on teaching activities in public HEIs is subject to annual indexation:

- *With regard to remuneration*: adjusted at least by the average annual salary increase rate in the state budget sector, as defined in the Budgetary Act for a given budgetary year;
- *With regard to other components:* adjusted at least by the average annual growth rate of consumer prices, as defined in the Budgetary Act for a given budgetary year.

In the next step, the Minister for Higher Education establishes, by regulation, an algorithm for the distribution of subsidies among individual HEIs to ensure the effective use of public funding, while taking into account the quality of education. Most of the subsidy is distributed separately among two groups of public HEIs: university-type and non-university HEIs.

The amount of the subsidy in a given year depends largely on that in the previous year, which is intended to ensure stability in HEI funding. This is achieved by applying a so-called transfer rate constant (with HEIs receiving in a given year a fixed percentage of their previous-year subsidy), which was as high as 65 % in 2016.

The distribution algorithm is based on the following six criteria:

- *Students*: this criterion which takes into account the number of students and doctoral students enrolled in full-time programmes and the difference in costs among fields of study, and which gives higher weightings to doctoral students and to students following practically-oriented ('practical-profile') programmes at public non-university HEIs;
- *Human resources*: a criterion which depends on the average number of academic teachers by degree and title (in FTE);
- *Proportionate development of education*: measuring balanced development of an HEI in terms of the ratio of staff to students;
- *Research*: a criterion which takes into account the number of national and international research projects financed or co-financed by the minister responsible for science;

- *Authorisations*: a criterion which is related to the number of authorisations to confer doctoral and postdoctoral degrees; and
- *Exchange*: based on the number of students participating in international exchange programmes covering study periods of at least one semester (weighting for outgoing students: 1, for incoming students: 3).

These criteria are used to distribute 35 % of the subsidy. The weightings assigned to each of the criteria are presented below.

Table 9: Basic subsidy – weightings and criteria

Criterion	University-type HEIs	Non-university HEIs
Students	0.35	0.35
Human resources	0.35	0.35
Proportionate development of education	0.10	0.30
Research	0.10	0.00
Authorisations	0.05	0.00
Exchanges	0.05	0.00

Source:
https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Higher_Education_Funding

Introduced in January 2017, the new funding formula is based on the so-called transmission constant – responsible for calculating 57 % of the total grant in 2017 (50 % in 2018) and four components – responsible for calculating 43 % (50%) of the total grant:

- Students and doctoral students with weightings for the levels of expensiveness; 40 % (out of 35 %);
- Teaching staff – 45 %;
- Research – 10 %; and
- International exchange – 5 %.

In addition, two new quality factors were introduced, notably student-staff ratio and a science potential indicator that refers to the average science unit category.

Grant for non-refundable financial support

Of the overall subsidy, 20 % is allocated to individual public HEIs in proportion to the number of students and doctoral students staying in dormitories in their home institutions. The remaining part is distributed among individual public and non-public HEIs and research institutions in proportion to the total number of students and doctoral students, the numbers receiving a maintenance grant, and the number of disabled students and doctoral students. A maximum of 5 % of the subsidy may be set aside for supplementary and adjustment allocations.

Grant to provide conditions for full participation of disabled students and doctoral students in the learning process

This type of grant is determined by the number of disabled students who:

- Are deaf or have impaired hearing (weighting 3.6);
- Are blind or visually impaired, or have a motor disability (weighting 2.9); and
- Have other types of disability (weighting 1.4).

Grants for investment

National legislation does not define any standardised or quantified criteria. An application from an HEI is assessed by a panel appointed by the minister which takes into account, in particular, the relevance of investment planned for the institution's development. Grants are provided based on an agreement. The total amount of such a specific-purpose state-budget grant may not be higher than the value of the investment, as specified in the estimated budget when a given project is implemented.

Acquisition and use of private funds

Public HEIs' activities can be financed from their own revenues which should be kept in a separate bank account. The range of different funding sources may vary widely. In particular, public HEI revenues may include:

- Fees charged for educational and research services;
- Income from economic activity;
- Income from the sale of the institution's own assets;
- Fees for the use of such assets based on tenancy, leasing or other agreements with third parties; and
- Income from gifts, inheritances, legacies and public donations.

An important element of the financial autonomy of public HEIs in Poland is the fact that unused funds in a given year remain at the institution's disposal.

Fees within public higher education

No tuition fees are charged by public HEIs for full-time first-, second- and long-cycle programmes and full-time doctoral programmes. Public HEIs may only charge fees for:

- Part-time degree programmes and part-time doctoral programmes;
- Classes repeated by a student as part of full-time degree programmes and full-time doctoral programmes due to unsatisfactory learning outcomes;
- Degree programmes offered in foreign languages;
- Classes not included in the outline of a study programme, including those leading to supplementary learning outcomes which should be achieved by students in order to enrol on second-cycle programme in a given field of study;
- Non-degree postgraduate programmes and in-service training courses; and
- Validation and certification of learning outcomes.

The amount of such fees is determined by the HEI's rector.

As regards the cost of part-time programmes, the Act on Higher Education states that fees may not exceed the costs incurred by the institution to establish and deliver programmes. This includes the cost of preparing and implementing the institution's development strategy and the development of academic staff and teaching, and the learning and research infrastructure, including depreciation and repairs. The fees for the validation and certification of learning outcomes may not exceed the costs incurred to deliver such services by more than 20 %. Detailed rules for charging fees, including the procedure and conditions for partial or full exemption from such fees, are laid down by an HEI's senate. Fee waivers may be granted to students or doctoral students who have

outstanding academic achievements or participate in international scholarship programmes, or to those who are in a difficult financial situation.

As from 2011, HEIs are required to conclude agreements with all students to determine the types and amounts of fees and conditions for collecting them. To be valid, an agreement should be concluded in writing no earlier than after the decision on admission and not later than 30 days after the courses commence. The agreement is concluded for the entire expected duration of study, and the student is not obliged to pay any fees other than those specified in the agreement.

An HEI does not charge fees for:

- Registration in the next semester or year of studies;
- Exams, including resit exams, exams conducted by a review examination board or final exams;
- The issue of a practical placement record book;
- The submission and assessment of a final thesis; and
- The issue of a diploma supplement.

However, public HEIs charge fees related to the admission process in individual fields of study. The maximum amount is determined annually in a regulation issued by the Minister for Higher Education.

Arrangements concerning doctoral programmes and doctoral students in research institutions other than HEIs are the same as those for HEIs, except that the amount of fees mentioned above is determined by the head of a given research institution.

5.1.2 Non-public HEIs

Non-public HEIs receive grants for tasks related to non-refundable financial support for students and doctoral students and to providing conditions for the full participation of disabled students and doctoral students in the learning process. The distribution mechanisms for these grants are described above.

In addition, a non-public HEI which complies with the requirements in the legislation may receive a grant for pro-quality tasks that may be used for tasks related to training full-time doctoral students and increasing doctoral scholarships for the best ones.

Students in non-public HEIs may apply for financial support in accordance with the same regulations as students in public HEIs.

Rules for charging fees and the amount of fees in a non-public HEI are determined by the body indicated in its statutes. However, fees for educational services relating to the provision of degree and doctoral programmes, and those for repeating courses within degree and doctoral programmes may not exceed the costs incurred for establishing and delivering such programmes or courses in the institution concerned. This includes the costs of devising and implementing the institution's development strategy, and in particular the development of academic staff and teaching and research infrastructure, including depreciation and renovation costs.

Full-time doctoral programmes are free in non-public HEIs if they receive a grant from the state budget.

5.2 Financing research activity[14]

With the exception of military R&D projects, which are financed through direct transfers from the Ministry of Finance to the Ministry of Defence, all government support for R&D is channelled entirely through the Ministry of Science and Higher Education. According to the Act on the Principles of Financing Science, there are seven major ways of financing:

[14] Chapter based on EC JRC, 2017.

1. Core funding for statutory R&D activities, i.e. institutional finance provided selectively to designated research organisations, units and university departments to cover the costs of their own research activities. Universities cannot use those funds to finance their educational or training activities;

2. Investments in R&D infrastructure, such as buildings and equipment;

3. Competitive, peer-reviewed research grants based on research proposals, presented by small research teams or individual researchers, no matter where they are employed or what scientific degrees they hold, as well as companies and consortia of all the above-mentioned.

4. Subsidies for strategic R&D programmes of national importance commissioned by enterprises, state administrative bodies or local authorities;

5. Subsidies for international scientific and technological cooperation;

6. Scholarships and awards, in particular for young researchers;

7. Subsidies for selected R&D support activities (e.g. information services, promotion, libraries etc.).

R&I funding is distributed directly by the MNiSW (e.g. statutory financing, investment in R&D infrastructure, international cooperation, scholarships and awards) or by two agencies supervised directly by the MNiSW:

- National Science Centre (NCN) – support through a system of competitive, peer-reviewed grants fundamental research, primarily performed by researchers from PROs;
- National Centre for Research and Development (NCBiR) – financing strategic R&D programmes and supporting primarily applied R&D in business enterprises and science-industry consortia.

Other founders of R&I related activities, in particular innovation and start-up activities, are also financed from other R&D budget resources, including:

- The Polish Agency for Enterprise Development (PARP) – supporting innovations and entrepreneurship, including funding for start-ups and industrial development;
- The National Capital Fund (KFK) – managing venture capital funds based on co-funding from the EU Structural Funds, 2007-2013;
- The Polish Development Fund (PFR) – newly established sovereign fund that is expected to play a key role in future R&I funding;
- The Industrial Development Agency (ARP) – coordinating management of selected state-owned enterprises and making venture capital and other equity investments in innovative companies;
- The Foundation for Polish Science (FNP) – a non-governmental institution, distributing European Structural and Investment Funds (ESIF) funding targeting public science;
- The Wittels Fund – newly created fund of funds that will hold shares in venture capital funds, based on the ESIF to offer equity investments in innovative high-tech companies; and
- The National Fund for Environmental Protection and Water Management (NFOŚiGW) – financed from environmental fees and the ESIF and offering dedicated, substantial R&I funding for eco-innovations.

In 2016, the government streamlined some of its expenditure, applying the principles of smart fiscal consolidation while raising spending on selected social objectives. This resulted in a reduction in the science budget, which nevertheless did not affect the amount of available competitive R&D funding. The science budget for 2016 was smaller than that executed in 2015 by 6.64 % (calculations based on: MNiSW, 2016c; MNiSW, 2016c), although expenditure was rationalised, with core R&D expenditure actually increasing, including: funding for NCN up by 14.17 %, national

funding for NCBiR rose by 23.87 % (although its overall funding fell by 28.74 % as it was tasked with distributing a substantial amount of EU Structural Funds in the last year of the financial perspective), and spending on defence-related R&D projects increased by 86.56 %. These three nationally funded R&D streams translate into approximately PLN 518.97 million (EUR 124 million) more grant financing available to beneficiaries in Poland in 2016.

Following the large institutional reform of science and higher education in 2010-2011, the focus was reoriented towards competitive project-based funding for R&D, although the funding available from the NCN can only be distributed among a limited number of research teams. The NCBiR focuses on business enterprises or research consortia driven by companies. Many scientists complain about the current focus on scientific competitiveness and performance-based funding, using the pejorative Polish neologism "*grantoza*", which may be translated as "grant-based illness".

Statutory financing

As described in Chapter 3.5, based on the outcomes of the institutional evaluation, organisations fall into specific categories. The best-performing receive A+ or A category, good ones category B and the least-performing category C. Organisational assessments are carried out at faculty level (not entire universities, i.e. worse-performing university departments/faculties cannot benefit from the successes of others).

These categories and the amount of organisational funding assigned are calculated on the status and number of full-time researchers employed by the organisation, with dedicated allocations assigned to young researchers and doctoral students, and the costs of infrastructure maintenance. The expectation is that statutory funding will be used for maintaining research organisations' research potential. In eligible cost categories in statutory financing are:

- Maintenance of research potential of research organisations, including:
    - measures necessary for the development of scientific specialties or directions of research and development and development of scientific staff
    - maintenance of research infrastructure, including libraries and archives
    - costs associated with the employment of the necessary scientific, engineering and technical staff
    - purchase or construction of scientific equipment
    - domestic and international scientific cooperation
    - dissemination of science
    - activities related to the commercialisation of the results of R&D activity (analysis of the market, analysis of the state of the art, patent protection, etc.)
    - tasks associated with the employment of disabled scientists and doctoral students
    - restructuring costs of research units;
- Maintenance of special research equipment, including IT infrastructure;
- Activities of basic organisational units in universities, institutes of the Polish Academy of Sciences, research institutes and international scientific institutes conducting R&D work and related tasks, contributing to the development of young scientists and doctoral students funded by the internal competition procedure; and
- Activities of research organisations securing access to scientific information, in particular information about the results of research, publications and monographs, including the Virtual Library of Science – a sharing system of electronic scientific databases and scientific publications.

The amount of funding for maintaining the research potential of research organisations depends on:

- The category of the research organisation;
- The estimated cost of research calculated for various fields of science;

- The nature of the research organisation (PRO type), and their importance for the implementation of scientific, technological and innovation policy;
- The number of staff (FTEs);
- The amount of funding granted to the research organisation in the preceding year; and
- The funds planned for this purpose in the state budget.

The amount of funding for the activities of basic organisational units in universities, institutes of the Polish Academy of Sciences, research institutes and international scientific institutes, depends on:

- The category of the research organisation;
- The estimated cost of research calculated for various fields of science;
- The number of young researchers (FTEs);
- The number of young researchers (FTEs) who received a doctorate degree outside the research organisation where they were employed, in the year preceding the year of application;
- The number of doctorate and habilitation degrees granted at a research organisation in the year preceding the year of application;
- The number of doctoral students in the research organisation in the academic year in which the application is made; and
- The amount of funding granted to the research organisation in the preceding year.

Beneficiary organisations apply each year for funding, outlining ongoing research projects to be supported from the budget, and then reporting the results achieved.

A formally defined algorithm determines the level of statutory funding based on: (a) the outcomes of the most recent organisational assessment, and (b) the level of funding granted based on a previous assessment. However, from 2010, part (b) of the algorithm gradually decreased until disappearing completely in 2015 with the new ordinance on financing the statutory activities of scientific institutions. In 2014, block funding represented only 77 % of the amount received in 2013. Therefore, in order to alleviate negative consequences, in the intermediate period (until 2017) there is a maximum threshold for increasing or decreasing research institute funding per number of full-time researchers, to avoid abrupt shocks to the system.

6 HUMAN RESOURCES

Main challenges
• Low level of R&D staff per 1000 citizens, in particular in business sectors;
• Age structure of R&D staff, in particular in institutes of the Polish Academy of Sciences (PAN) and research institutes (IB);
• Ridged career path rules do not stimulate intersectoral and interinstitutional mobility;
• Limited attractiveness of Polish HEIs and PROs as a destination for foreign students and researchers.

6.1 General overview

6.1.1 HR in R&D activity

In 2014, 153 500 people were employed in R&D in Poland, 104 400 as full-time equivalents (FTE). Compared to 2013, these numbers have increased by 5.4 % and 11.3 %, respectively. Poland holds a relatively low position in terms of R&D employment in the EU. In 2013, it was 25th in the EU in terms of employment in R&D in FTE per 1000 people employed, but was placed 23rd in a similar ranking of researches employed in R&D.

In 2015, the number of employees in R&D activities in different sectors was as follows:

- Government sector (mainly the Polish Academy of Sciences and research institutes) – 26 459 people (a drop of 4.1 %), including 15 468 researchers (decreasing by 3.6 %);
- Higher education sector – 82 282 people (a fall of 0.2 %), including 70 658 researchers (0.2 % lower);
- Corporate sector – 48 963 people (a rise of 13.4 % compared to the previous year), including 32 204 researchers (an increase of 13.5 %);
- Private-sector non-profit institutions – 217 people (a drop of 11.8 %), including 164 researchers (a 2.4 % decrease).

In 2015, the largest share of those employed in R&D activity (measured in FTE) was recorded in engineering sciences – 45.3 %, followed by the natural sciences – 19.4%, medical and health sciences – 12.0 %, social – 10.2 %, and humanities – 7.7 %, while the lowest proportion occurred in the agricultural sciences – 5.4 %. The structure of employment in the fields of science and technology was clearly differentiated by sectors. In engineering sciences, more than half of the personnel involved in R&D were employed in the business sector. In the social sciences and humanities, over 80 % of staff were employed in the higher education sector.

In 2014, the supply of human resources in science and technology amounted to 8.1 million. The largest and most important group employed in science and technology are those who successfully completed tertiary education (3.5 million). In the analysed year, women constituted 60.2 % of this group.

6.1.2 Gender issues

Gender balance seems to be an issue when it comes to researchers. Between 2010 and 2014, even though the share of women among newly promoted PhDs exceeded 50 %, it was much lower in the case of habilitation degrees awarded (40 % in 2014) and the title of professor (33.7 % in 2014).

In terms of policy directions, Poland is seeking to promote gender equality. There are several provisions in the Polish Labour Code that prohibit the discrimination of women in access to the labour market. To help women maintain their work-life balance, the Code offers additional protection for pregnant women and those on maternity leave.

To support female researchers, there are special ways of calculating the maximum age while applying for young researchers' grants, which exclude the duration of maternity and child-care leave when defining the age of eligibility. These rules have been adopted by both R&D funding agencies (NCN and NCBiR). Similar rules apply to students and PhD students who can extend their study periods on this basis (as stipulated by the Ordinance of the Minister of Science and Higher Education, 2011).

Polish women scientists can benefit from several dedicated programmes and competitions. 'New Technologies for Girls', organised by Intel Technology Poland, and the Educational Foundation 'Perspectives' offers professional support, financial assistance and internships for high-school female graduates and female students at technical universities. Foundation L'Oréal and UNESCO offer a scholarship programme called 'Women and Science'. In February 2016, the Association TOP500 Innovators and the Educational Foundation Perspectives launched a new mentoring programme 'Girls go start-up!' dedicated to women scientists and young women entrepreneurs. The aim is to promote the engagement of women in STEM (science, technology, engineering and mathematics) studies, support them with knowledge about start-up creation, and help to accelerate their ideas. Moreover, the Conference of Rectors of Polish Technical Universities manages a programme and promotional campaign known as 'Girls on technical universities'. The initiative 'LeadersIN', launched in June 2016 by the Polish branch of the Vital Voices in co-operation with various enterprises (including Bank BPH, Citi, Coca-Cola HBC, Dell, Deloitte, Google, JLL, MetLife, Microsoft, Rothschild and T-Mobile) is dedicated to women managers. It addresses the need to increase the number of women leaders and ensure their professional advancement. As of 2016, the number of women-oriented initiatives has been growing. It is worth noting that most of these initiatives are run by non-government entities.

