Rialtas na hÉireann
Government of Ireland

Higher Education Research & Development Survey
2016-2017

Prepared by the Department of Business, Enterprise and Innovation

The Department of Business, Enterprise and Innovation would like to thank all the respondents to this survey who have taken the time to gather information and complete the data requests for this key area of Government policy.

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Executive Summary

This report presents the results of the survey of research and development (R&D) activities in the higher education sector – the Higher Education R&D Survey (HERD) – for the academic year 2016/17. Expenditures and human resources devoted to research work in the higher education sector are measured biennially in the HERD survey. The sector includes the Universities, Institutes of technology, and other Institutions that are in receipt of public funding and engaged in research and development activities.

The main findings of the HERD 2016 survey are summarised below:

Table 1 - Summary of key results, 2006-2016, current prices

	2006	2008	2010	2012	2014	2016
Higher education expenditure on R&D (HERD)	600.5	749.8	708.3	664.4	730.1	748.8
HERD as a % of GNP	0.37	0.47	0.51	0.48	0.45	0.34
Ireland's rank out of 36 countries	19	14	14	18	20	24
Total researchers in HE sector (FTE)	7,353	11,246	12,140	12,117	12,836	12,627
Researchers per 1000 labour force - Ireland's rank out of 32 countries	9	5	7	9	7	8
Percentage of HERD financed by industry	2.7%	3.8%	3.9%	3.3%	4.4%	4.5%

Source: DBEI HERD Data and OECD, Main Science and Technology Indicators, May 2019

- Total expenditure on R&D in the higher education sector in 2016 amounted to €748.8 million. HERD increased by almost one quarter between 2006 and 2016 and by 2.6% between 2014 and 2016.
- HERD as a percentage of GNP fell from 0.45% in 2014 to 0.34% in 2016. It should be noted that despite the increase in HERD expenditure, the HERD intensity rate continued to slip in 2016 due to significant GDP/GNP growth in recent years (i.e. a denominator effect). **Note:** See Appendix 3 for note on GDP, GNP and GNI*.
- Ireland's rank out of 36 OECD countries for HERD as a percentage of GDP (GNP for Ireland) has declined from 20th place in 2014 to 24th place in 2016.
- The total number of full-time equivalent (FTE) researchers (excluding technical and administrative support staff) has remained relatively unchanged since 2014 with 12,627 researchers in 2016.
- Ireland ranked 8th out of 39 OECD countries on headcount researchers per 1,000 of the labour force in 2016.

- TCD had the largest spend on R&D at €143m in 2016, followed by UCD at €127m, UCC at €107m, NUIG at €81m and UL at €72m. These five institutions together account for almost three quarters of HERD in 2016.
- Funding from Science Foundation Ireland to the higher education sector amounted to €162.1m in 2016, accounting for 46% of total direct government funding.
- The percentage of HERD financed by Industry increased marginally from 4.4% in 2014 to 4.5% in 2016.
- Pay costs have increased by 5% between 2014 and 2016, from €491m to €516m while non-pay costs have increased by 14% to €206m.
- Capital costs have decreased by almost 38% over a ten-year period, from €42.5m in 2006 to €26.5m in 2016.

Methodology

This survey was carried out following the OECD Frascati Manual (2015) guidelines for estimating levels of research and development in the higher education sector and the results for Ireland are comparable to those from other OECD countries. The Frascati Manual is the internationally recognised methodology for collecting and using R&D statistics. Data captured in the survey relates to the 2016 academic year (September 2016 to September 2017).

There were two elements to this survey of research and development in Higher Education Institutes:

- An analysis of financial data from each institution;
- An analysis of personnel data and time-use data based on the amount of research per person employed from each institution.

New metrics

While the Financial questionnaire was unchanged from the previous HERD survey, an important addition was made to category of the Personnel questionnaire. A breakdown of the Doctoral/Master students was sought, as per the Frascati manual 2015. This is following the 2014 HERD Survey in which the Doctoral/Master's students working for a R&D Unit were included for the first time in the "researchers" category. For the 2016 survey, the Higher Education Institutes (HEIs) were asked to breakdown the data collected on the number of Doctoral/Master's students into the following categories:

- Internal R&D Personnel – Employed Students
- External R&D Personnel – Students receiving a grant from their host institution
- External R&D Personnel – Students that have secured competitive funding to complete their studies

For further details see Appendix 4.

Headcount and Full-time equivalent data

Detailed departmental headcounts were obtained from the personnel offices, categorised by research academic staff and research support staff. In order to calculate full-time equivalent totals the percentage of time spent on research was also obtained. In addition, the headcounts were split between male and female to allow gender comparisons.

Each academic department was also asked to estimate the time spent on research activities by each member of staff in his/her department. Strict guidelines and instructions were circulated to each head of department outlining a single agreed methodology which identified comparable time spent on research activities. This methodology is as recommended by the international OECD Frascati Manual.

The following matrix was used to determine the percentage of time spent on research.