6.1.3 HR in academia[15]

Students

In 2015, according to data from the system POL-on, there were nearly 1.31 million students in Polish HEIs. Compared to 2013, the number of students fell by 7 %. Although the number of public universities is smaller, over three-quarters of the students attended these institutions. In 2013-2014, in absolute numbers, public universities reported a larger student outflow than private universities. However, in percentage terms, the opposite is true. There was only a 5 % drop in the number of students in public universities, falling by as much as 13 % for non-public schools. The gross enrolment ratio indicates a gradual decrease from 53.8 % in the academic year 2010/2011 to 49.2 % in 2013/2014.

Statistics on the mode of study indicate that the number of full-time students is almost twice as many as part-time students. While the population of full-time students decreased over the last two years by just 0.8 %, simultaneously the number of people enrolled part-time fell by as much as 17.5 %. In public universities, the number of full-time students exceeds the number of part-time students by 3.5 times. Meanwhile, in private universities, the situation is reversed: there are 3.5 times fewer full-time students than part-timers.

Women students accounted for approximately 58 % of all students with the share of women in the student population remaining relatively stable between the academic years 2010/2011 to 2014/2015. As for STEM students, who constitute approximately 29 % of all students, the share of

[15] Chapter based on EC JRC, 2017.

women is much lower: in 2014, it was 41.6 % (GUS, 2015c). Moreover, the share of women studying at technical universities has increased steadily since 2007/08, when it was 30.7 % of the total number of students. As of 2014/15, women account for nearly 37 % of students in technical universities, a trend which is gradually strengthening (Perspektywy.pl, 2016). Nevertheless, women participating in PhD programmes in technology and engineering only accounted for just over 10 %.

To reduce the negative effects of a demographic decline, higher education entities enrich their educational offers by creating more courses and trying to attract foreign students. Invariably, social sciences and humanities rank highly in the hierarchy of the most popular fields of study. Law and medicine continue to be popular choices. The higher number of foreign students have been noted at private schools, which rose to 29 % of full-time students in 2015.

The demographic decline reduced the demand for paid educational services and generally affected the financial state of the higher education system. In 2015, as regards public universities, the net result was positive, as in previous years (2012-2014). However, in the same period, for the first time, private universities recorded a negative result. Therefore, it is possible to forecast a lower trend in the number of private universities in Poland. Primarily, this issue is most likely to concern small and medium-sized HEIs and those with negative financial results.

A systematic increase in the number of foreigners in Polish universities confirms that the country is slowly becoming an attractive destination for students from abroad. There were 53 000 foreign students in 2015, representing 4 % of the total student population. Their most popular mode of study was full-time at non-public universities, while in terms of field of study, medical sciences came top.

Despite the demographic decline, the increased availability of academic staff to students should be considered a positive trend. Nevertheless, a further decline in the number of students in future could lead to a drop in the demand for academic posts. On the other hand, a reduced teaching load for the academic staff may result in their greater involvement in research.

By far the largest number of students are in the field of social sciences (550 000), with the economy still the most popular field of study. Second place goes to the technical sciences, although this has far fewer students (319 000).

Interest in multidisciplinary studies remains stable, applying to less than 4 % of students, often women and students studying at public universities. Law is the most popular field of education to be studied in parallel with other courses.

In recent years, a steady increase has been recorded in the number of doctoral students at Polish public and private universities. In 2005, approximately 31 600 doctoral students were registered In the POL-on system, while in 2015 this number increased by 10 000 (to around 42 000). The vast majority of PhD students are studying at public HEIs, mainly universities (21 839 students) while technical universities (7855 students) are in second place. A significantly smaller number of doctoral students study at medical universities (3183) and universities of economics (2092).

Despite the increase in numbers studying technical sciences, the socio-humanities profiles remain the most popular. Doctoral students in humanities and social sciences represent 55 % of all doctoral students.

However, this increase is not reflected in the number of open doctoral procedures and a significant rise in those granted a doctoral degree. This may be due to the growth of requirements in the procedure for starting a doctoral degree.

In 2015, 395 200 students graduated from universities of all types (first degree, second degree and Master studies) including 64.8 % women and 1.8 % foreigners. The number of graduates the science and technology (S&T) reached almost 98 000, accounting for 24.7 % of the total graduate population. In the group of S&T graduates, 44.7 % were woman.

Structure of the academic staff

Despite the decline in student numbers, a slight increase academic staff has been observed. In 2015, there were more than 95 000 academics in Poland, the vast majority of whom (90 %) were employed in the public sector. The private higher education sector has recently recorded a systematic decline in staffing. In 2015, private universities employed 11 400 teachers which is only about 12 % of the total number of Polish academics.

The decrease in student numbers at the same time as a slight rise in the number of academic staff has the potential to create a better environment between students and teachers. In 2015, the average ratio of teachers to students was 1 to 14, respectively. However, this was slightly lower (1 to 12) at public universities, while in the private sector it was almost double (more than 1 to 26).

The clear majority of academic staff are research and teaching staff (74 % at public universities and 70 % for non-public), although one-fifth of employees in higher education are only teachers.

Most academics, as many as 44 000, are aged between 40-59 years (in this group, 53 % have a doctorate degree, and 25 % a habilitated doctor). However, 38 % of professors are 60 years or older.

Women represent a significant part of the total academic staff – 43 000 (45 % of the total). In the two youngest age groups – up to 30 years and 30-39 years – women outnumber male academics. In the 40-49 group, the gender ratio is more balanced but there is systematic decline in numbers of women researchers which declines with successive stages in their scientific career. Only 14 % of women have a postdoctoral degree and 6 % have a professorship, while 21 % of men have a postdoctoral degree and 16 % are professors.

The phenomenon of multiple employment, defined as work contracts with more than one university, affects one in 20 academic researchers. Similarly, habilitated PhDs and professors are more likely to be employed in parallel in more than one university, a feature more common among men than women.

The main human resource indicators are presented in Table 10 below.

Table 10: Supply of human resources

	2010	2014	2015
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	NA	0.44	NA
New graduates in STEM per 1000 population	2.59	2.79	NA
Number of researchers per 1000 population	2.65 (2011)	3.03	NA

Source: Eurostat, 2016

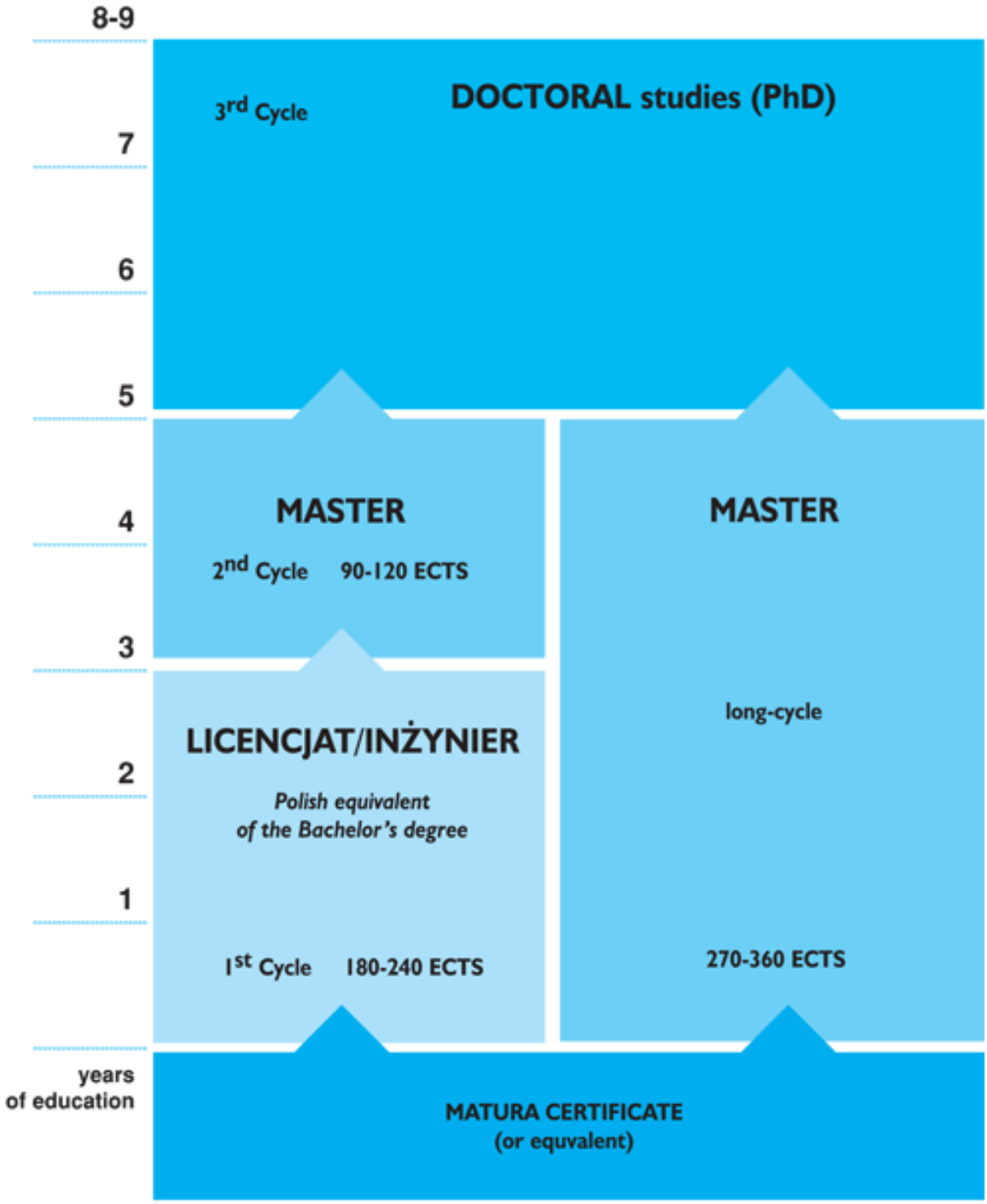
6.2 Structure of studies[16]

The HEIs run full-time, part-time (extramural), evening and external courses. Full-time courses are defined as the basic type of studies.

Poland conforms to the guidelines from the Bologna Process in European higher education. The degree system, based on the three-cycle structure, has been successfully implemented together with the European Credit Transfer and Accumulation System (ECTS). The European standard in higher education makes it easier for students to obtain recognition of their qualifications in other countries.

[16] Chapter based on EURYDICE, Country Pages: Poland; https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Overview

Figure 8: Cyclic structure of the Polish education system



Source: http://www.studyinpoland.pl/en/index.php/education-in-poland/9-polish-education-system

6.2.1 1st cycle

First-cycle studies (3 to 4 years) leading to the professional title of *licencjat* or *inżynier* (engineer, in the field of engineering, agriculture or economics). This is the Polish equivalent of the Bachelor's degree and focuses on preparing students for future employment or continued education in Master's degree programmes. To obtain this degree, students must earn 180-240 ECTS credits.

6.2.2 2nd cycle

Second-cycle studies – Master's degree programme (1.5 to 2 years) following the first-cycle studies and leading to the professional title of Master (*magister*, or an equivalent degree depending on the study course profile). It focuses on theoretical knowledge as well as the application and development of creative skills. In artistic disciplines, the emphasis is on developing creativity and talent. Master's degree holders may enter a doctoral programme (third-cycle studies). To obtain a degree, students must earn 90-120 ECTS credits.

6.2.3 Long-cycle studies

In addition to the general structure, 11 fields of study, including drama, art conservation and restoration, canon law, dentistry, law, medical analysis, medicine, production and photography, pharmacy, psychology and veterinary medicine, only offer long-cycle programmes.

Long-cycle studies – Master's degree programme (4.5 to 6 years) leading to the professional title of Master (*magister*, or an equivalent degree depending on the study course profile). To obtain this degree, students must earn 270-360 ECTS credits. Such single long-cycle studies are based on an integrated study programme covering both basic studies and in-depth specialisation. Completion of this degree will provide a qualification corresponding to the Master's degree in second-cycle studies.

6.2.4 3rd cycle

Third-cycle studies – Doctoral degree programmes (normally 3 to 4 years) accessible for graduates of Master's degree programme, leading to a PhD degree, offered by the university-type schools as well as some research institutions (departments of the Polish Academy of Sciences as well as research and development institutions). The PhD degree is awarded to candidates who submit and successfully defend a doctoral dissertation before the thesis committee and pass the doctoral examination.

6.2.5 Examinations

All higher education institutions are required to complete their courses with examinations. There may be several independent examinations or tests in separate parts of a subject. Usually, oral and written examinations are held during the examination session at the end of each semester. Students sit examinations on each subject separately. The performance assessment period covers either one semester or one academic year. To successfully complete a semester (or a year), a student must attain the pass mark (at least 'satisfactory') for all assessments and examinations in the subjects covered by the curriculum and obtain performance assessment credits for all integrated placements.

Grading: Each HEI identifies its grading scale in its study rules. The most common scale is based on the following marks:

- 5 very good (*bardzo dobry*)
- 4 good (*dobry*)
- 3 satisfactory (*dostateczny*)
- 2 unsatisfactory/fail (*niedostateczny*), and
- credit/pass (*zaliczenie*).

It must be pointed out that grades awarded on this scale are not directly transferable to ECTS credits.

6.2.6 ECTS credits

In addition to the grading scale, there are HEIs in the ECTS under which a certain number of credits is allocated to a given subject, independently of marks awarded. To complete a year successfully, the student must collect 60 credits (30 per semester).

The ECTS is the standard adopted by all universities in the EHEA in the convergence process between Europe's higher education systems. Since 2007, all Polish HEIs have been required to use ECTS for both credit transfer and accumulation within their degree programmes. The ECTS credits allow foreign students' periods of study at HEIs in Poland to be recognised.

6.2.7 Diploma

To graduate, students are required to:

- Pass a performance assessment in all subjects, integrated placements and practical work sessions, and pass all examinations covered by the study programme set for a given field of study;
- Present, at an appointed date, a diploma project and attain a pass mark for that project;
- Pass the diploma examination.

Upon graduation, the student receives a completion of studies diploma in a specific field of study together with a diploma supplement (copy of the diploma translated into a foreign language, describing the degree, level and specialisation).

6.2.8 Academic calendar

The academic year in Poland is divided into two semesters of 15 weeks each – the winter and the summer semester. The former starts in October and ends in mid-February, with a break of about 10 days for the Christmas holidays. The examination session usually takes two to three weeks, beginning in January. The summer semester starts in mid-February and ends in June, with a one-week break for Easter. Summer holidays last for three months from the beginning of July to the end of September, but only for those students who pass all their exams in the summer examinations (two-three weeks in June). Those who fail resit the exams in September.

6.3 Career paths in research and HE[17]

6.3.1 Degrees/professional titles, academic/research degrees and the academic/ research title

Professional titles are Bachelor's degrees (*licencjat* or *inżynier*) and Master's degrees (*magister* or *magister inżynier*) or equivalent degrees.

Academic/research degrees include a doctoral degree (*doktor*) and a postdoctoral degree (*doktor habilitowany*) which are awarded within a given area of science or scientific discipline. Doctoral degrees are conferred through so-called doctoral proceedings/a PhD award procedure, and post-doctoral degrees through postdoctoral (*habilitacja*) proceedings/award procedure, initiated at the request of the person applying for a degree.

The academic/research title is the title of professor (*profesor*) in a given area of science. The title is conferred for a lifetime, and for all research/scientific achievements, by the Polish President, at the request of the Central Commission for Degrees and Titles (responsible for ensuring the harmonious development of research staff in line with highest research standards required for the award of the academic degrees and titles).

The rules for conferring the two academic degrees and the academic title are laid down in the Act on the Academic Degrees and Title, and in the Degrees and Title in the field of Art. The award requirements defined in the Act are minimum requirements.

[17] Chapter based on EURYDICE, Country Pages: Poland;
https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Overview

6.3.2 Conditions of service for academic staff working in higher education

The status and conditions of service for academic teachers and other higher education staff are regulated by the Act on Higher Education and a number of regulations adopted on its basis.

Matters relating to authorisations to award doctoral and postdoctoral degrees (*doktor* and *doktor habilitowany*) and the title of professor (*profesor*), which are required for holding or promoting to higher-level research-and-teaching and research positions, as well as related award procedures, are regulated by the Act of 14 March 2003 on the Academic Degrees and Title and the Degrees and Title in Art.

Research-and-teaching staff and research staff are employed in the following positions:

- Full professor/Professor ordinarius *(profesor zwyczajny)*
- Associate professor/Professor extraordinarius *(profesor nadzwyczajny)*
- Visiting professor *(profesor wizytujący)*
- Assistant professor *(adiunkt)*, and
- Assistant *(asystent)*.

Teaching staff are employed in the following positions:

- Senior lecturer *(starszy wykładowca)*
- Lecturer *(wykładowca)*, and
- Foreign language teacher *(lektor)* and instructor (*instruktor)*.

Academic teachers may be people who:

- Have the qualifications specified in the Act on Higher Education
- Have full legal capacity
- Have not been convicted of an intentional offence by a valid court judgement
- Have not been punished by a disciplinary penalty specified in the Act on HE, and
- Have full civic rights.

The requirements for individual positions are as follows:

- The position of full professor (*profesor zwyczajny*) may be taken up by a person holding the academic title of professor (*profesor)*;
- The position of associate professor *(profesor nadzwyczajny)* may be taken up by a person holding a postdoctoral degree (*doktor habilitowany*) or the academic title of professor;
- The position of visiting professor (*profesor wizytujący*) may be taken up by a person employed in another HEI who holds a postdoctoral degree (*doktorhabilitowany*) or the title of professor;
- The position of assistant professor (*adiunkt)* may be taken up by a person holding at least a doctoral degree (*doktor)*;
- The position of assistant (*asystent)* may be taken up by a person holding at least a Master's degree (*magister*) or an equivalent degree.

Teaching staff positions may be taken up by those holding a Master's degree (*magister*) or equivalent. As of 1 October 2016, the rector of an HEI may also employ in the position of associate professor or visiting professor a person with a doctoral degree awarded in Poland or abroad who has led research teams in another country for at least five years and has significant research achievements (*Journal of Law* 2015, item 1767).

The requirements concerning the level of formal qualifications and the academic degree or title (*doktor*, *doktor habilitowany* or *profesor*, respectively) to be held by research-and-teaching staff – research staff and teaching staff – are defined by the Act on Higher Education. HEI statutes may define additional requirements and professional qualifications for research-and-teaching, research and/or teaching staff.

Academic teachers are employed in public HEIs for either a definite and indefinite period, based on an open competition procedure should their working time exceed 50 % of the statutory working hours.

Competition procedures and conditions are laid down in HEI statutes. They publish announcements on their websites and those of the Ministry of Science and Higher Education, another ministry supervising a given HEI (where applicable), and the European Commission on the European portal for mobile researchers.

An academic teacher who is entitled to retirement may be re-employed in the same position in the same HEI without a competition procedure. Similarly, the regulations concerning competition procedures are not applicable where, for a definite period, an HEI employs an academic teacher who:

- Has been seconded to work in the HEI based on an agreement concluded with an academic institution abroad;
- Is a beneficiary of a grant under a national call published by the NCN or the NCBiR or an international call for research proposals related to a given academic area where degree programmes are offered;
- Is employed for the implementation period of a project funded by the EU or another grant-awarding body; or
- Is employed in the same position if the previous employment contract was concluded for a period of at least three years.

Recruitment arrangements in non-public HEIs are laid down in their internal regulations.

6.3.3 Professional status

Academic teachers are employed on the basis of appointment, providing greater legal protection, or an employment contract. They may be employed by appointment only when they hold a professorial title and are employed on a full-time basis in a given HEI as the place of their primary employment.

The employment relationship with academic teachers is established by the rector in public HEIs or by the body specified in the statutes in non-public HEIs, in both cases following a procedure laid down in HEI statutes.

Upon the rector's consent, academic teachers in public HEIs may work under an employment relationship for only one additional employer involved in teaching or research activities. Taking up or continuing additional employment without the rector's consent is the basis for termination of employment in the public HEI which is the teacher's primary employment.

Academic teachers are an intellectual and scientific elite; they enjoy the freedom to conduct scientific research, freedom of artistic creation and freedom of teaching. They benefit from the entitlements granted to creators in respect of copyright protection.

Statutory duties of research-and-teaching staff and research staff include:

- Conducting scientific research and development work;
- Developing research and artistic activities; and
- Participating in the performance of organisational tasks in their institution.

Research-and-teaching staff are also obliged to train and educate students.

Statutory duties of teaching staff include:

- Training and educating students;
- Upgrading professional qualifications and skills; and
- Participating in the performance of organisational tasks in their institution.

All academic teachers are subject to periodic assessment which concerns the performance of their statutory duties, and observance of intellectual property, related rights and industrial property rights.

Assessment is carried out by the body specified in the HEI's statutes at least every two years, or every four years for teachers with a professorial title and employed on the basis of appointment, or at the request of the head of the basic organisational unit (the dean of a faculty where faculties are basic organisational units) where the teacher is employed.

Assessment procedures and criteria are laid down in HEI statutes, but HEIs are obliged to take into account student and doctoral student course evaluations when assessing teaching performance.

Conditions for the termination or expiry of an employment relationship with academic teachers employed on the basis of appointment include:

- The teacher's inability to perform work due to health reasons;
- The liquidation of an HEI;
- The teacher being convicted by a valid court judgement or punished by a disciplinary penalty; or
- A negative assessment of the teacher's performance.

In the case of a negative performance assessment, the HEI rector may terminate an appointed teacher's employment, while in the case of two successive negative assessments, the rector is obliged to terminate it.

An employment relationship with an academic teacher on an employment contract is terminated or expires in accordance with the generally applicable provisions of the Labour Code.

In addition, this group of teachers is subject to the same provisions concerning termination of an employment relationship due to negative performance assessment as those employed on the basis of appointment.

6.4 Mobility[18]

In recent years, a systematic increase has been observed in universities' internationalisation process. This is evidenced by the two phenomena: first, Polish academic staff eagerly take advantage of the wide offer of internships abroad. Poland is also amongst the leading EU Member States to host foreign academic researchers within the framework of the Erasmus programme.

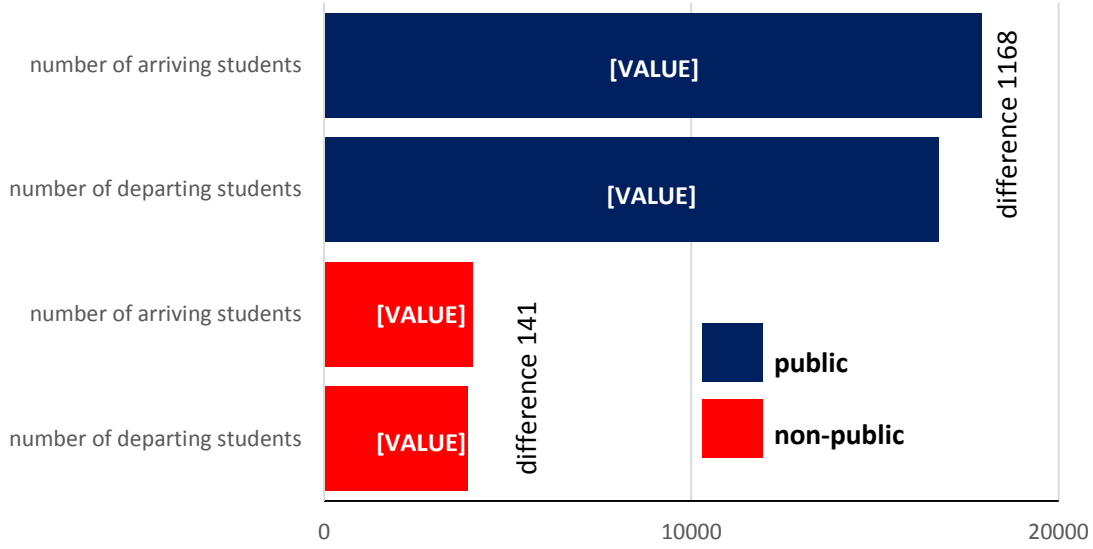
Secondly, Polish universities have extended their offer to foreign students. However, despite the increase in foreign students, their share in the total number of students remains low. Nevertheless, visible and positive changes in internationalisation would appear insufficient to compensate for the negative consequences of long-term demographic trends.

6.4.1 Student mobility

Students participate in mobility primarily within the EU Erasmus+ programme, although there are also multilateral and bilateral programmes and national programmes or initiatives. National initiatives are targeted at both Polish and international students.

[18] Chapter based on EURYDICE, Country Pages: Poland; https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Poland:Overview

Figure 9: Number of students departing/arriving in the academic year 2014/2015



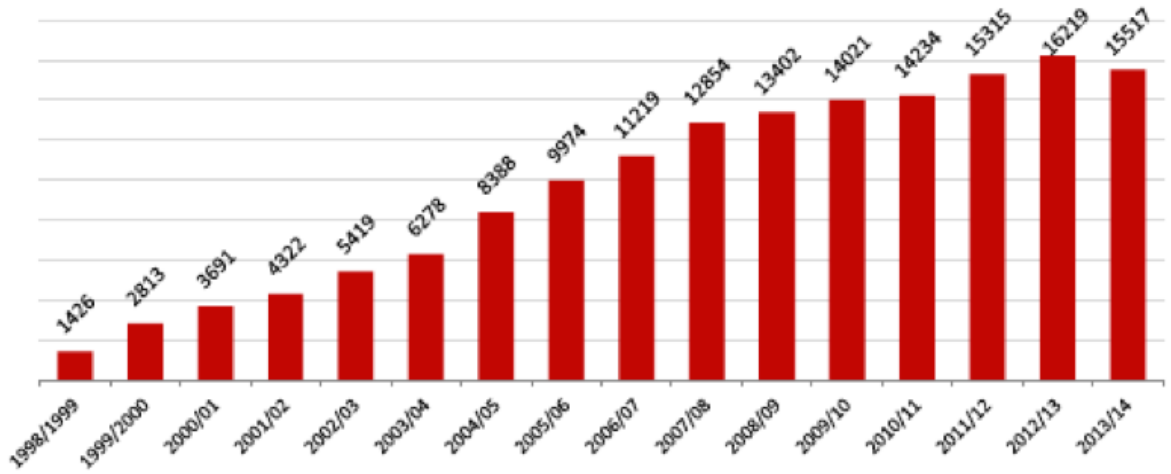
Source: OPI, 2016

6.4.1.1 EU Programmes

In 1990, opportunities arose for Polish students to undertake a study period in EC countries when the European Community launched the TEMPUS programme for Poland, Hungary and the former Czechoslovakia. In 1998, like other EU candidate countries, Poland joined the intra-Community Socrates programme (Stage I: 1995-1999; Stage II: 2000-2006) whereby students could undertake a period of study within the framework of the Erasmus (sub-)programme. Between 2007 and 2013, Erasmus was part of the larger EU Lifelong Learning programme. In the academic year 2013/2014, 331 Polish universities (among a total of 4900 European universities) participated in Erasmus+ programme (2014-2020) offering students several mobility opportunities.

In total, in the period 1998–2014, 155 092 Polish students participated in Erasmus programmes, 135 825 of them for a study period and 19 267 for short-term practices.

Figure 10: Departure of Polish students, 1998-2013



Source: http://www.erasmus.org.pl/sites/erasmus.org.pl/files/Erasmus_statystyki_12-2015.pdf

In the period 1998-2014, the top five destinations for study periods for Polish students were Germany (30 296 students), Spain (20 727), France (15 116), Italy (12 707) and Portugal (9085). In the same period, Poland hosted approximately 68 000 foreign students, while in 2014 there were only 11 696 students. Poland was chosen as a destination mainly by students from Spain (14 304), Turkey (12 895), Germany (8494), France (7456) and Portugal (5656).

6.4.1.2 Multilateral programmes

Central European Exchange Programme for University Studies, CEEPUS

CEEPUS is the first multilateral co-operation programme in education in Central Europe, established on the basis of an international multilateral agreement. Poland has taken part in the programme since 1994. The other participating countries are: Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Hungary, Macedonia, Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia and Kosovo. The CEEPUS programme supports mainly the establishment of inter-university networks whereby partners from at least three countries offer joint programmes and doctoral programmes. Within this framework, the programme offers scholarships to students and academic teachers based on the principle that each country is required to fund at least 100 scholarship months for inward mobility in each academic year. Scholarships are granted for short study visits, semester study periods and practical placements. Support is also provided for training seminars, language courses and specialist courses.

In various forms of education and professional qualifications, more than 500 Polish students and doctoral students and approximately 300 teachers participate every year in ongoing CEEPUS projects. On average, during the academic year, around 300 foreign and graduate students and approximately 200 teachers come to Poland under the programme. CEEPUS is recognised as the second most important multilateral co-operation programme in higher education (after Erasmus) for MNiSW.

International Visegrad Fund

The International Visegrad Fund was created in 2000 by the prime ministers of the Czech Republic, Slovakia, Poland and Hungary (V4 countries). Each country makes an equal contribution to the fund. Moreover, the fund is supported by other governments or government organisations, including Canada, Germany, South Korea, the Netherlands, Sweden, Switzerland and the United States. Currently, it aims to strengthen co-operation among the V4 countries and between them and other countries, in particular in the Western Balkans and the Eastern Partnership Regions. The fund awards grants for various projects and individual scholarships. The latter include scholarships for Master's degree studies and post-Master (PhD and postdoc) research stays for a period of either one to two semesters, or one to four semesters in the case of Master's studies. Scholarships are available to students from the V4 countries as well Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kosovo, Macedonia, Moldova, Montenegro, Russia, Serbia and the Ukraine.

6.4.1.3 Bilateral programmes/initiatives

Bilateral agreements

Poland has signed bilateral agreements for scholarship-based exchanges and/or recognition of qualifications with 35 countries, mainly EU Member States, and Armenia, Kazakhstan and the Ukraine, Macedonia, Turkey, China, Mongolia, Japan and Vietnam, Israel and Egypt. In some of the agreements, the Polish government and/or the partner country offer(s) a number of scholarships to academic staff and students. Types and conditions of mobility depend on the arrangements agreed with individual countries.

6.4.1.4 Scholarship programmes

Fellowship Fund

The Fellowship Fund was established in 2009 within the framework of the Sciex-NMSch Scientific Exchange Programme between Switzerland and the new EU Member States for the period 2009-2016. It aimed to contribute to reducing economic and social disparities within the enlarged EU by developing the capacities of Polish academic staff and promoting sustainable partnerships between a new Member State and Switzerland in research. Fellowship Fund projects are designed mainly to establish research partnerships to develop the capacities of individual researchers and help to establish or strengthen links between researchers. The total budget allocated by Switzerland for the Polish Fellowship Fund was CHF 12 million (approximately EUR 11.21 million). The programme,

which ran from 1 April 2009 to 31 December 2016 was implemented in Poland by the Swiss institution, CRUS (Conference of Rectors of Swiss Universities).

The following types of projects have been supported by the Fund:

- Fellowship visits undertaken by doctoral students and young researchers (with a PhD) to conduct research in Swiss research institutions; fellowships are awarded for a period of six to 24 months;
- Visits undertaken by senior Polish or Swiss researchers to develop research projects or in connection with their implementation: five-day stays in Switzerland or Poland.

The Fellowship Fund was open to researchers in all academic disciplines.

Fullbright Programme

As part of the Fullbright Programme, the Polish-US Fullbright Commission offers scholarships for studies and research stays funded by the Polish Ministry of Science and Higher Education and the US State Department. Scholarships are awarded, among others, to graduates from Polish HEIs who plan to take up, or have been enrolled on the first year of a Masters or PhD studies at US institutions (nine months to a full academic year); PhD students preparing their doctoral theses at Polish higher education or research institutions for a research project to be carried out at an US institution (six to nine months); and to US citizens for postgraduate studies or research at Polish higher education or research institutions (up to nine months).

6.4.1.5 Other international/bilateral scholarship programmes

Lane Kirkland Scholarship Programme

The programme was launched in 2000 and is funded by the Polish-American Freedom Foundation. Scholarships (around 50 per year) for studies at Polish HEIs are currently awarded to students from Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova, Russia and the Ukraine. The programme is managed by the Education for Democracy Foundation.

6.4.1.6 National programmes/initiatives

Studies abroad for outstanding Polish students and graduates

A Polish government programme 'Studies for the Outstanding' (*Studia dla wybitnych*) was announced in 2015. It is designed to provide grants for studies at the best international universities in the Shanghai Ranking (Academic Ranking of World Universities) for Bachelor's degree programme graduates and outstanding students who have completed the third year of a Master's degree programme. The new government (which took office in November 2015) is working to improve the programme's application and selection procedures.

6.4.1.7 Scholarship programmes/funds for international students

Polish Erasmus for Ukraine

The programme, launched in 2014 by the Ministry of Science and Higher Education, is based on the same principles as the EU's Erasmus programme, providing opportunities to undertake a fee-free study period (two semesters) at Polish HEIs. Scholarships are available to students, including PhD students, from the entire Ukraine territory, but priority is given to those living in military conflict areas.

Other scholarship programmes

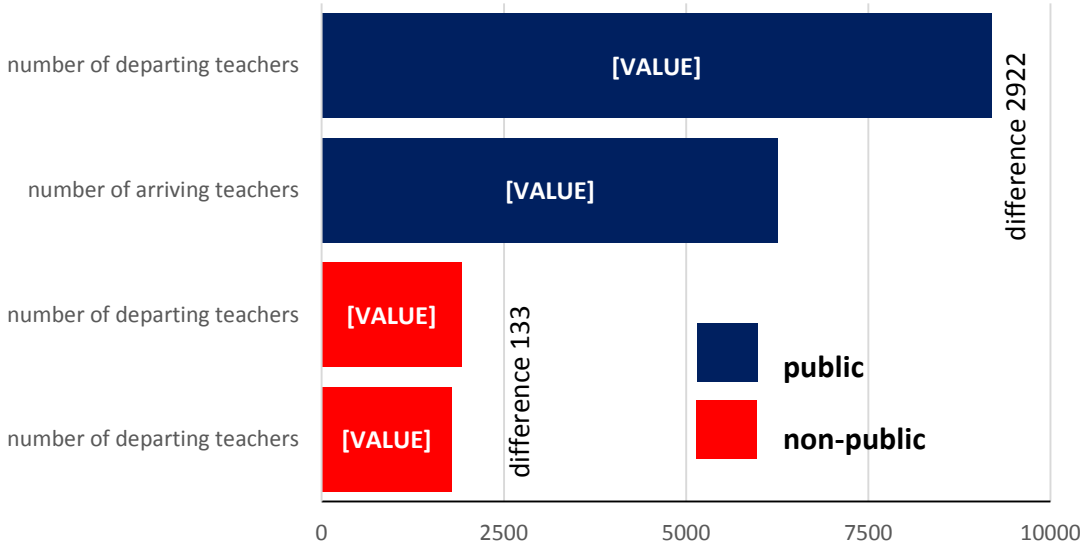
There are several government scholarship programmes open to students from Eastern Partnership and post-Soviet countries, including, for example: the Konstanty Kalinowski Scholarship Programme; the Programme for specialist Eastern Studies students; and the Stefan Banach Scholarship Programme for second- and third-cycle studies.

6.4.2 Academic staff mobility

For many years, Poland has been at the forefront of those EU countries which extensively utilise mobility opportunities for academic teachers' internships under the Erasmus programme. In the period 2013-2014, the Polish became the largest group of educators using the possibilities offered by this programme (European Commission, 2015). Moreover, Poland is also high on the list of countries hosting the largest number of teachers.

Data from the POL-on system presented in Figure 11 shows that public university teachers participate in visits abroad 30 % more often than teachers from abroad visit Poland. At private schools, this trend is much weaker (the difference being only 7 %).

Figure 11: Number of academic teachers departing and arriving in the academic year 2014-2015



Source: OPI, 2016

Polish academic staff mobility to European countries is closely related to implementation of the Bologna Declaration as the activities undertaken abroad are aimed at improving the quality of education and developing new study programmes in Polish HEIs. Currently, internationalisation, including mobility, is one of 10 key issues addressed by the government in a new Law 2.0 (Ustawa 2.0).

HEIs are required by national legislation to conduct a periodic appraisal of academic staff as part of their internal quality assurance systems, although detailed performance-assessment criteria are laid down by individual institutions within their autonomy. International experience, such as visits, exchange, participation in Erasmus, etc. may be taken into consideration in the periodic staff appraisal and when assessing their achievements for academic career progression.

As is the case for students, EU Erasmus+ is currently the most important programme in terms of the number of outgoing and incoming teachers, but mobility opportunities are also offered by other multilateral, bilateral and national programmes or initiatives.