The following activities are deemed as "research activities" for the purpose of this survey: ✓	**The following activities are not deemed as "research activities" for the purpose of this survey:** X
• Personal research • Team research • Writing research proposals • Writing research reports • Supervision of PhD students • Other research-based activities including admin and planning	• Teaching • General Admin • Supervision of non-PHD students • Other non-research-based activities • External activities

Survey coverage

The coverage included all academic departments in seven Universities, fourteen Institutes of technology, as well as the Royal College of Surgeons and Mary Immaculate College.

Universities	Institutes of technology
Dublin City University, NUI Galway, Maynooth University, University College Cork, University College Dublin, Trinity College Dublin and University of Limerick.	*Athlone IT, Cork IT, Dublin IT, Dundalk IT, Dun Laoghaire Institute of Art, Design and Technology, Galway-Mayo IT, Letterkenny IT, Limerick IT, Waterford IT, IT Blanchardstown, IT Carlow, IT Sligo IT, Tallaght and IT Tralee.*

Questionnaires were sent out in April 2018 to the Universities and Institutes.

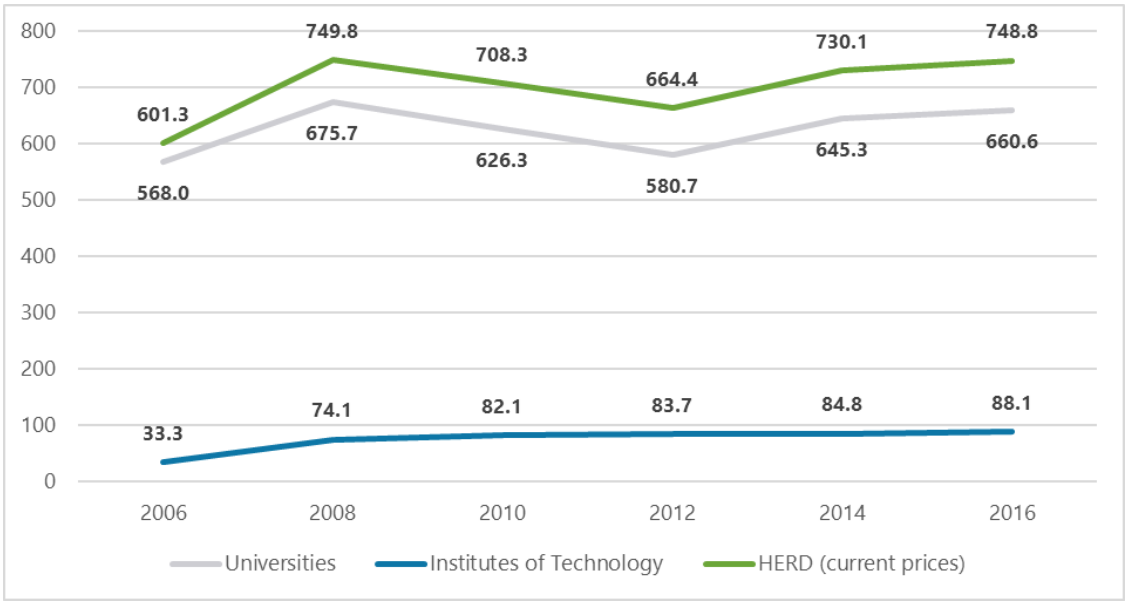
Detailed departmental income and expenditure was obtained from the finance office in each university. Industrial liaison offices provided similar information for the Institutes of technology.

This information comprised total capital and current expenditure from the colleges' block grant for all departments, from which a research proportion was derived, based on the amount of research-time reported by the respondents.

Research income for each department was provided by source of funds and types of costs.

Chapter 1: General trends in higher education R&D expenditure

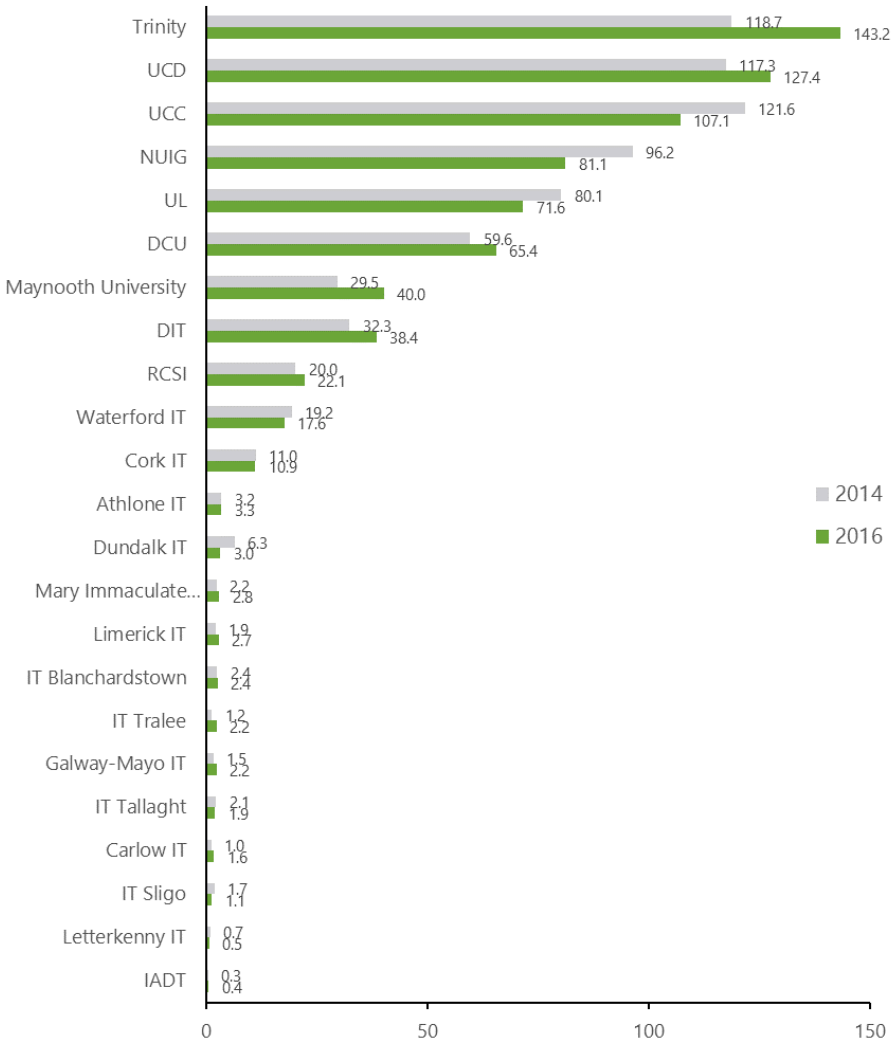
Figure 1: Trend in HERD expenditure, 2006-2016, in current prices (€ millions)