6.4.2.1 EU Programmes

Similarly, greater mobility opportunities were offered to Polish academic teachers by the TEMPUS programme, launched by the European Community in 1990, and, subsequently, by the EU Socrates and Lifelong Learning programmes. Currently, the Erasmus+ programme (2014-2020) supports academic staff mobility as part of Learning Mobility projects in Action 1 and three types of projects in Action 2: Strategic Partnerships, Knowledge Alliances, and Capacity Building in Higher Education.

From 1998-2014, there were more than 47 000 academic staff visits, which included 34 182 visits by lecturers and 13 182 study visits. The top five destinations for academic staff were Germany (6776), Spain (5239), Italy (4047), France (3327) and Czech Republic (3245).

6.4.2.2 Multilateral programmes

Following multilateral programmes described above in the students mobility subchapter 5.4.3, Central European Exchange Programme for University Studies (CEEPUS) and International Visegrad Fund are also available for academic staff.

6.4.2.3 Bilateral programmes/initiatives

In line with the bilateral programmes described above in the Students mobility subchapter 5.4.4, bilateral agreements and the Fellowship Fund are also available for academic staff.

Fullbright Programme

The Fullbright Programme, mentioned above, offers scholarships to Polish and American academic staff. Scholarships for Polish academic staff are intended for teaching assignments and research work at US HEIs (three to nine months) or academics' own research projects to be conducted at US HEIs, non-profit research institutions and some government institutions (four to nine months). American academic staff may receive a scholarship for a teaching assignment (one semester or academic year) or research work (three months to an academic year) at a Polish higher education or research institution. Scholarships are also awarded to American experts in various areas for teaching assignments or research at Polish academic, cultural and educational institutions (14 to 42 days) and to recent graduates of US institutions for English-language assistantships or teaching at Polish higher education institutions (one academic year).

Other scholarship programmes

The Foundation for Polish Science manages a number of programmes, funded from various sources, which offer, among others, scholarships to academic staff at various stages of their research career, e.g. junior researchers and outstanding researchers with documented achievements.

6.4.2.4 National programmes/initiatives

Mobility Plus

The Mobility Plus Programme (*Mobilność Plus*) launched by the Ministry of Science and Higher Education in 2012, provides opportunities for junior researchers (aged up to 35 years), including PhD students, to participate in research conducted at renowned international research institutions. Scholarships are awarded for a period of six to 36 months.

7 COMMERCIALISATION ACTIVITY[19]

Main challenges
• Despite the reforms made in previous years, the weak linkages between the business sector and academia remain a challenge for the Polish R&I system;
• Quantifiable outcomes of science and industry co-operation are very limited, including low counts of joint private-public co-publications and co-patents;
• A very low proportion of enterprises declaring co-operation with scientific organisations and shares of R&D expenditure for public science (HEIs and PROs) funded by business enterprises;
• The number of research projects carried out by public HEIs and PROs that were contracted by industry remains persistently low (with business funding of research performed by academia amounting to 0.02 % of GDP in 2015, one of the lowest values in the EU-28).

7.1 Framework conditions

Following the science and higher education reform during 2010-2011, numerous support measures contributed to the transformation of HEIs into entrepreneurial universities, engaged in knowledge transfer and closer to industry. The effectiveness of these measures remains limited, but they have contributed to institutional changes (including the establishment of technology transfer centres, special purpose vehicles – university holding companies – and numerous academic spin-offs). They have also increased the extent of academic patenting and generated revenue from technology licensing. Moreover, most support measures available to HEIs do not differentiate between universities and other public and private academic institutions, so funding allocated through many competitive calls is dispersed between organisations of different scale and type. Incubators and technology parks operate in most academic cities, usually relying on public co-funding.

Regrettably, the overall effectiveness of these measures could be considered limited and substantial public investments have failed to bring about major changes in the motivation, perception and behaviour of researchers and entrepreneurs, or organisational practices (NIK, 2013; NIK, 2016a; NIK, 2016b). In various R&D programmes offered by NCBiR, proposals could only be submitted by consortia encompassing both companies and scientific organisations, and many collaborations established in this way did not last beyond the end of the publicly co-funded project. Until 2016, there were no tax incentives to encourage business enterprises to fund R&D projects at HEIs or PROs. Innovation vouchers offered by the PARP, which can be used by companies to finance contracted research at HEIs, have very limited financial value and are used for analytical services rather than innovative R&D. Most R&D co-funding schemes available for companies, particularly schemes based on the ESIF, allow the beneficiaries to subcontract parts of the project but do not incentivise co-operation with scientific organisations. The number of existing innovative clusters is relatively high and most include both private and public actors, but the majority undertake only limited activities unless they receive dedicated public funding (PARP, 2016). Extensive support for innovation brokers and incubators established at universities contributed to only a small number of licensing agreements (NIK, 2016a). More positive were the results of measures intended to increase the awareness of employees at HEIs and PROs. Support schemes – 'Top 500 Innovators' and 'Transformation.doc' – trained young scientists and research administrators, exposing them to the well-developed innovation ecosystems in the USA, the UK, Canada, Sweden and the Netherlands and promoting best practices in technology transfer and co-operation with industry. The impacts of these efforts will be seen for years to come, thanks to the transformed mindset of the new generation of researchers.

[19] Chapter based on EC JRC, 2017.

Although, the institutional evaluation system of the PROs increasingly pays more attention to and incentivises patenting and different forms of commercialisation, a typical academic career trajectory in Poland is based on generating publications rather than commercially useful solutions, with limited importance paid to societal or economic impacts of the research. Higher education curricula are usually not oriented towards industry. Among those HEIs offering dedicated higher education programmes addressing identified labour market needs ("ordered specialities", *kierunki zamawiane*) based on EU Structural Funds, 2007-2013, some did not appear to adequately take into account the specific requirements of potential employers or to ensure the highest possible educational standards.

Universities earn very small revenues from knowledge transfer, including technology licensing or sales (NIK, 2016a). Many HEIs and PROs generate substantial numbers of patents but the majority seem to have no commercial applications and are abandoned after being issued (i.e. owners do not pay patent renewal fees) (NIK, 2016a). A recent audit report from the Supreme Audit Chamber also revealed the very limited scope of knowledge-transfer activities in public research institutes (NIK, 2015), even though the IB are supposed to operate in close partnership with industry and differentiate themselves from universities by a strong focus on applied R&D and commercial projects. Aggregate revenues from knowledge transfer incurred by research institutes were lower in 2013 than in 2010 (i.e. before the legislative reform that was intended to increase the institutes' cooperation with industry) (NIK, 2015).

In the near future, HEIs may face additional barriers to effective technology transfer due to amendments to the Act on Higher Education in 2014. Unlike almost all EU countries, the legislator initially intended to assign the ownership of IPR (intellectual property rights) to university employees (i.e. introducing the so-called professor privilege). However, the outcome of the legislative process merely increased the administrative burdens on universities, offering university management an option to transfer IPR to the employed inventors only directly after the invention had been made and against a symbolic payment, rather than covering the actual R&D costs. The latest change to the Act on Higher Education introduced by the new government in 2016 removed part of the administrative burden, but the main source of problem, namely the professor privilege, remained.

Other forms of technology transfer in public science institutions require formal valuation of IPR before concluding sales transactions (as the assets of public HEIs and PROs are considered as public property, the disposal of which is governed by strict regulations). This substantially restricts the flexibility needed in effective technology-transfer negotiations (NIK, 2016a).

7.2 Tax incentives

In the past, R&D tax incentives in Poland were not effective in stimulating private R&D due to their design and implementation. However, a new law supporting innovativeness introduced new R&D tax incentives from the beginning of 2016. The definition of qualifying R&D costs is now broader and has been extended to internal R&D. The new R&D tax incentives consist of a 30 % deduction in the wages of R&D personnel and 10 % in qualifying R&D costs (20 % for SMEs). However, the effectiveness of new R&D tax incentives will depend on how they are implemented; much depends on how easy it will be for young and small companies to apply for the new R&D tax solutions. For example, a short carry forward of unused deductions and lack of cash refunds may limit the attractiveness of tax incentives for young innovative companies. The new law also creates tax exemptions for funds on the sale of stocks in qualifying companies in which funds hold at least 10 % of the capital. This aims to stimulate equity financing for innovative businesses. The Innovation Council has underlined the need for further changes in R&D tax incentives, including introducing tax breaks to stimulate science-to-business collaboration (EC, 2016c). As of 1 January 2017, a further significant change was made to R&D tax credits, which increased their availability and size (according to the first Act on Innovativeness), expanded the deduction period, proposed new eligible cost categories, and proposed additional incentives for start-ups, such as cash refunds for those conducting R&D activities. A second innovation law is currently being prepared on the basis of the White Paper on Innovation, proposing more attractive tax incentives as from 1 January 2018. To date, the more R&D-friendly tax regulations are already appreciated by the business sector and are expected to trigger proportional increases in BERD (EC, 2017).

7.3 Access to finance

In terms of enterprises' access to finance, Poland's overall performance is above the EU average. SMEs can access small loans and public financial support relatively easily. Financing provided by banks is also available (EC, 2016c). The government has created three types of new, preferential loans to facilitate access to finance for SMEs. The first is designed to finance technological innovations for SMEs, the second to set up a business, and the third to support businesses employing job-seekers. Leasing is the second most common external source of financing investments, with growth in the total value of assets financed in this way of 13 % year on year in 2013 and over 21 % in 2014 (MG, 2015).

The first publicly supported fund of funds investing in venture capital (VC)/private equity (PE) funds in Poland is the National Capital Fund (KFK), established in July 2005 with the aim of filling in the equity gap on the Polish SME market. Its portfolio consists of 17 capital funds which focus on high-potential innovative enterprises performing R&D activities, with 171 completed transactions as of July 2016 and an aggregate portfolio capitalisation of PLN 983 million (EUR 234.9 million).

In June 2016, the government announced the launch of a new programme supporting innovative start-ups called '#StartInPoland'. Its objective is to create the largest VC investment platform in Central and Eastern Europe and provide expert and finance support to innovative enterprises.

The Responsible Development Strategy (SOR), adopted in February 2017, announced plans to introduce new measures aimed at financing development projects at the regional level. These include: creation of regional business angel networks, promotion of mentoring in business plan implementation by young entrepreneurs, and providing incentives for specialised entities to establish VC funds (MR, 2016e).

In addition, corporate venture programmes are run by several large companies, including KGHM and media group TVN.

Crowdfunding is another way to finance entrepreneurial initiatives and is relatively popular in Poland. As of July 2016, there were more than 25 crowdfunding platforms (Collaborative Economy Centre, 2015), including PolakPotrafi.pl – the first Polish crowdfunding initiative that now gathers 2448 projects worth a total of PLN 13.9 million (EUR 3.3 million). The main platforms in Poland include Wspolnyprojekt.pl, Wspieramkulture.pl Wspieram.to and Odpalprojekt.pl. Polish entrepreneurs also use the world's largest funding platforms, such as Kickstarter or Indiegogo (Granicki et al., 2015: 25). The Ministry of Economic Development, in response to market needs concerning the promotion of innovation and investing in start-ups, has started work on introducing a new legal form that will be appropriate for start-up companies, called the simple joint-stock company (MR, 2016). The proposed concept aims to achieve the following basic objectives: facilitating setting up a company (including the use of digital infrastructure), small capital requirements, possibilities to use various forms of investment (including crowdfunding), reconciling the interests of founders and investors, as well as the fast and uncomplicated liquidation of the company. The date for introducing this legal form has yet to be set.

7.4 Intermediary structures

The Polish landscape of intermediary structures consists of two influential start-up foundations (Startup Hub Poland, Startup Poland), around 30 co-working spaces in the biggest cities (such as Reactor in Warsaw, COLAB in Cracow), multiple online platforms (e.g. www.mojepanstwo.pl, www.u24.pl), and a network of incubators operated by the private Foundation of Academic Entrepreneurship Incubators (AIP) is present in major academic centres. In 2016, AIP had 50 offices with conference rooms and workplaces located in 24 cities and was the biggest network of start-up incubators in Poland. The Foundation Startup Poland is a grass-roots organisation founded by entrepreneurs. It aims to create better conditions for Polish start-ups, deepening dialogue with the public administration, and recommending measures to stimulate technological entrepreneurship in Poland. It is the largest community voice for Polish new technology-based companies (Startup Poland, 2014). Its achievements include the publication in 2015 of the first Polish report on the results of a nation-wide survey of start-up companies and highlighting their important role in the economy (Skala et al., 2015). Startup Hub Poland helps to develop new technologies in Poland and facilitates access to start-up communities, laboratories, the financial market and professional networks.

The Polish Business and Innovation Centres Association (SOOIPP), established in 1992, is the oldest and a leading association of many important but more traditional mediating structures. It is in permanent working contact with over 800 innovation and entrepreneurship centres, including most parks and technology incubators, technology transfer centres, business incubators, loan funds, training and consultancy centres. The SOOIPP's ambition is to shape business environment supporting innovation, entrepreneurship and regional development, as well as to set standards for activities of different types of mediating organisations. It participates in public consultation concerning important strategic and programming documents at regional, national and EU level, and represents the interests of representatives of Poland's business environment.

Every two years, SOOIPP publishes a Report on Business and Innovation Centres in Poland, based on its own surveys and analysis. The latest edition (2015), based on surveys conducted in September 2014, reports 681 active business and innovation centres in Poland (SOOIPP, 2015), among them:

- 42 science and technology parks
- 24 technology incubators
- 24 incubators operated by the AIP
- 42 technology transfer centres
- 47 innovation centres
- 103 equity funds
- 81 local and regional loan funds
- 58 credit guarantee funds
- 7 business angel networks
- 207 training and consulting centres
- 46 incubators.

Figure 12: Regional distribution of business and innovation centres in Poland

Source: SOOIPP, 2015

7.5 Instruments

Several examples of programmes or large-scale projects which are most relevant to supporting PROs, in particular universities, in their commercialisation efforts are presented below:

- 'Spin-Tech' was a programme to support activities of special purpose vehicles created by PROs according to amendments to the 2011 Act on Higher Education, set up by universities to commercialise the results of R&D work by taking stakes in spin-offs organised by researchers to implement the results of such work. The total value of the programme, which was run by the NCBiR and implemented from 2014-2016, was PLN 113 million (approximately EUR 27 million).
- 'Bridge Alpha' is a project aimed at co-financing R&D projects in the early stages of development – in the proof-of-principle phase (early verification of the idea), or proof of concept (verification of the idea) through private investment vehicles (similar to seed capital funds) called Alphas. During its first edition, which finished in 2015, around PLN 51 million (ca. EUR 12 million) were invested through 10 Alphas. The second edition started in 2016 with a total budget of PLN 450 million (ca. EUR 105 million) with 19 Alphas.
- 'Patent-Plus' was a programme aimed at supporting scientists, research institutions and entrepreneurs in applying for European and international patent protection. Its total budget was PLN 40 million (approximately EUR 9.5 million).
- 'Demonstrator +' was a programme which aimed to strengthen the transfer of research results to the economy by supporting R&D projects leading to a new technology or product at demonstration scale (tests at demonstration scale). Its total budget was PLN 423 million (ca. EUR 100 million).

- The 'Innovation Agent' programme aimed to help university faculties to co-operate with technology transfer centres by appointing innovation brokers engaged in establishing co-operation between academia and the business environment in applying research results in enterprises. The first edition finished in 2015, with a budget of PLN 5.6 million (approximately EUR 1.3 million) spent on 29 brokers working with 29 departments in 18 universities.
- The 'Innovation Incubator' programme set out to support entities active in the field of the commercialisation of R&D results. The first edition, which finished in 2015, supported 14 entities, mostly technology transfer centres at universities with a total budget of almost PLN 20 million (ca. EUR 4.8 million). Early evaluation of the programme signalled quite a notable success since it significantly stimulated universities in their licensing and spin-off activities. The second edition, 'Innovation Incubator Plus', which began in 2016 with a budget of PLN 50 million (approximately EUR 12 million) integrates the previous Innovation Incubator and Innovation Agent programme in a revised formula. In February 2017, 20 beneficiaries (single institutions or consortia of universities, its SPVs and other PROs and/or its SPVs) were selected in a competitive procedure and have started their activities.

7.6 Commercialisation output

No aggregated data on the effects of PROs' commercialisation efforts are publicly available. As commercialisation is still not well defined in the Polish legal and fiscal system, there are no standard procedures for collecting relevant data.

The Supreme Audit Chamber prepared a detailed analysis of these efforts and their suboptimal results (NIK, 2016a). In 2011-2014, the largest technology and medicine universities had relatively low licensing revenues per each filed patent application. These revenues amounted to only a minor fraction of each organisation's total R&D expenditure (NIK, 2016a), funded mostly by the government. Data on the R&D and knowledge-transfer activities of selected HEIs are presented in technology transfer.

Table 11. Moreover, most HEIs discontinued patent protection following the patent grant (NIK, 2016a) as they needed the patents primarily as indicators of applied R&D performance rather than for technology transfer.

Table 11: R&D expenditure and technology transfer performance of key technology and medicine universities in Poland (2011-2014)

Higher Education Institute	Total R&D expenditure (2011-2014)	Patent applications (2011-2014)	Total licensing revenues (2011-2014)
Kraków University of Technology	PLN 119 940 3k (EUR 28 664k)	86	PLN 75k (EUR 18k)
AGH University of Science and Technology, Kraków	PLN 1 074 835 3k (EUR 256 873k)	388	PLN 3 738 4k (EUR 893k)
Łódź University of Technology	PLN 433 357 9k (EUR 103 568k)	289	PLN 1 302 5k (EUR 311k)
Warsaw University of Medicine	PLN 213 153 5k (EUR 50 941k)	23	PLN 0 (EUR 0)
Warsaw University of Technology	PLN 998 697 5k (EUR 238 677k)	201	PLN 189 5k (EUR 45k)
Wrocław University of Medicine	PLN 96 695 3k (EUR 23 109k)	46	PLN 98 4k (EUR 24k)
Wrocław University of Technology	PLN 560 019 8k (EUR 133 838k)	651	PLN 997k (EUR 238k)

Source: NIK, 2016a

The Supreme Audit Chamber also carried out an extensive audit of IB, pointing to the problems of many institutes, such as maintaining very limited contacts with industrial companies, suboptimal scientific performance, and excessive reliance on government funding (NIK, 2015).

7.7 Proposed changes in the R&I policy mix

In 2016, the MNiSW and MR made concerted efforts to modify some of the legal bases for the R&I system. The initiatives from the work of the Council for Innovativeness resulted in specific recommendations stemming from the NIK audits, and ad-hoc needs arising from changes in certain funding programmes or modalities. Even though the government declared a drive to reduce the bureaucratisation of the science sector and eliminate legal barriers to innovativeness, the number of legislative amendments did not live up to the promises of simple and non-redundant laws.