Source: DBEI HERD data

- Total expenditure on R&D in the Higher Education sector increased by almost 25% in the 10-year period 2006-2016, from €601.3m to €748.8m.
- Expenditure on R&D in the university sector increased from €645.3m in 2014 to €660.6m in 2016, an increase of 2.4%.
- Spend on R&D in the university sector has increased by 16.3% over the 10-year period.
- The university sector accounted for 88% of total HERD in 2016.
- R&D expenditure in the Institutes of Technology has been steadily increasing since 2006, from €33.3m to €88.1m in 2016, almost a threefold increase and the highest level recorded so far.
- The technological higher education sector accounted for 12% of total HERD in 2016.

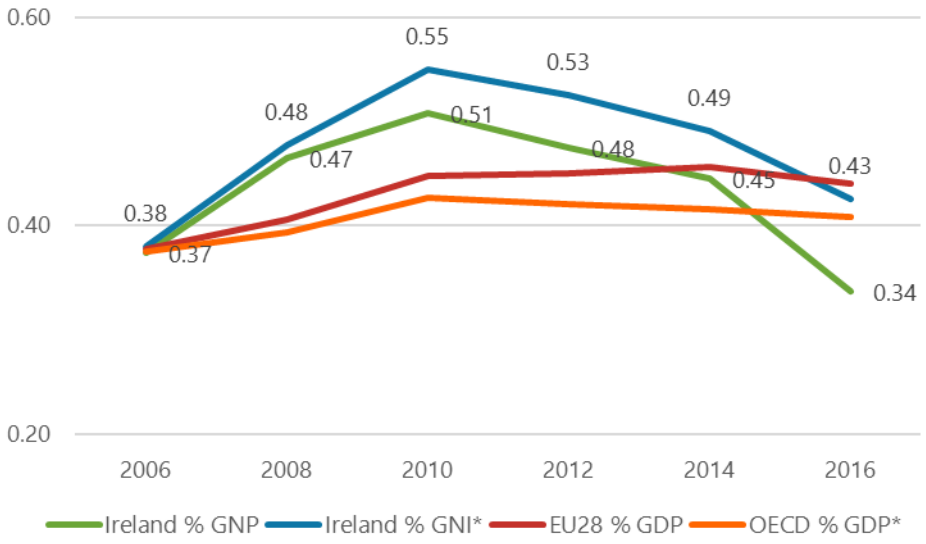
Figure 2: Research expenditure by Universities and Institutes of Technology (€ millions)



Source: DBEI HERD data

- TCD spent €143.2m in 2016, making it the highest spending institution in R&D since 2014.
- UCD and UCC had expenditures of €127.6m and €107.1m respectively in 2016.
- In the case of the Institutes of Technology, expenditure on R&D for DIT, WIT and CIT amounted to €38.4m, €17.6m and €10.9m respectively in 2016.
- The variability in expenditure in the top R&D performers can be explained by R&D capital expenditure projects in a given year.

Figure 3: HERD as a percentage of GNP/GDP/GNI*, 2006-2016, Ireland, OECD and EU28



Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

- HERD as a percentage of GNP (2016) for Ireland increased from 0.37% in 2006 to a high of 0.51% in 2010 then declined to 0.34% in 2016.
- It should be noted that the HERD intensity rate fell sharply in 2016 despite the increase in HERD expenditure, owing to significant GDP/GNP growth in recent years.
- As a percentage of modified Gross National Income (GNI*), Ireland fared better compared to the EU 28 and the OECD, but HERD as a percentage of GNI* has decreased since 2012 (see Appendix 3 for a note on GDP, GNP and GNI*).

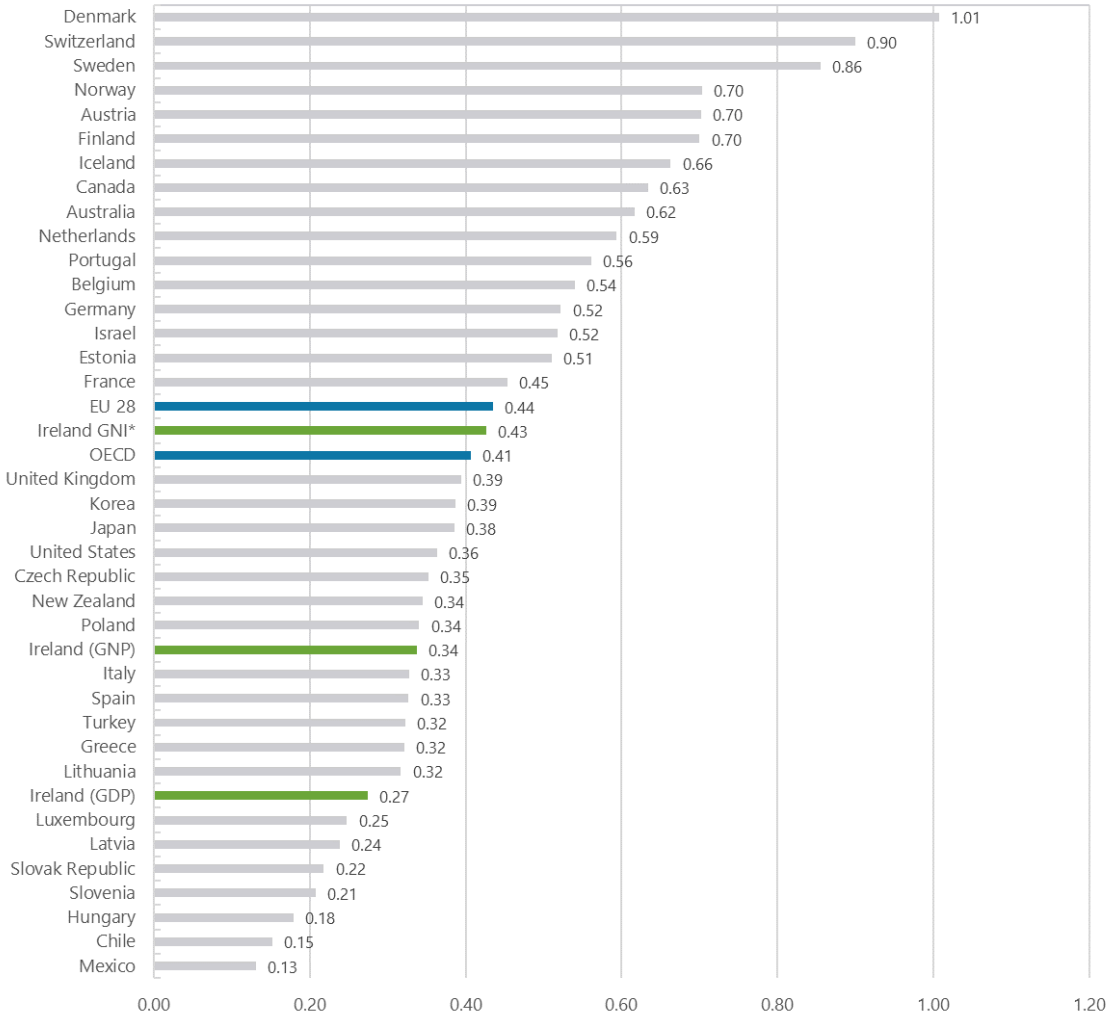
Figure 4: HERD as a percentage of GDP - Ireland's ranking GNP/GNI* (36 OECD Countries) 2006-2016

Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

- Using the GNP as the denominator, Ireland scored 24th out of 36 OECD countries on HERD as a percentage of economic activity in 2016, dropping from 20th place in 2014[1]. The fall in ranking can be explained a 'denominator effect' with growth of Ireland's GNP of 35.6% between 2014 and 2016 which outstripped the growth in the HERD of 2.6%. (see Appendix 2 on GDP, GNP and GNI*).
- Using the GNI* as the denominator, Ireland ranked 17th in 2016.

[1] Data for Lithuania became available for the 2016 HERD Survey and their inclusion has meant that the rankings have changed since the 2014 HERD Survey.

Figure 5: HERD as a percentage of GDP (& Ireland GNP/GNI*) - 2016 or latest available data



Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

- In 2016, the top performers were Denmark and Switzerland, spending 1.01% and 0.90% of GDP on R&D in the higher education sector. Sweden, at 0.86%, scored 3rd place. Ireland is in 18th place 0.43% when using GNI* as the denominator, between the EU28 and the OECD average. The UK spent 0.39%, slightly higher than the Irish level of GNP HERD intensity at 0.34% of GNP, while the USA spent 0.36%.

Chapter 2: Human resources allocated to higher education research

Headcount Figures

Doctoral/Master students were included in the definition of researchers for the first time in the 2014 HERD survey, in accordance with the 2015 Frascati Manual. The HEIs (Higher Education Institutions) were asked at the time to "*only include Doctoral/Masters students receiving wages or salaries from the R&D unit*". It should be noted that data on Doctoral/Master students were collected in the past but were not included in the 'total researchers' figures until 2014. The data were revised back to 2008 to ensure a consistent time series.