In March 2016, the MNiSW shared with stakeholders a proposal for amendments to the key legal acts, affecting the innovativeness of various actors, including HEIs, PROs and companies. As the ministry suggested, the consultative process would involve two steps. The first comprised "small" amendments adopted in 2016 (to eliminate the most controversial or irrational administrative burdens or barriers to innovativeness as soon as possible), and secondly, more comprehensive changes developed through a longer process, involving stakeholder representations and broad consultations (with a view to defining radically new legal foundations for the sector).

The "small" amendments (proposed in March 2016 and updated in July 2016) include minor tweaks to the procedures for technology transfers at HEIs and PROs (MNiSW, 2016b) by:

- Reducing the number of decisions that need to be formally issued by an organisation's management in patenting and commercialisation procedures;
- Granting scientists-inventors the rights to a share of profits incurred by the employing HEI or institute of the Polish Academy of Sciences based on the commercialisation of IPR generated by a given scientist (inventors employed by research institutes do not participate in their profits. As from 2014, inventors were only able to participate in these profits during the first five years following a successful commercialisation);
- Enabling the disposal of intellectual or fixed assets above the financial threshold of EUR 250k without the need to apply for the Minister of Treasury's permission, merely by submitting the information to him/her about the intended transaction and having the right to conclude it if the minister takes no action within 30 days; and
- Empowering HEIs to create as many special purpose vehicles/holding companies (*spółka celowa*) as they consider suitable (currently, only one company per university is allowed).

These changes streamlined the technology transfer procedures and could strengthen the capitalisation of university-owned companies by opening them up to external investors. The Act's key provisions concerning business enterprises included:

- Contributions of intellectual property to a joint stock company would not be taxable (so far, similar provisions were available but were introduced as an exceptional tax incentive only applicable in 2016 and 2017);
- Costs of patenting (including patent drafting, filing, legal proceedings and patent defence) are eligible as R&D costs;
- R&D tax incentives are increased from 10-20 % of incurred R&D costs in 2016 to 30-50 % of costs, starting from 2017, with different rates depending on type of expenditure and company size;
- R&D costs would be tax-deductible for a period of six years to better match the longer time horizon of R&D endeavours (as against only three years according to regulations in force in 2016);
- Start-ups incurring R&D expenditures and not generating sufficient revenues to benefit from the R&D tax incentives would be eligible for cash reimbursements;
- Companies that systematically increase their R&D expenditures over a period of three subsequent years would benefit from an additional tax bonus in the fourth year, calculated

on a pre-defined formula (this provision incentivises increases in corporate R&D that would directly influence the value of BERD in 2020 and help to meet the national GERD-to-GDP target).

It should be noted that this legislation introduces significant changes to the design of R&D tax credits, increasing their amounts, adding new eligible cost categories, expanding the deduction period and offering additional incentives for start-ups and companies that consistently increase their R&D expenditures. In the Polish tax system, these changes could be considered revolutionary and, unsurprisingly, the draft Act triggered critical reactions from the Ministry of Finance, which estimated the expected lost revenue of PLN 4.4 billion (EUR 1.05 billion) in 10 years (MF, 2016), even though there is no empirical basis for calculating such impacts, and companies started including R&D costs in their financial books in 2016. At the same time, the legislator is aware of the limited attractiveness of the proposed R&D tax incentives in comparison with countries such as Czech Republic, Hungary or the UK (MNiSW, 2016a). It even declares that the introduction of R&D tax incentives serves the purpose of being better able to estimate the scale of R&D activities in Poland (MNiSW, 2016a) and thus able to prepare evidence-based plans for future action.

The "larger" legal amendments will come from the White Paper on Innovations, prepared by the MNiSW. The ministry published an online form asking all interested stakeholders to identify specific regulations that present barriers to the innovativeness of the Polish economy (MNiSW, 2016d). The 340 inputs received were comprehensive but also incommensurable. The stakeholders were not able to present more systemic views on the desirable changes and could only suggest individual areas for improvement, with a limited number of characters per submission. The MNiSW published the White Paper in September 2016 as the basis for subsequent reform efforts (MNiSW, 2016e). It identifies 58 actions, including changes that would affect 15 existing legal acts, which are expected to be adopted in 2017. These actions are described in a very general way, without any justifications for the proposals. Therefore, the rationale behind some of them remains unclear; they do not seem to result from a thorough diagnosis of the challenges faced by Poland's R&I system or to be presented convincingly as having the potential to actually strengthen the country's innovativeness.

Many of the actions outlined could be beneficial, but the lack of detail or argument does not help in their interpretation. An example of a puzzling lack of precision is the proposed "introduction of systemic solutions to stimulate medium-sized and large firms to introduce innovative solutions and to generate demand for them" (MNiSW, 2016e). The actions covered by the White Paper on Innovations include the:

- Introduction of more attractive incentives for business enterprises benefiting from the status of R&D centres;
- Launch of pre-commercial procurement for innovations;
- Introduction of a patent box-like R&D tax incentive;
- Establishment of a dedicated court dealing with intellectual property issues;
- Changes to the legal framework to facilitate company registration of R&D expenditure;
- Introduction of industrial PhDs;
- Development of templates for technology-transfer agreements to be used by HEIs and PROs;
- Reform of research institutes;
- Additional incentives for scientists commercialising their R&D results, including reduction of workloads related to other academic obligations and ability to take six months paid leave to organise the commercialisation process;
- Elimination of applicant age limits in all R&D programmes (currently, in some programmes only applicants of 35 years or younger are eligible);
- Introduction of legal regulations for crowdfunding and tax incentives for companies investing in start-ups;
- Establishment of a one-stop-shop for R&D project funding; and

- Better use of IT infrastructures by public administration and unrestricted access to public data.

It must be stressed that the White Paper does not go into the details about the proposed actions and is restricted to listing them in a manner similar to the list presented above. No time frames, assumptions, action plans or success indicators have been included. Some of the actions are actually already being implemented, having been initiated before the release of the White Paper.

8 INTERNATIONAL CO-OPERATION IN RESEARCH

8.1 Poland in Horizon 2020

The statistics presented below have been prepared on the basis of the eCORDA databases published by the European Commission (EC) on 10 October 2016. They contain data on project proposals in response to 274 calls for the Horizon 2020 (H2020) programme and grant agreements signed between 13 December 2013 and 30 September 2016.

The 274 calls for Horizon 2020 submitted 343 236 project proposals, of which 330 463 have passed the EC's initial formal assessment (eligible proposals) in single- and two-stage competitions. There were 71 018 applicants from 189 countries worldwide involved in preparing these proposals.

Following the evaluation, the EC has signed grant agreements (GA) with 16 645 applicants from 132 countries (28 from the EU, nine associated countries, five candidate countries and 90 third countries) for co-financing 10 965 projects with a EUR 20.27 billion budget.

Among them, 2036 Polish organisations have participated in the preparation of 5447 project proposals, including 1975 coordination projects. Following the evaluation of the proposals, 373 Polish organisations have signed GA for 598 projects, including 107 coordination projects with total funding of EUR 180.9 million.

Polish teams participate in projects in 30 H2020 thematic areas. As many as 117 participations in the Maria Skłodowska-Curie actions resulted in grants of almost EUR 29 million. In the area of ICT and health, 76 and 46 participants have accessed funding close to EUR 24 million and EUR 13.3 million, respectively. Other areas with the largest participation and funding include: energy, infrastructure, environment, transport and food.

Poland recorded a 11.52 % success rate for financed project proposals and 6.63 % for the grant budget. The average success rates for all Member States are 14.62 % for the number of financed projects and 11.30 % for the grant budget.

Polish science is represented by 67 universities involved in 207 projects (including 37 coordination) and receive financing from the EC to the sum of EUR 54 334 812. The HEIs with the largest number of H2020-funded projects (more than 10) are: University of Warsaw (29), Warsaw University of Technology (18), AGH University of Science and Technology, Kraków (15), Jagiellonian University, Krakow (14), Wrocław University of Technology (10), and Adam Mickiewicz University of Poznan (10).

In addition, 78 Polish research institutes (PRO – non university) are involved in 208 projects (including 20 coordination) and receive financing from the EC amounting to EUR 53 265 089. PROS with the largest number of H2020-funded projects (more than 10) are two institutes of the Polish Academy of Sciences: The Institute of Bioorganic Chemistry (28 projects) and the Institute of Fundamental Technological Problems (22 projects) – the Institute also hosts the National Contact Point for EU Research Programmes. The best research institute (IB) - the National Centre for Nuclear Research – is in fourth place with seven projects.

There are 171 private for-profit organisations participating in 186 projects (with 38 coordinators) with an EC contribution of EUR 46.4 million. The most successful private company, ITTI Ltd, has been given grants for six projects, while only 13 companies have received grants for more than one project.

8.1.1 National Contact Point activities[20]

The National Contact Point (KPK) for EU research programmes is hosted by the Polish Academy of Sciences Institute of Fundamental Technological Problems. It employs over 30 specialists with diverse educational backgrounds, which usually correspond to the R&D areas they oversee. About 25 % of them have doctoral degrees, and all are fluent in English and trained in legal aspects of the EC funding programmes and project management. The KPK's complex services cover all areas of H2020, and its work is organised by thematic areas. In addition, a network of 11 regional contact points covers Poland's extensive territory. KPK experts focus on specialist issues, while regional contact points offer more generic support as the first contact for applicants, and channels requests to relevant experts at the KPK. At the same time, the KPK also maintains direct contact with applicants from various Polish regions, carrying out activities that partly overlap with the efforts by regional structures. Centrally employed experts dedicate a lot of time to answering questions from applicants who had no previous contact with the relevant regional contact point.

The network of contact points in Poland is subsidised by the Ministry of Science and Higher Education, with sizeable budgets amounting to PLN 9.63 million in 2012 (EUR 2.30 million), PLN 9.46 million in 2013 (EUR 2.26 million) and PLN 10.13 million in 2014 (EUR 2.42 million). The KPK only benefits directly from part of this budget (approximately EUR 1.2 million per annum) (MNiSW, 2013b; MNiSW, 2014d; MNiSW, 2015b).

The KPK offers mentoring to applicants, support in selecting the most relevant funding instruments, financial and legal consultations (including IPR and project budgets) and the pre-screening of applications. When working with business enterprises, non-disclosure agreements are usually signed if a potential applicant intends to share project details with the KPK. It also offers an extensive range of information events, trainings and mailings, and is active in promoting H2020 participation at other public or private organisations' events.

The KPK's information sharing was positively evaluated by the beneficiaries interviewed, including its well-received, country-wide tour promoting H2020. Interviewees' opinions about the specialist advice it provided were more divided.

Another challenge identified is KPK's strong orientation towards scientific organisations and its more limited experience with SMEs. It nurtures synergies with the Enterprise Europe Network (EEN) contact points in Poland, particularly in reaching out to companies and encouraging them to apply for H2020 funding. The problems concerning SMEs include their specific attitudes and misunderstandings surrounding H2020 fundamentals (i.e. research excellence and innovativeness), and for many calls, their lack of established collaboration with foreign partners.

Poland also has a separate KPK for financial instruments in EU programmes, managed by the Polish Bank Association (Związek Banków Polskich) which was appointed by the Council of Ministers. This specialist contact point coordinates the efforts of financial institutions, offering preferential financing for SMEs. These operations focus on the distribution of instruments defined in FPs (including CIP, FP7, COSME, EaSI and the H2020 instrument 'InnovFin SME Guarantee'). However, the engagement of Polish financial organisations raised their awareness of opportunities related to financing innovative projects.

8.1.2 Financial support for FP7/H2020 participation

Polish H2020 applicants can benefit from co-funding for the preparation of applications, including meetings with potential consortium partners and specialist consulting services. The available support measures referred to as "grants for grants" are differentiated, depending on the type of beneficiaries (i.e. scientific organisations or SMEs), and funded from the state budget. Support for scientific organisations (including universities and research institutes) has been offered by MNiSW for many years, with support rules adjusted to H2020 conditions in 2014. Funding is available to organisations planning to act as project coordinators. Applications can be received at any time, without specific call deadlines. Applicants can also apply for reimbursement of previously incurred

[20] Chapter based on EC JRC, 2015.

costs of successful H2020 applications. However, some beneficiaries have implied that the application forms and reports for these scientific grants for grants are relatively complex, which is discouraging potential applicants. The maximum reimbursement levels are also perceived as low, with restrictive types of eligible costs and detailed reporting requirements (MNiSW, 2015a). The grants for grants support measure involved budgets of PLN 2.81 million in 2012 (EUR 0.67 million, 79 projects funded), PLN 1.48 million in 2013 (EUR 0.35 million, 49 projects) but only PLN 0.62 million in 2014 (EUR 0.15 million, 23 projects) (MNiSW, 2015b), with annual expenditure dependent on the number of incoming applications.

In FP7, scientific organisations were also able to apply to the MNiSW to cover parts of the expected national contributions in project budgets. Co-funding for FP7 covered up to 75 % of the own contribution required from the Polish FP7 beneficiary. Budgets allocated to this form of support were substantial: PLN 72.45 million in 2012 (EUR 17.31 million), PLN 59.84 million in 2013 (EUR 14.29 million) and PLN 57.16 million in 2014 (EUR 13.65 million) (MNiSW, 2015b). The Ministry of Science and Higher Education also co-funded the participation of scientific organisations in other, non-EU R&I programmes, but these allocations were substantially lower than for FP7: PLN 3.43 million in 2012 (EUR 0.82 million), PLN 3.36 million in 2013 (EUR 0.80 million) and PLN 4.09 million in 2014 (EUR 0.97 million) (MNiSW, 2015b). In addition, Polish KIC co-location centres benefited from state co-funding of PLN 4.88 million in 2013 (EUR 1.17 million) and PLN 1.77 million in 2014 (EUR 0.42 million) (MNiSW, 2015b).

Small and medium-sized business enterprises benefited from a dedicated funding scheme called 'Support for securing a grant'. The scheme was provided from 2011 to 2015 by the Polish Agency for Enterprise Development (PARP) based on a dedicated ordinance from the Minister of Economy on financial support offered by PARP (MG, 2014). The support was available to both project coordinators and consortium partners. Applicants could only apply for reimbursement of costs previously incurred if the project application met formal FP evaluation criteria (up to PLN 75 000, EUR 18 000 for project coordinators, PLN 35 000, EUR 8000 for consortium members). In 2015, the budget for this measure amounted to PLN 2 million (EUR 478 000). The funds could be used for applications in "international innovation programmes", which support R&D co-operation with entities from other countries (i.e. not for applications to the H2020 SME Instrument, CIP or COSME), with reimbursements going back to 2007, if the applicant had the required financial documents. In previous years, PARP allocated the following budgets to the support instrument: PLN 313 000 in 2011 (EUR 76 000, 10 projects, four beneficiaries), PLN 489 000 in 2012 (EUR 117 000, 15 projects, 10 beneficiaries) and PLN 1.31 million in 2013 (EUR 313 000, 40 projects, 12 beneficiaries). Although budgets increased, only a small group of SMEs applied for the support, with multiple applications from the same beneficiaries: seven organisations received between four to eight grants each, accounting for 58 % of all funded projects. The PARP's instrument for SMEs differs from the grants for grants provided by the MNiSW to scientific organisations, as the MNiSW can only reimburse costs of H2020 applications, which surpassed the evaluation threshold set for a given call (MNiSW, 2015a). PARP, on the other hand, refunds the cost of preparing applications but only takes into account the outcomes of their formal evaluations. This could potentially promote opportunistic behaviour by applicants while, at the same time, significantly reducing the risks incurred by SMEs preparing applications – the numbers of Polish business enterprises applying for FP7/H2020 funding might justify this approach.

8.2 Bilateral co-operation

Different types of programmes and projects related to bilateral co-operation are being carried out separately by the ministry and two implementing agencies.

Ministry of Science and Higher Education
The ministry implements bilateral co-operation based on international agreements concluded between the Government of the Republic of Poland and the governments of other countries. Under agreements or executive protocols for these agreements, open calls are announced for "research exchange" (grants to cover costs of travels and short visits by the scientists carrying out a project in the country co-realising the project).

In Poland, projects are financed from funds transferred to research institutions for financing their statutory activities (or other own resources). The ministry does not directly provide additional funds for the implementation of projects under the executive protocol.

National Centre for Research and Development
In accordance with Article 30 of the Act on the National Centre for Research and Development, participation in the implementation of international R&D programmes, including those co-financed from foreign funds, is one of the Centre's tasks. To do this, it can co-operate with domestic and foreign entities as a partner for joint ventures and, with the consent of the Minister for Science, partner, shareholder or shareholder in companies operated in Poland or abroad.

Initiating and concluding formal bilateral agreements on co-operation with foreign partners, the NCBiR takes the following into account: priority thematic areas, economic benefits, proximity, best experience in international co-operation of Polish scientists, and cultural relations as well as historical associations at the level of states and research units.

The most commonly used form of bilateral co-operation for the NCBiR is a parallel call for proposals in each of the partner countries. These projects are evaluated and national ranking lists created. A common ranking list is prepared for the competition and the recommended projects are financed.

At present, NCBiR manages bilateral agreements with 12 partners (Berlin, Brazil, China, Czech Republic, Germany, Israel, Japan, Luxembourg, Republic of South Africa, Singapore, Taiwan and Turkey). At the time of NCBiR implementation, there were 24 bilateral, parallel calls conducted with a total of 487 applications and 76 projects financed with a Polish contribution of PLN 71.2 million (approximately EUR 17 million). It is important to mention that no bilateral calls have been opened yet some partners.

National Science Centre
In accordance with Article 20 of the Act on the National Science Centre, one of the Centre's task is to finance basic research conducted in projects not co-financed from foreign funds, implemented under international programmes or initiatives announced in a bilateral or multilateral co-operation or research activity on a large international research infrastructure.

The NCN's current involvement in international co-operation in financing basic research activities is streamlined in the following bilateral and international programmes:

BEETHOVEN
A programme implemented jointly with the German Deutsche Forschungsgemeinschaft (DFG). The first call, which closed in 2016, covered the entire field of humanities, social sciences and art. The second call opened in autumn 2016 and covered humanities, social sciences and art, and selected panels of sciences and engineering were closed mid-December 2016. In 2017, evaluation and selection procedures carried out jointly by the Polish-German team of experts are ongoing. For the second call, 155 applications were submitted: 72 in the humanities, social sciences and art, and 83 in selected science and technology disciplines.

PIRE
In 2016, the NCN entered the Partnerships for International Research and Education (PIRE) competition organised by the US National Science Foundation (NSF). Projects included the basic sciences, whose thematic scope was included in the NCN panels and in areas financed by the NSF, e.g. biological sciences, computer sciences, ICT and engineering, education and human resources, environmental research and education, geosciences, mathematical and physical sciences, social, behavioural and economic sciences. The project leader proposed had to be a researcher working in the US who could invite scientists working in PIRE countries to collaborate. The call for proposals ended on 14 September 2016. Seven projects were submitted by US research groups in co-operation with Polish teams. The projects were evaluated then subjected to a merit-based assessment coordinated by the NSF. None of the applications reached the second assessment stage.

Cooperation with the Lithuania Grant Agency
On 16 November 2016, the NCN signed a co-operation agreement with the Lithuanian Grant Agency (Lietuvos mokslo taryba). This resulted in the preparation of the joint competition for Polish-Lithuanian research projects in basic research in all fields covered by the NCN panels. The launch of the competition is scheduled for September 2017, and the NCN will coordinate the first call.

HARMONIA
This is a competition for research projects in the field of basic sciences carried out in the framework of international cooperation. Within the HARMONIA framework, international research projects are financed: in the international co-operation established directly with a partner or partners from foreign scientific institutions, in international programmes or initiatives announced in

bilateral co-operation, in international programmes or initiatives announced in multilateral cooperation, and using Polish research teams at large international research facilities.

9 PUBLICATIONS AND CITATIONS

This chapter describes the bibliometric and patent indicators for Poland. In the first section, the description of Poland's bibliometric profile is built upon data extracted from the SCImago Journal and country ranks[21]. The second section provides a benchmark analysis with the EU-28 and a set of five benchmark countries, the Czech Republic, Finland, Hungary, the Netherlands and Spain. Countries with a comparable number of researchers, size and geographic location were taken into account. The final selection of benchmark countries was agreed with the Polish authorities. Indicators include the specialisation per subject area, citations per publication, h-index, and the top 10 % most-cited publications. The third section includes indicators measuring the levels of collaboration of the selected countries. This covers the share of international co-publications, public-private co-publications and the share of international co-patenting. This section is complemented with the share of public sector patenting. Finally, the last section includes a number of indicators, namely patent grants per field of technology, community design applications and trademark applications.

9.1 Poland's bibliometric profile

Poland's bibliometric profile is based on data extracted from SCImago which presents its aggregate number of publication counts, citable documents, citations, self-citations, citations per document, and h-indexes (for the period 2011-2015).

Poland's five subject areas with the highest number of publication counts are in medicine (42 149), physics and astronomy (32 770), engineering (32 514), materials science (23 360) and chemistry (21 524). Poland's lowest levels are found in multidisciplinary (535), dentistry (886), nursing (998), decision science (1263), and economics, econometrics and finance (1299).

The subject areas that show the highest annual average growth rate of publications (above 15 %) are economics, econometrics and finance (23 %), decision science (23 %), Decision Science (19 %), arts and humanities (18 %), immunology and microbiology, and psychology (each 15 %). Negative average annual growth rate is only recorded in dentistry (-7 %).

When considering the aggregate number of citable documents, medicine (39 624), physics and astronomy (32 286), engineering (32 036), materials science (23 092), biochemistry, genetics and molecular biology (20 233), rank among the five highest subject areas. Conversely, Poland exhibits low levels of citable documents for the period under consideration in multidisciplinary (516), dentistry (848), nursing (931), decision science (1187), economics, econometrics and finance (1261).

Overall, the number of citable documents for Poland increased by 23 % from 2011 to 2014 taking into account all subject categories. The subject areas with the highest average annual growth rates of citable documents (above 15 %) are economics, econometrics and finance (26 %), decision science (20 %), arts and humanities (18 %), multidisciplinary, and psychology (each 15 %). As for publications, a negative average annual growth rate is only observed in dentistry (-7 %).

As regards the sum of Poland's citations from 2011 to 2015, the five highest subject areas are medicine (203 535), physics and astronomy (147 502), biochemistry, genetics and molecular biology (119 511), chemistry (97 243) and materials science (70,464). Nonetheless, the subject areas with the lowest figures are in dentistry (1072), economics, econometrics and finance (1648), business, management and accounting (2851), decision science (3242), and health professions (4225).

In the sum of self-citations, physics and astronomy ranks highest (50 649). This subject area is a long way ahead of medicine (35 312), chemistry (33 013), engineering (32 523) and materials science (30 728). Dentistry (396), economics, econometrics and finance (530), multidisciplinary (752), nursing (909), business, management and accounting (940) have the lowest self-citations for the same period.

[21] Available at: http://www.SCImagojr.com; data represents a static image of the Scopus database. Calculations of the indicators are performed once a year, around April/May.

Regarding the average citations per document for Poland for 2011-2015, the highest figure is in the subject area of biochemistry, genetics, and molecular biology (6.1). This is followed by neuroscience (6.0), immunology and microbiology (5.7), pharmacology, toxicology and pharmaceutics (5.0) and medicine (4.8). Dentistry, social sciences, economics, econometrics and finance, veterinary; and business, management and accounting are ranked lowest in terms of average citations per document.

Finally, when considering the h-indexes for the period 1996-2015[22], medicine (285), physics and astronomy (246), biochemistry, genetics and molecular biology (214), chemistry (187) and materials science (143) rank as the five highest subject areas. The subject areas with the lowest averages are economics, econometrics and finance (31), dentistry (32), business, management and accounting (40), veterinary (42) and health professions (50).

9.2 Poland and benchmark countries: a bibliometric analysis of key indicators

This section presents the bibliometric indicators collected/calculated for Poland, the EU-28 and the additional benchmark countries including the Czech Republic, Finland, Hungary, the Netherlands and Spain. The bibliometric data, retrieved in February 2017 from the SCImago Journal and country rankings, cover a five-year period from 2011 to 2015 for the journals and country scientific indicators developed from information in the Scopus database. These journals are grouped by subject area (27 major thematic areas) and present the total number of documents, citable documents, citations, self-citations, average citations per document, and average h-indexes.

9.2.1 Specialisation

Specialisations by subject area, compared to the world and based on counts of peer-reviewed publications and reviews from 2007 to 2016 are summarised in

[22] SCImago calculates the h-index over the entire period 1996-2015 only.

Table 12. The data indicates Poland's specialised subject areas are chemistry, mathematics, physics and astronomy, and veterinary.

Among its specialised subject areas, Poland stands out in chemistry, mathematics, physics and astronomy, and veterinary. indeed, for these specific subject areas it has an advantage compared to the benchmarked countries. In fact, in chemistry, Poland is the most specialised among benchmarked countries, while the Netherlands and Finland are under-specialised. Moreover, while Poland is specialised in mathematics, the Netherlands stands out as the only under-specialised country among the benchmarks. Furthermore, Poland is the most specialised country among the benchmarks in the subjects of physics and astronomy, while the Netherlands is the only under-specialised country. Finally, Poland is also the most specialised country in the subject area of veterinary, followed closely by Hungary, while Finland and Spain are under-specialised.

Nonetheless, the country is under-specialised in the fields of arts and humanities, business, management and accounting, computer science, decision science, dentistry, economics, econometrics and finance, energy, health professions, immunology, medicine, multidisciplinary sciences, neuroscience, nursing, psychology, and social sciences.

In arts and humanities, Poland stands out as the only under-specialised country when compared to the benchmarks. It is the most under-specialised country in business, management and accounting, although the Czech Republic, Hungary, as well as the EU-28 are also under-specialised. In computer science, Poland is under-specialised, as is the Czech Republic and the Netherlands. However, the Netherlands stands out as the most under-specialised country among benchmarks, while only Spain is specialised. The subject area of decision science shows that Poland is under-specialised, compared to Finland, the Netherlands and Spain which are specialised, although the Czech Republic is the most under-specialised country in this subject area. Poland, the Czech Republic, Hungary and Spain are all under-specialised in dentistry, while only Finland is specialised. However, Poland is the least under-specialised when compared to the benchmarked countries. In economics, econometrics and finance, Poland is the only under-specialised country among the benchmarks, while in energy, Poland is under-specialised alongside the Czech Republic, Hungary, the Netherlands and the EU-28. Regarding health professions, Poland and Hungary are the only under-specialised countries compared to the benchmarked countries. In the case of immunology and microbiology, Poland is the only under-specialised country with respect to the benchmarks. Specialisation levels in the multidisciplinary are show that all countries are under-specialised, with the exception of Hungary. In addition, figures show that Poland is the most under-specialised in this subject area. Poland and the Czech Republic are both under-specialised in neuroscience, while Hungary and the Netherlands are specialised. In nursing, Poland and the Czech Republic are equally under-specialised, followed by Hungary, while Finland is specialised. The figures for the subject area of psychology show that Poland and the Czech Republic are under-specialised, while the Netherlands stands out as the only specialised country among the benchmarks. Finally, in the social sciences, Poland is the most under-specialised of the benchmark countries. The Czech Republic is also under-specialised, while Finland and the Netherlands are both specialised.

While Poland is not the benchmarked country with the most specialisations in each subject area, it is not the country with the least, either, at four. Indeed, Spain has the least specialisations, with just three. The former figure is equivalent to the EU-28 number of specialisations. The Czech Republic and Poland share the same number of specialised subject areas, closely following Hungary (5). The Netherlands and Finland have the most specialised subject areas at nine each.

Table 12: Specialisation by country (2006-2017)

Country	Poland	Czech Republic	Finland	Hungary	Netherlands	Spain	EU-28
Agriculture and biology	14	48	30	30	-2	15	0
Arts and humanities	-43	-18	8	22	15	4	27
Biochemistry, genetics and molecular biology	-7	5	5	15	13	-14	1
Business, management and accounting	-67	-64	60	-45	31	-10	13
Chemical engineering	13	-22	-29	-29	-49	-18	-29
Chemistry	29	22	-30	7	-53	-9	-14
Computer science	-26	-25	15	-14	-30	69	-12
Decision science	-32	-47	32	8	27	29	8
Dentistry	-22	-88	35	-78	5	-24	3
Earth and planetary sciences	18	14	31	16	15	11	7
Economics, econometrics and finance	-56	26	31	-11	45	1	30
Energy	-44	-53	-13	-55	-48	-10	-36
Engineering	-6	-36	-31	-52	-58	-4	-34
Environmental science	18	15	43	-9	11	9	3
Health professions	-36	-17	7	-64	30	-5	9
Immunology and microbiology	-24	11	9	12	32	-5	8
Materials science	17	2	-27	-34	-62	-29	-26
Mathematics	25	21	-10	44	-48	32	1
Medicine	-15	-14	-7	-15	30	-8	8
Multidisciplinary	-86	-68	-25	-9	-23	-50	-34
Neuroscience	-39	-33	17	47	46	-19	18
Nursing	-80	-80	21	-76	8	-7	5
Pharmacology, toxicology and pharmaceutics	-10	-29	-38	12	-21	-35	-17
Physics and astronomy	41	28	8	25	-24	6	0
Psychology	-56	-86	18	-10	61	-12	19
Social sciences	-57	-41	27	-2	29	0	17
Veterinary	62	8	-43	52	-9	-23	7

Source: Own calculations based on Scopus

Notes: Specialisation indices are calculated based on the relative weight of the peer-reviewed publications and reviews of Poland and benchmark countries compared to the weight in the world, with transformations applied to the measure in order to centre the indices around zero and fix their range between -100 and 100 (based on logarithmic and hyperbolic tangent functions); large positive (resp. negative) values illustrate high (low) specialisation in the subject area

9.2.2 Citations per publication

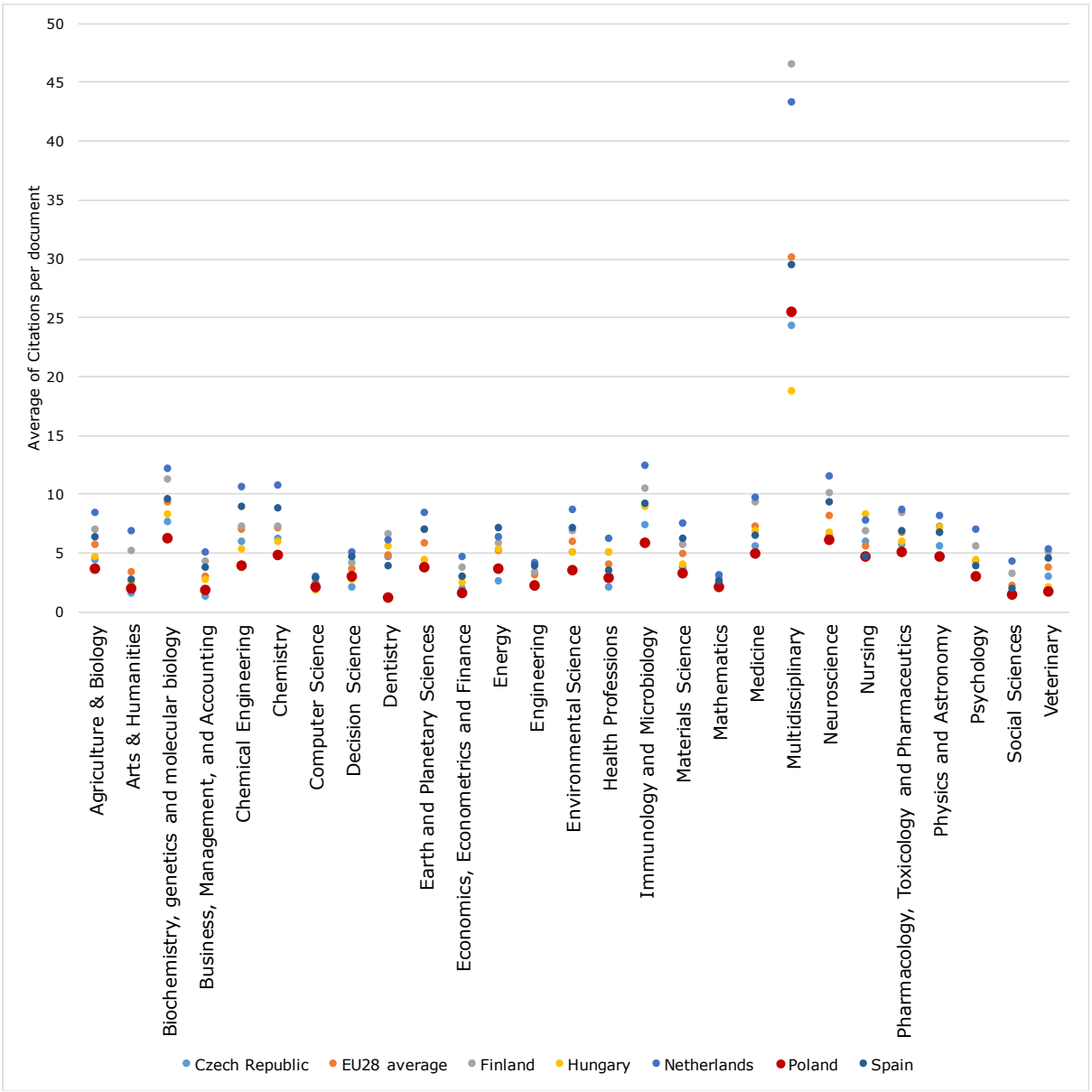
Figure 13 shows the average number of citations per publication for Poland, the EU-28 and benchmark countries, the Czech Republic, Finland, Hungary, the Netherlands and Spain (for the period 2011 to 2015). According to the data collected from SCImago, Poland has the lowest total average of citations per document, accounting for 3.6 for all subject categories. The Netherlands leads in terms of average citations per publication at 7.7 for all subject categories.

Poland's highest averages of citations per document (higher than 5) are in **biochemistry, genetics and molecular biology** (6.1), **neuroscience** (6), **immunology and microbiology** (5.7), and **pharmacology, toxicology and pharmaceutics** (5). Nonetheless, these figures are slightly below the EU-28 average. In addition, all the aforementioned subject areas are comparatively lower than the average citations per document of the benchmarked countries.

Its lowest averages (below 2) are in **dentistry** (1.15), **social sciences** (1.35), **economics, econometrics and finance** (1.53), **veterinary** (1.6), **business, management and accounting** (1.74), and **arts and humanities** (1.85). Moreover, in dentistry, there is a substantial gap between Poland's average citations per document and other benchmarked countries. Indeed, while Spain ranks second to last in this area, it accounts for more than double the average of Poland at 3.81.

Overall, for average citations per document, Poland scores lower than the EU-28 average in every subject area except for **multidisciplinary**. Moreover, there is generally a substantial gap between figures for Poland, the Czech Republic, Hungary, the Netherlands, Finland and Spain.