It is now apparent that this request for the number of Doctoral/Masters students was interpreted by the HEIs to mean that they should include all their Doctoral/Masters students in their 2014 returns, including Doctoral/Masters students in receipt of grants or scholarships, possibly because the grant/scholarship payments come through payroll.

This 2016 HERD Survey saw the addition of two additional sub-categories of Doctoral/Masters students, as per the Frascati Manual:

- Doctoral/Master's students receiving a grant from their host institution (e.g. a Research Centre or School).
- Doctoral/Master's students receiving a grant from a source other than the R&D reporting Unit (students who have received competitive funding to complete their Doctoral studies, e.g. IRC, SFI, EU grants, private businesses, grants from home country).

Table 2: Total researchers by performer, 2008-2016[2] (headcount)

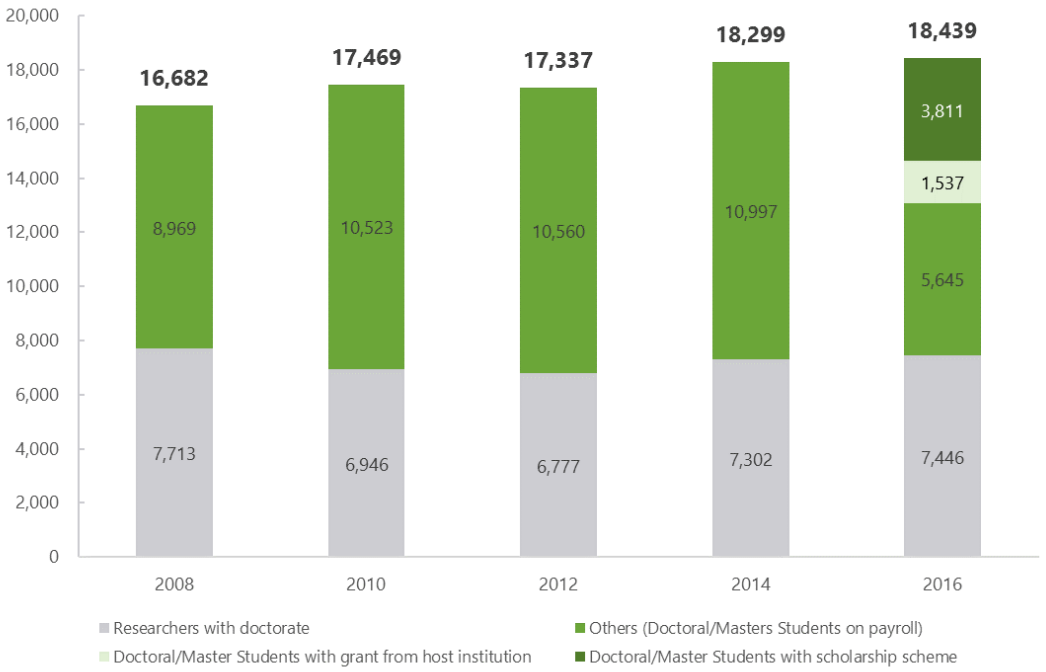
Sector	2008	2010	2012	2014	IoT 2016	Universities 2016	Total – 2016
Academic Staff	5,994	6,155	5,642	6,124	3,083	3,115	**6,198**
Principal Investigators	1,032	951	1,265	1,557	252	1,586	**1,838**
Post-doctoral Fellows	2,278	1,771	1,818	1,740	93	1,421	**1,514**
Contract Lecturers	1,396	783	1,074	1,045	153	775	**928**
Contract Researchers	911	1,398	1,423	1,419	274	1,308	**1,582**
Doctoral/Master students	5,072	6,411	6,115	6,413	1,440	4,939	**6,379**
- *Employed by R&D Unit*	*n/a*	*n/a*	*n/a*	*n/a*	*162*	*869*	***1,031***
- *In receipt of a grant from host institution*	*n/a*	*n/a*	*n/a*	*n/a*	*685*	*852*	***1,537***
- *In receipt of a competitive funding scheme*	*n/a*	*n/a*	*n/a*	*n/a*	*593*	*3,218*	***3,811***
Total Researchers	**16,682**	**17,469**	**17,337**	**18,299**	**5,295**	**13,144**	**18,439**
Technicians	1,079	1,115	1,007	976	166	662	**828**
Other staff	2,798	4,241	3,255	2,429	161	2,424	**2,585**
Total research Personnel	**20,559**	**22,825**	**21,599**	**21,704**	**5,622**	**16,230**	**21,852**

Source: DBEI HERD data

- There were 18,439 researchers in the higher education sector (headcount) in 2016, accounting for 84% of total research personnel.
- Technicians and Other Staff accounted for 4% (828) and 12% (2,585) respectively of total research personnel.
- Overall, there were 21,852 research personnel in the higher education sector in 2016, a figure which is essentially unchanged since 2014.
- There were 13,144 researchers in the university sector in 2016 (accounting for 71% of total researchers in the higher education sector) and 5,295 researchers in the Institutes of Technology, accounting for 29%.
- There was a 15% fewer Technicians than in 2014 while the number of Other staff increased slightly.