Figure 13: Citations per publication (2011-2015)



Source: Own calculations based on SCImago data

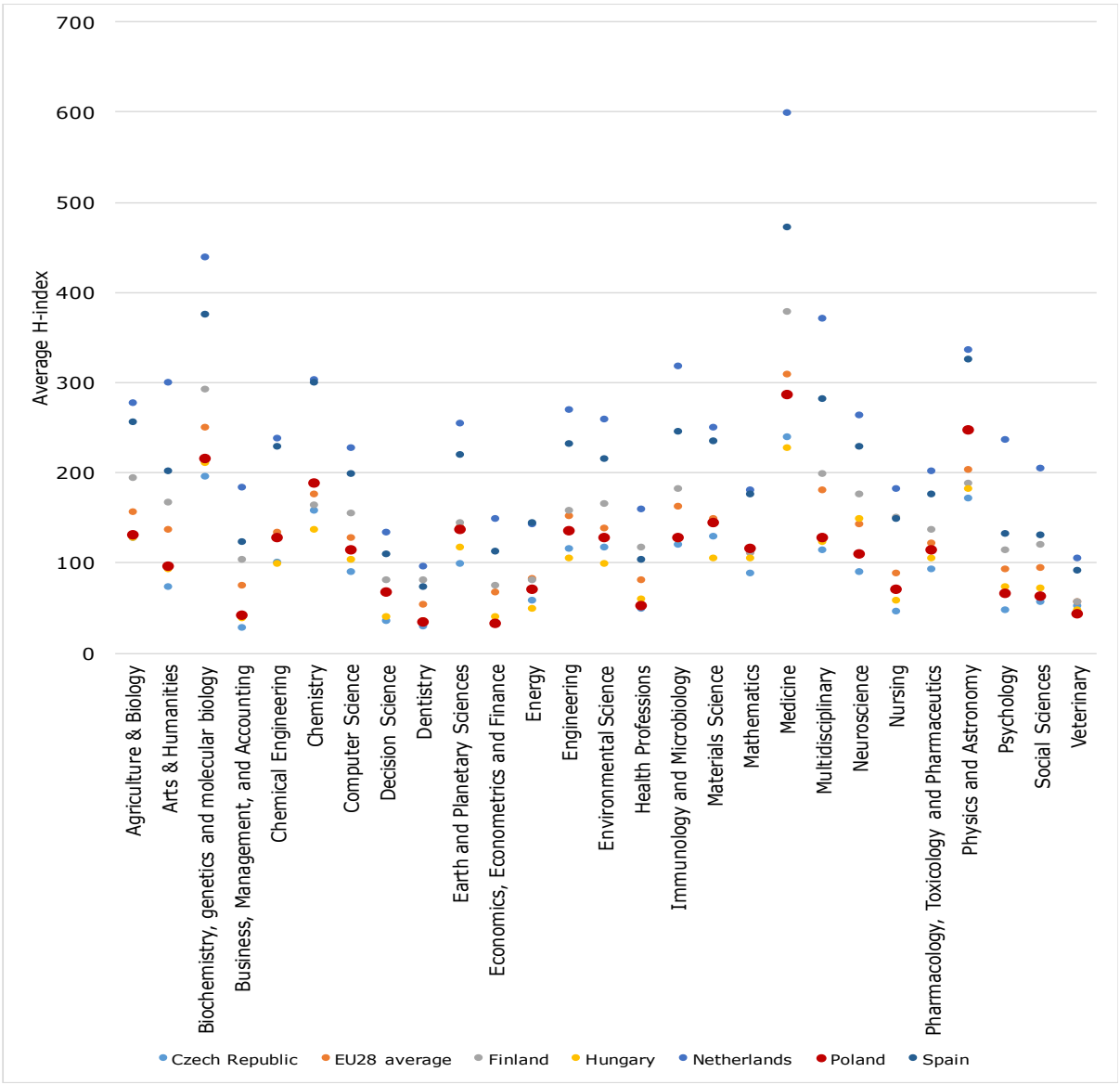
9.2.3 H-Index

Figure 14 represents the h-index for Poland, the Netherlands, the Czech Republic, Finland, Hungary, Spain and the EU-28 (for the period 1996 to 2015). According to the data, Poland shows no clear advantage compared to the benchmarked countries. Overall, it ranks fourth in terms of **all subject categories**, accounting for an average 401 h-index, after the Netherlands (752), Spain (648) and Finland (479). Its figures are also below the EU-28 average.

Poland's h-index is highest (over 200) in medicine (285), physics and astronomy (246), and biochemistry, genetics and molecular biology (214). In medicine, Poland ranks fourth behind the Netherlands, Spain and Finland and its figures represent more than twice the EU-28 average.

However, its lowest output (below 50) is in economics, econometrics and finance (31), dentistry (32), business, management and accounting (40), and veterinary (42). Poland's lowest average h-index (economics, econometrics and finance) is below the EU-28 average, and is comparatively lower than all the benchmarked countries. This is not the case for dentistry and business, management and accounting, as it performs relatively better than the Czech Republic, Hungary and the EU-28 average. Overall, **dentistry** and **veterinary exhibit the lowest EU-28 averages at 52 and 54, respectively**, while **medicine, biochemistry, genetics and molecular biology, and physics and astronomy** register the highest averages of the EU-28 at 307, 249 and 201, respectively.

Figure 14: H-index (2011-2015)



Source: Own calculations based on SCImago data

9.2.4 Top 10 % most-cited publications

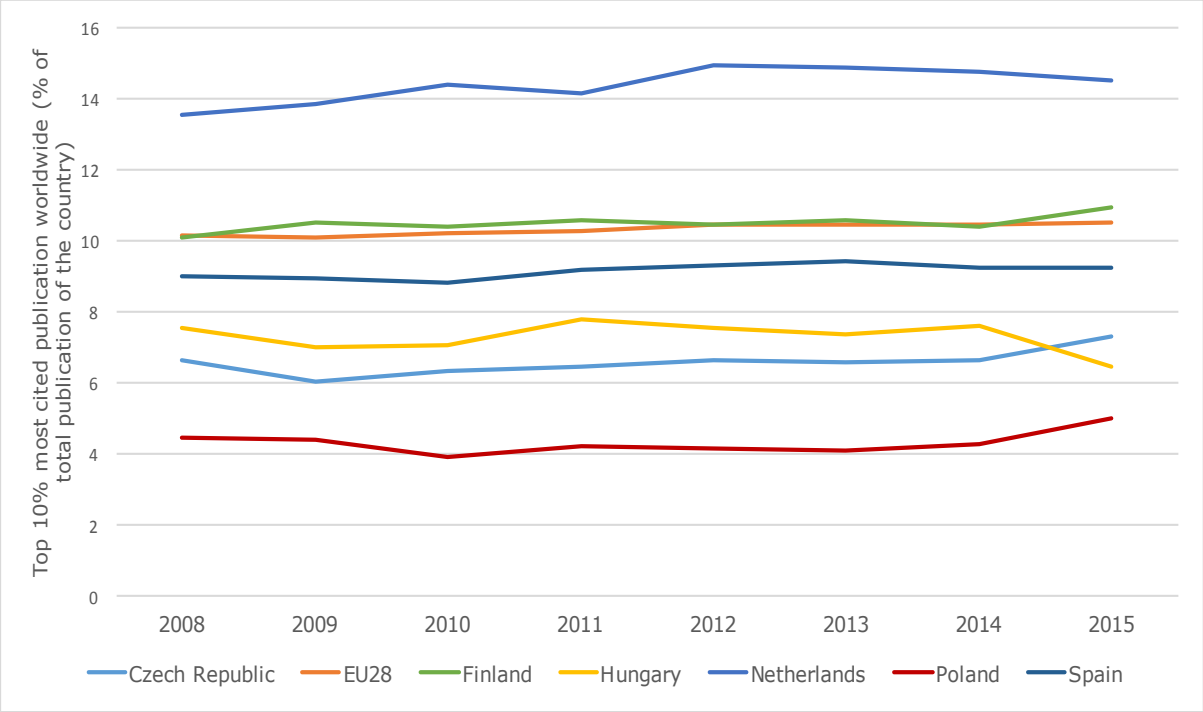
Figure 15 shows data on scientific publications among the top 10 % most cited worldwide (as % of a country's total scientific publications) collected from the Centre for Science and Technology (CWTS) for the Innovation Union Scoreboard 2016. It compares this data as a percentage of total scientific publications for Poland and benchmarked countries (for the period 2008 to 2015).

Overall, Poland has the lowest comparative percentages over the specified period, ranking last after the Czech Republic, Hungary and Spain, which are all below the EU-28. The Netherlands ranks first among all benchmarked countries at 14.5 % (in 2015), followed by Finland (10.9 %) and the EU-28 (10.5 %).

According to the data, Poland's top 10 % most-cited publications among its total volume of publications stood at 4.4 % for 2008 to 2009. Between 2009 and 2010 there was a 10 % decrease, while from 2010 to 2014 there was a slight increase then a more substantial one of 17 % between 2014 and 2015.

Poland exhibits the highest annual growth rate for all considered benchmarks, accounting for a positive 2 %. It also has highest annual growth rate among benchmarked countries, with Hungary and Spain below the EU-28 average, at -2 % and 0 %, respectively.

Figure 15: Top 10 % most-cited publications worldwide



Source: IUS, 2016

9.3 Collaboration

9.3.1 International co-publications

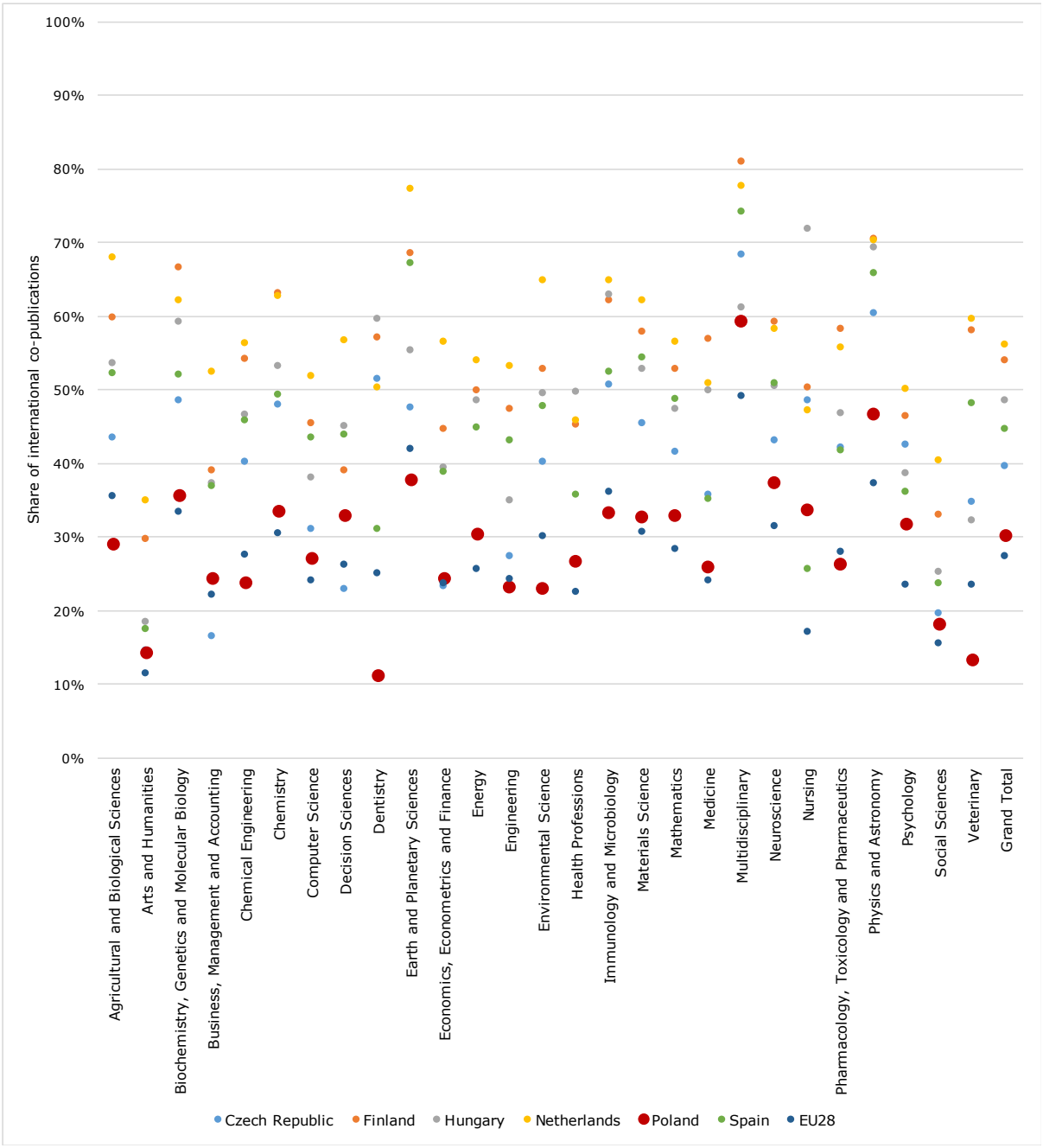
The number of exclusively international co-publications was computed from data extracted from Scopus by subtracting the total number of a country's publications from the number of exclusively national publications. Data for 2011 to 2015 was processed for Poland and its benchmark countries, the Czech Republic, Finland, the Netherlands and Spain. Furthermore, data for the EU-28 comprises the output of publications for the Member States, excluding any other country in the world.

Figure 16 shows the share of international co-publications among total publications by subject area for Poland and benchmarks. The data indicates that Poland has a comparatively low share compared to benchmarked countries.

Its highest share of international co-publications is in the multidisciplinary subject area, accounting for 59 %, although it is the second lowest compared to the benchmarked countries. Poland's second highest share of international co-publications is in physics and astronomy, at 47 %. However, once again this represents the second lowest share among benchmarks. Earth and planetary sciences represent the third highest share of international co-publications, at 38 %, but is the lowest among compared countries.

Poland's lowest share of international co-publications is in dentistry sciences, at 11 %. There is substantial gap between this figure and the other benchmarked countries; veterinary sciences show a similar situation at 13 %. It has the third lowest share of international co-publications in arts and history, at 14 %, although this is not such a substantial gap compared to other benchmarked countries.

Figure 16: Share of international co-publications (2011-2015)



Source: Own extract based on Scopus

9.3.2 Public-private co-publications (per million population)

For this indicator, data was extracted from the European Innovation Scoreboard. Figure 17 shows public-private co-publications per million inhabitants (for the period 2008 to 2015); compared to all the benchmark countries, Poland ranks last and is below the EU-28 average.

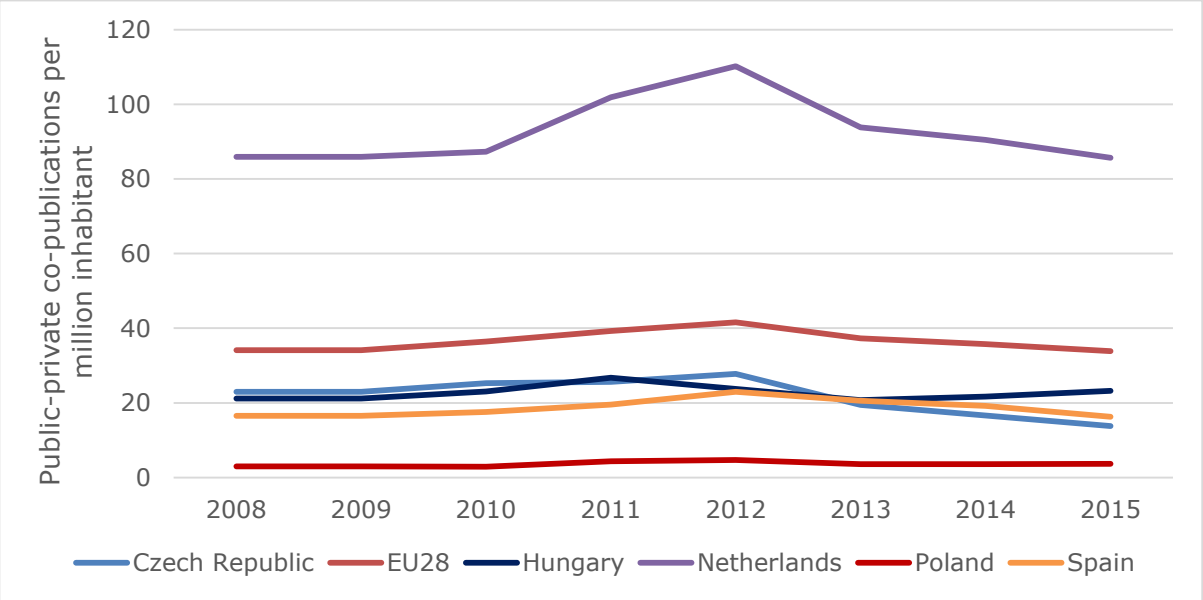
More specifically, in 2015, Poland had the lowest figures for this indicator at 3.7 public-private co-publications per million inhabitants. From 2008 to 2009, the data remained stable around 3, with a slight decrease to 2.9 in 2010. However, the country showed an increasing trend from 2011 to 2012, at 4.7. From 2013 to 2014, publications fell to 3.6, only to rise to 3.7 in 2015.

Although Poland displays the lowest levels of all the benchmark countries, it records the highest average annual growth in the group, at 3 %. Hungary recorded an average annual growth rate of 1 %, the EU-28, the Netherlands and Spain tallied 0 %, while the Czech Republic showed an average annual decline in growth of -7 %.

While the Netherlands has the largest spike in 2012, other benchmarked countries show a similar trend between 2011 and 2012. This is not the case for Poland where the number of public-private co-publications per million inhabitants does not drop from 2013 to 2015, but does in all other benchmark countries, except for Hungary.

That said, there is a substantial gap between Poland and the benchmarked countries. In addition, the Netherlands has a considerable lead over all benchmarks. Indeed, at 85.6 in 2015, it represents nearly 23 times the Polish figures. Moreover, except for Hungary, all countries show substantial increases in 2012, and a slight fall in 2013.

Figure 17: Public-private co-publications per million inhabitants (2008-2015)



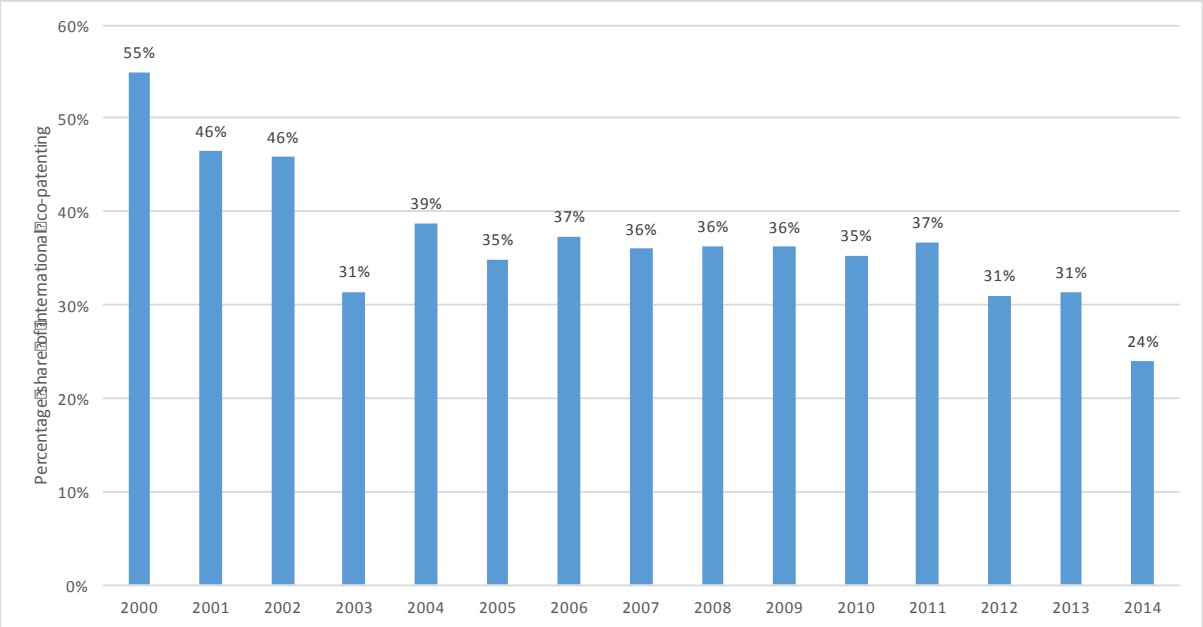
Source: IUS, 2016

9.3.3 International co-patenting

The indicator for co-patenting is based on data extracted from PATSTAT (Worldwide Patent Statistical Database). Figure 18 shows the patents (applications and grants) with at least one Polish inventor plus at least one inventor of another nationality. Poland recorded a negative trend from 2000 to 2014. Over the considered period, the volume of international co-patenting has more than halved.