[2] The data series starts in 2008 as Principal Investigators were added to the Researchers category in 2008 and data prior to this are not comparable.

Figure 6: Researchers by qualification, 2008-2016 (headcount) [3]

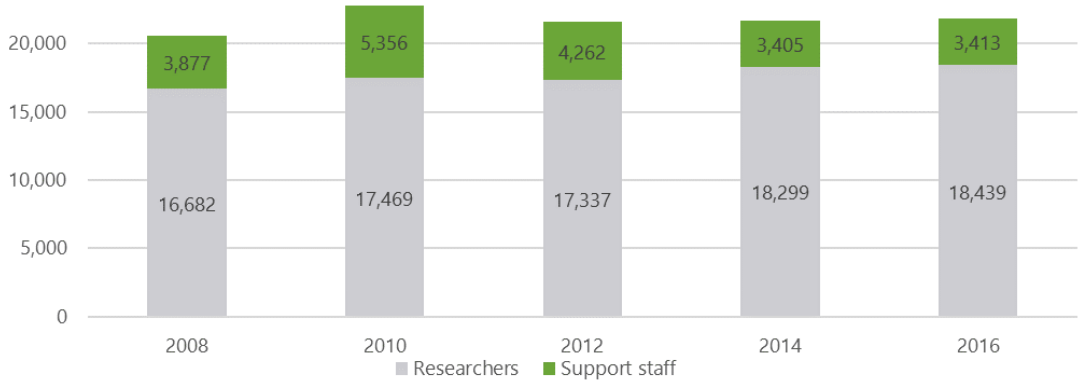


Source: DBEI HERD Data

- 7,446 researchers (40%) were doctorate holders in 2016 in the higher education sector, an increase of 2% since 2014.
- 5,645 Other qualified researchers (31%) (with educational attainment below doctorate level and including internally employed Doctoral/Master students) were employed in 2016.
- Figures for the Doctoral/Master students were broken down in the 2016 HERD survey, as per the 2015 Frascati manual. The 2016 figures now include the number of external R&D Doctoral/Master students:
    - 1,157 Doctoral/Master students (8%) were in receipt of a scholarship or grant from their host institution; and
    - 3,811 Doctoral/Master students (21%) had secured competitive funding to complete their studies.

[3] The data series starts in 2008 as Principal Investigators were added to the Researchers category in 2008 and data prior to this are not comparable.

Figure 7: Researchers and support staff, 2008-2016 (headcount)[4]



Source: DBEI HERD Data

- There were 18,439 researchers (headcount) in the higher education sector, which was relatively unchanged since in 2014.
- There were 3,413 support staff (including technicians) in the higher education sector in 2016, similar to the 3,405 recorded in 2014.

[4] The data series starts in 2008 as Principal Investigators were added to the Researchers category in 2008 and data prior to this are not comparable.

Table 3 gives a breakdown of research personnel by occupation and field of science.

Table 3: Researchers by occupation and field of science (Headcount), 2016

Sector	Total Researchers	Total Support Staff	Total Research Personnel
Natural Sciences	4,781	501	5,282
Engineering and Technology	3,564	376	3,940
Medical and Health Science	3,075	513	3,588
Agricultural Sciences	562	119	681
Social Sciences	4,565	581	5,145
Humanities	1,718	69	1,787
Not classified[5]	175	1,253	1,428
Total - 2016	**18,439**	**3,413**	**21,852**
Total - 2014	18,299	3,405	21,704
Total - 2012	17,337	4,261	21,598
Total - 2010	17,469	5,356	22,825

Source: DBEI HERD Data

- There were a total of 21,852 research personnel in the higher education sector in 2016, a slight increase on the 2014 figure.
- 5,282 research personnel were employed in Natural Sciences in 2016. This field of science accounted for 24% of all research personnel.
- Social Sciences had the same proportion (24%) with 5,145 research personnel.
- Engineering and Technology accounted for 18% of the total research personnel with 3,940 employed, while Medical and Health Sciences accounted for 16% of the total research personnel with 3,588 employed.
- Agricultural Sciences and Humanities accounted 3% and 8% respectively of the total research personnel with 681 and 1,787 employed in 2016.
- Not Classified accounted for 7% of the total research personnel with 1,428 employed. Note that the 'Not Classified' category includes the Research Office, Admin and Support, etc.