The share of international co-patenting fell from 2000 until 2003 from 55 % to 31 %, respectively. Figures remained relatively stable from 2004 to 2011. Nonetheless, from 2012 to 2014, there was a considerable fall in the percentage share of international co-patenting.

Figure 18: Poland's share of international co-patenting (2000-2014)



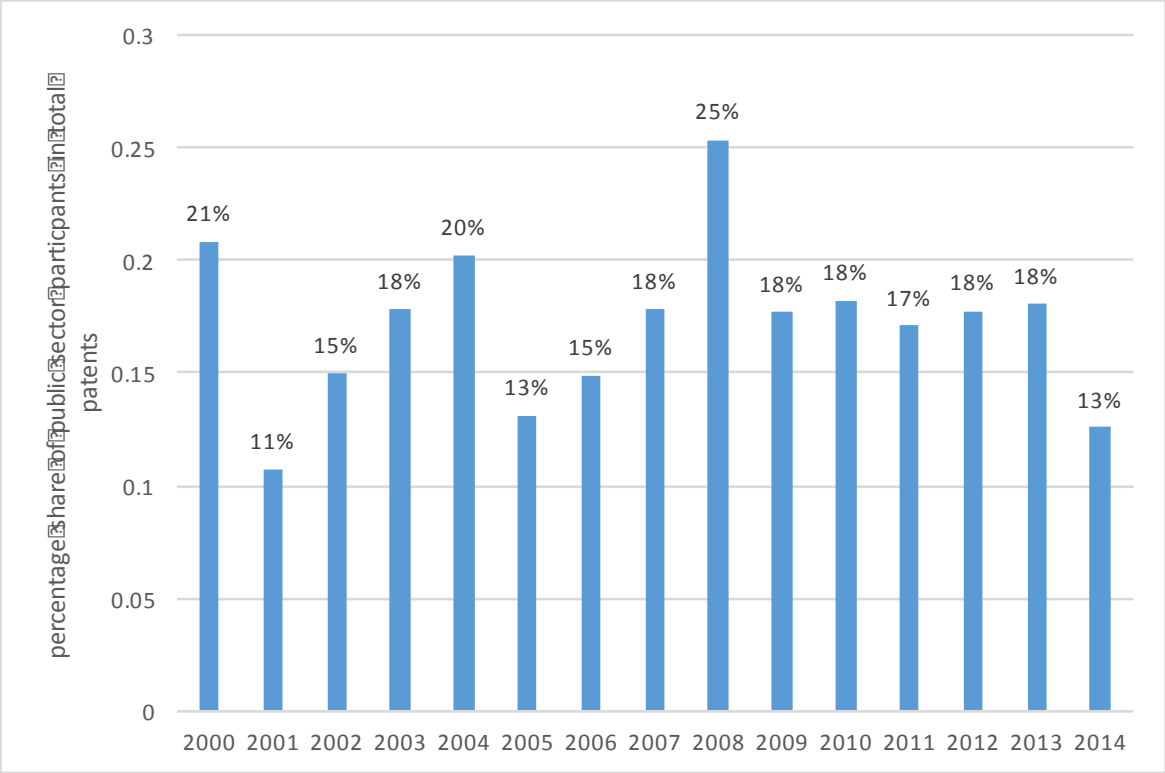
Source: Based on own extract from Scopus

9.3.4 Public sector patenting

The share of public sector patenting (as % share) is based on data extracted from PATSTAT. The numerator comprises patents (applications and grants) of inventors and applicants from the public sector, including universities, non-governmental organisations, non-profit governmental organisations and hospitals. The denominator consists of patents (applications and grants) with at least one Polish inventor/applicant, and at least one inventor/applicant of another nationality.

From 2000 to 2014, the overall share of public sector patents recorded an average annual growth of 4 %. In absolute terms, the number of public sector patents is low, ranging from a minimum of nine (in 2001) to a maximum of 126 (in 2012). Overall, the number of public Polish inventors and applicants is substantially lower than its private counterparts. However, it is important to note that these figures do not account for the inventors and applicants who apply as individuals, even though they may be affiliated to the public sector and thus the research may have been at least partially funded by public sector institutions.

Figure 19: Poland's share of public sector patenting (2000-2014)



Source: Based on own extract from PATSTAT

9.4 Patents, trademarks and design

9.4.1 Patents

Table 13 shows the number of European patents granted by field of technology per million inhabitants. The technologies include electrical engineering, instruments, chemistry, mechanical engineering, and others, each of which includes sub-categories. Data was collected for Poland, the EU-28 average and benchmark countries from the EPO statistics database (for 2006 to 2015).

The technology sub-field for which Poland has the most patents granted per million inhabitants is in civil engineering (1.8), followed by biotechnology (1.2), organic fine chemistry (1.1), and medical technology (1.1). In comparison, Finland and the Netherlands have a significant lead over Poland's highest-performing subject area, civil engineering. Indeed, taking into account values per million inhabitants, Finland and the Netherlands show 39 and 37.3 European patent granted per million inhabitants for the aforementioned subject area.

Moreover, Poland exhibits its highest patent grants in the field of chemistry technology, with 4.6 patent grants per million inhabitants. While this equates to the EU-28 output, it is considerably lower than all other benchmarked countries. For instance, the Czech Republic has the second lowest output of patent grants per million inhabitants in this field of technology, with more than three times that of Poland at 16.3.

Poland's lowest figure is in the technology field of electrical engineering, with only two patents granted per million inhabitants. In comparison, the EU-28 average shows that electrical engineering ranks second last in terms of patents granted from 2006 to 2015.

As regards the total number of patents granted for all technology fields, Poland ranks fourth behind Hungary, accounting for 16.4 and 42.59, respectively. Indeed, there is a considerable gap between the two top-performing countries – the Netherlands and Finland – and the rest of the benchmarks. Finland ranks first in the total number of patents granted, having a substantial lead with 1323.15 patent grants per million inhabitants. The Netherlands is second at 1092.11 patent grants per million inhabitants, representing over 80 times more patents granted per million inhabitants than Poland.

Table 13: European patents granted from 2006-2015 by technology field (absolute values)

Field of technology[1]	Sub-category	Czech Republic	Spain	Finland	Hungary	Netherlands	Poland	EU-28 average
Electrical engineering	Electrical machinery, apparatus, energy	1.9 (20)	4.4 (203)	49.8 (267)	1.5 (15)	60.2 (1000)	0.7 (27)	1.2 (619)
	Audio-visual technology	0,3 (3)	0,8 (38)	34,7 (186)	0,5 (5)	64,4 (1070)	0,2 (9)	0,4 (214)
	Telecommunications	0,2 (2)	1,4 (63)	240,1 (1288)	0,2 (2)	35,5 (590)	0,3 (12)	0,7 (364)
	Digital communication	0,3 (3)	1,3 (59)	188,9 (1013)	0,2 (2)	39,9 (663)	0,1 (5)	0,7 (369)
	Basic communication processes	0,2 (2)	0,2 (8)	21,6 (116)	0,3 (3)	29,9 (496)	0,1 (2)	0,2 (95)
	Computer technology	0,2 (2)	1 (45)	66,9 (359)	0,4 (4)	69,8 (1159)	0,1 (3)	0,6 (295)
	IT methods for management	0 (0)	0 (1)	0,9 (5)	0 (0)	0,2 (3)	0 (0)	0 (4)
	Semiconductors	0 (0)	0,1 (4)	6 (32)	0,1 (1)	28,1 (466)	0 (1)	0,3 (145)
Instruments	Optics	0,3 (3)	0,5 (23)	12,7 (68)	0,6 (6)	50,2 (834)	0,2 (6)	0,3 (153)
	Measurement	2 (21)	1,9 (87)	46,1 (247)	1,3 (13)	49,1 (815)	0,4 (17)	0,9 (453)
	Analysis of biological materials	0,1 (1)	0,7 (33)	9,1 (49)	0,3 (3)	7,4 (123)	0 (0)	0,2 (77)
	Control	0,4 (4)	1,6 (74)	11,6 (62)	0,4 (4)	9,3 (154)	0,1 (5)	0,3 (168)
	Medical technology	1,6 (17)	4,1 (191)	36,2 (194)	1,9 (19)	64,6 (1072)	1,1 (40)	1 (515)
Chemistry	Organic fine chemistry	6,2 (65)	5,7 (262)	10,6 (57)	8,7 (87)	38,1 (633)	1,1 (41)	0,8 (408)
	Biotechnology	1,3 (14)	4,2 (192)	19 (102)	1,8 (18)	43 (714)	1,2 (44)	0,6 (298)
	Pharmaceuticals	3,4 (35)	5,5 (251)	12,9 (69)	7 (70)	28,8 (479)	0,6 (23)	0,6 (295)
	Macromolecular chemistry, polymers	0,6 (6)	0,7 (31)	46,4 (249)	0,4 (4)	46,1 (766)	0,2 (8)	0,5 (241)
	Food chemistry	0,4 (4)	1,7 (78)	8,8 (47)	0,6 (6)	39,4 (655)	0,2 (8)	0,2 (100)
	Basic materials chemistry	0,6 (6)	1,2 (57)	11,7 (63)	1,1 (11)	36,6 (607)	0,4 (14)	0,4 (221)
	Materials, metallurgy	1,5 (16)	1,6 (75)	20,9 (112)	0,4 (4)	11,1 (185)	0,5 (18)	0,3 (165)
	Surface technology, coating	0,5 (5)	1 (44)	14,9 (80)	0,4 (4)	10,8 (179)	0,6 (21)	0,3 (141)
	Micro-structural and nano-technology	0 (0)	0,1 (5)	0,6 (3)	0,1 (1)	1,4 (24)	0 (0)	0 (9)
	Chemical engineering	1,2 (12)	1,8 (81)	35,4 (190)	0,9 (9)	25,1 (416)	0,4 (15)	0,6 (284)
	Environmental technology	0,7 (7)	1,1 (51)	19,2 (103)	0,9 (9)	14,8 (245)	0,4 (15)	0,3 (149)
Mechanical engineering	Handling	1,2 (12)	6,7 (309)	89,1 (478)	1,9 (19)	44,6 (741)	0,8 (30)	1 (494)
	Machine tools	1,9 (20)	2,7 (122)	26,1 (140)	0,7 (7)	13,5 (225)	0,7 (26)	0,8 (381)
	Engines, pumps, turbines	1,2 (13)	2,5 (115)	25 (134)	0,8 (8)	7,8 (129)	0,3 (10)	0,8 (424)
	Textile and paper machines	3,1 (32)	1,5 (71)	85,6 (459)	0,5 (5)	22 (366)	0,3 (12)	0,5 (273)
	Other special machines	3,2 (33)	4,6 (211)	40,8 (219)	1,4 (14)	58,1 (964)	0,4 (17)	0,9 (444)
	Thermal processes and apparatus	0,7 (7)	1,5 (68)	16,8 (90)	0,4 (4)	8,7 (144)	0,4 (17)	0,3 (146)
	Mechanical elements	2 (21)	2,9 (135)	16,8 (90)	0,8 (8)	19,8 (328)	0,5 (20)	1 (507)
	Transport	5,9 (61)	10,1 (467)	38,2 (205)	0,8 (8)	36,7 (610)	0,9 (34)	1,9 (938)
Other fields	Furniture, games	0,6 (6)	3,6 (167)	11 (59)	1,7 (17)	25,5 (423)	0,5 (18)	0,6 (284)
	Other consumer goods	1,8 (19)	2,1 (98)	9,9 (53)	0,8 (8)	14,3 (238)	1 (39)	0,5 (242)
	Civil engineering	3 (31)	6,5 (300)	39 (209)	2,7 (27)	37,3 (619)	1,8 (68)	0,9 (466)

Source: EPO statistics

9.4.2 Design applications

Table 14 shows community design applications per million inhabitants, extracted from Eurostat. The data provide information for Poland, the Czech Republic, Spain, Hungary, the Netherlands, Finland and the EU-28 (for the period 2003 to 2015).

In 2015, Poland had the third highest number of design applications per million inhabitants, accounting for 38.8. From 2003 to 2009, this number increased substantially from 0.4 to 23.2. A slight decrease is noted from 2009 to 2010, to 21.4 design applications per million inhabitants. However, design applications figures rise significantly from 2011 to 2015, from 24.8 to 38.8.

Poland shows the largest increase in numbers compared to the benchmark countries. This increase is also noticeable to a lesser extent in the Czech Republic and Hungary. When comparing community design applications, Poland seems to have enjoyed the largest increase among those countries joining the EU in 2004. On the other hand, countries that were part of the Union prior to the period under consideration did not experience such comparably large increases in community design applications.

When comparing values in absolute terms, in 2015, there is a substantial difference between the number of design applications made by Poland, Finland and the Netherlands, and those made by other benchmarked countries. Nonetheless, Poland ranks third in the number of design applications per million inhabitants, behind Finland and the Netherlands; the latter two accounting for 53.7 and 44.7 design applications per million inhabitants, respectively.

Table 14: Community design applications

Year	EU-28	Czech Republic	Spain	Hungary	Netherlands	Poland	Finland
2003	15.4 (7534)	1 (10)	15.8 (662)	0.6 (6)	30.1 (488)	0.4 (15)	21.3 (111)
2004	19.9 (9812)	3.5 (36)	19.6 (833)	2.9 (29)	43.7 (711)	2.3 (89)	30.1 (157)
2005	23.5 (11 609)	8,1 (83)	23 (994)	3.8 (38)	46.9 (764)	7 (268)	36.9 (193)
2006	24.4 (12 136)	14.5 (148)	22.1 (972)	3 (30)	45.4 (741)	10.5 (400)	35 (184)
2007	26.8 (13 375)	14,2 (146)	23,5 (1053)	6.1 (61)	45.2 (739)	13.7 (522)	35.6 (188)
2008	26,4 (13 225)	13.5 (140)	21.4 (978)	5.3 (53)	51.9 (851)	16.8 (640)	37.9 (201)
2009	27 (13 547)	15,3 (159)	19,9 (922)	5.8 (58)	53.8 (887)	23.2 (883)	42.4 (226)
2010	27.9 (14 056)	18.7 (196)	23.1 (1076)	6.9 (69)	47.6 (789)	21.4 (812)	45.2 (242)
2011	28.8 (14 490)	24.7 (259)	20.7 (968)	4.7 (47)	49.2 (819)	24.8 (945)	43.5 (234)
2012	29.6 (14 911)	26.7 (281)	18.9 (886)	5,6 (56)	54.3 (909)	27.6 (1052)	51.8 (280)
2013	30.6 (15 453)	22.5 (237)	20.1 (939)	5.9 (58)	48.4 (812)	30 (1140)	58 (315)
2014	31 (15692)	24.4 (257)	19.8 (919)	7,1 (70)	49.8 (838)	34.6 (1314)	57.6 (314)
2015	29.5 (14982)	20.5 (216)	20.1 (933)	7.1 (70)	44,7 (755)	38.8 (1473)	53.7 (294)

Source: Eurostat, 29.11.16

9.4.3 Trademark applications

Table 15 shows the European Union trademark (EUTM) applications by class (Nice classification), including 46 different classes (timeframe 1996-2015). Poland's highest number of trademark applications is in advertising, business management, business administration, office functions totalling 1402 in absolute terms. For the period in question, its trademark applications increased considerably from 4.9 in 2003 to 96.4 in 2015. In fact, countries that did not join the EU until 2004 have seen the highest rise in trademark applications. In comparison, the number of trademark applications in Spain, the Netherlands and Finland have increased to a lesser extent, while those countries in the EU prior to the period under consideration show smaller increases in absolute terms.

As regards the benchmarks, in 2015, Poland ranked fourth after Spain with 96.4 and 202.5, respectively. The Netherlands had the highest levels of trademark applications per million inhabitants in 2015, by a considerable margin at 268.2. Nonetheless, Hungary and the Czech Republic are below Poland in terms of trademark applications per million inhabitants at 94.1 and 57.3, respectively.

Table 15: European Union trade mark (EUTM) applications by class (Nice classification) (1993-2016)

Country /Year	European Union (28 countries)	Czech Republic	Spain	Hungary	Netherlands	Poland	Finland
2003	81,3 (39917)	9,1 (93)	139,3 (5825)	5,6 (57)	137 (2219)	4,9 (186)	85,3 (444)
2004	82,7 (40711)	26,1 (266)	129,5 (5509)	13,6 (138)	129,2 (2101)	15 (573)	84,3 (440)
2005	89,3 (44174)	21,9 (223)	134 (5800)	16,4 (166)	139,3 (2272)	20,2 (770)	102,7 (538)
2006	107,8 (53511)	33,7 (345)	143 (6294)	19,6 (197)	171,3 (2798)	25 (954)	119,9 (630)
2007	124,4 (61992)	46,8 (480)	163,8 (7337)	26,1 (263)	194 (3174)	33,3 (1268)	137,8 (727)
2008	122,6 (61325)	43,6 (451)	152 (6941)	28,7 (288)	196,1 (3217)	42,2 (1607)	142,8 (757)
2009	126,7 (63604)	46,5 (485)	151,8 (7020)	28,7 (288)	237,3 (3912)	40,6 (1548)	147 (783)
2010	139,6 (70221)	61,9 (648)	167,6 (7789)	38,1 (382)	228,7 (3791)	46,5 (1767)	180 (963)
2011	148,8 (74822)	71,4 (749)	170,9 (7975)	35,4 (353)	234,8 (3910)	51,1 (1944)	184 (989)
2012	151,8 (76526)	87,5 (919)	171,6 (8032)	35 (348)	236,2 (3951)	56,5 (2152)	195,5 (1056)
2013	158,7 (80182)	81,8 (860)	181,6 (8484)	47,4 (470)	230,3 (3864)	71,9 (2735)	199,2 (1081)
2014	162,9 (82602)	85,5 (899)	188,5 (8768)	53,9 (532)	236,3 (3977)	84,8 (3223)	190,2 (1037)
2015	175,9 (89412)	94,1 (992)	202,5 (9405)	57,3 (565)	268,2 (4532)	96,4 (3663)	250,7 (1372)

Source: Eurostat, 29.11.16

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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 and higher education in Poland and provides a focused background for the PSF Peer Review of Poland's research and innovation system, conducted in 2017 by a panel of independent experts and national peers.

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