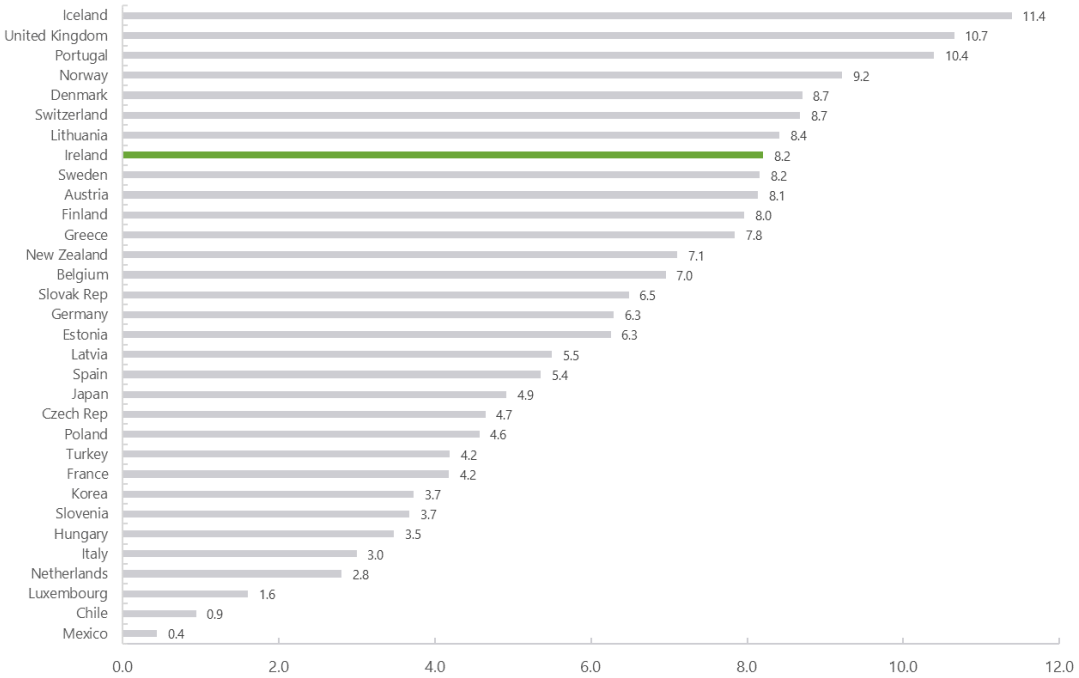
[5] A 'Not Classified' category was added to the Field of Science breakdowns in the 2012 HERD report for the first time. A Department/School not readily classified into a field of science was included in the "Not classified" category e.g. Research Office, Office of VP for Research, President's Office, Admin and Support, Research and Commercialisation Support, etc. Prior to the 2012 survey these offices were coded under Social Sciences.

Figures 8 and 9 illustrate Ireland's ranking against other OECD countries in terms of the number of researchers in the higher education sector per 1,000 of the labour force. In 2016, Ireland was ranked 8th out of 32 countries for which data was available.[6] Iceland reported the highest number of researchers per thousand of the labour force at 11.4.

Figure 8: Ireland's ranking, researchers per 1,000 of the labour force, 2006 -2016

Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

Figure 9: HE researchers (HC) per 1,000 of the labour force, 2016 (or latest available data)



Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

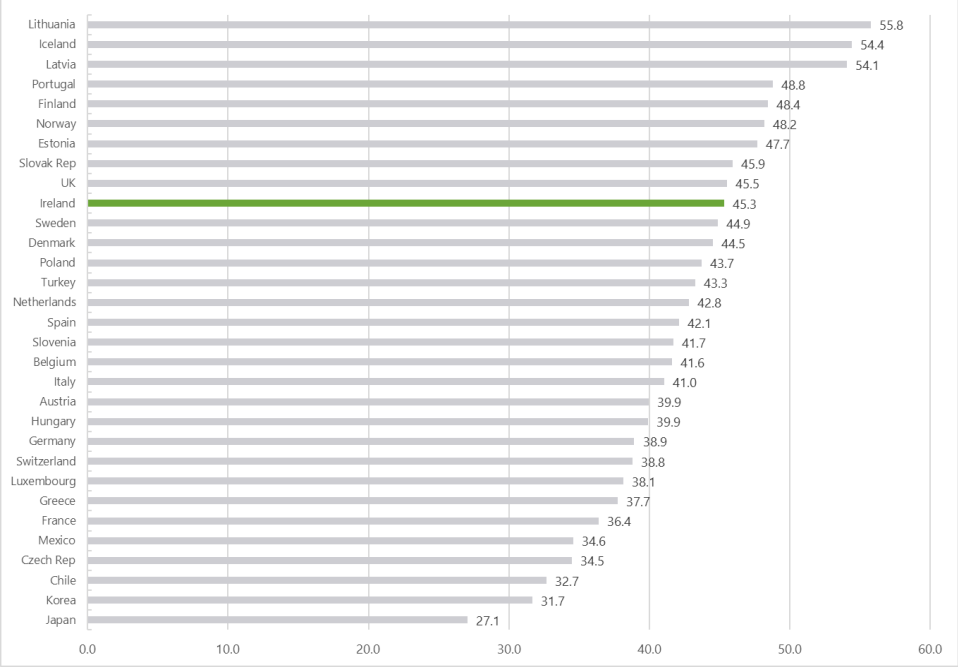
[6] Data for Lithuania became available for the 2016 HERD Survey and their inclusion has meant that the rankings have changed since the 2014 HERD Survey.

Figures 10 and 11 below capture Ireland's place internationally with respect to female researchers as a percentage of total researchers in the Higher Education sector. Ireland went up two places since 2014, ranking 10th out of 31 OECD countries on this indicator for which data were available[7]. Some 45% of all researchers in Ireland are female while Lithuania and Iceland reported the highest number of female researchers accounting for 55.8% and 54.4% respectively of all researchers in 2016.

Figure 10: Ireland's ranking, Female researchers as a % of total researchers (HC), 2006-2016

Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

Figure 11: Female researchers as a % of total researchers (HC), 2016 or latest available data



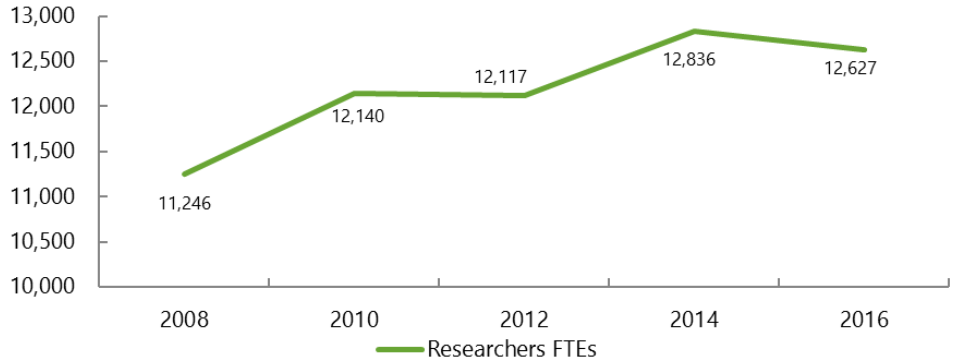
Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

[7] Data for Lithuania became available for the 2016 HERD Survey and their inclusion has meant that the rankings have changed since the 2014 HERD Survey.

Full time Equivalent Figures (FTE)

In FTE terms, there were 12,627 researchers in the higher education sector in 2016, a decrease since 2014 but a 72% increase compared to 2008.

Figure 12: Total researchers in the higher education sector, 2006-2016 (FTE)



Source: DBEI HERD Data

Table 4: Researchers by occupation and FOS in the higher education sector, FTEs, 2016

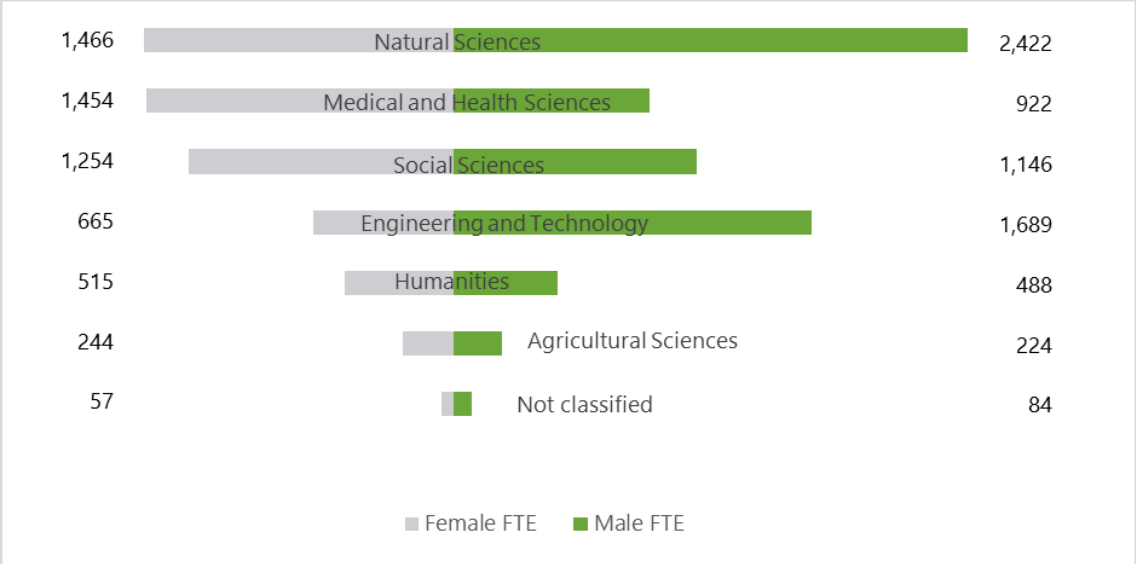
Sector	Total Researchers	Total Support Staff	Total Research Personnel
Natural Sciences	3,887	330	4,217
Engineering and Technology	2,354	281	2,635
Medical and Health Science	2,376	391	2,766
Agricultural Sciences	468	72	540
Social Sciences	2,400	463	2,863
Humanities	1,002	52	1,054
Not classified	140	962	1,103
Total – 2016	12,627	2,551	15,178
Total – 2014	12,836	2,011	14,847
Total – 2012	12,117	933	13,050

Source: DBEI HERD Data

- There were 15,178 FTE research personnel in the higher education sector in 2016, an increase of 2% since 2014.
- 4,217 FTE research personnel were employed in Natural Sciences in 2016. This field of science accounts for more than a one quarter of all research personnel.
- 2,863 FTE research personnel were employed in Social Sciences in 2016, accounting for 19% of research personnel.
- Medical and Health Sciences accounted for 18% of the total FTE research personnel, with 2,766 employed in 2016.
- There were 2,635 FTE research personnel employed (17% of total) in Engineering and Technology in 2016.

Figure 13 below shows the number of FTE male and female researchers by field of science in 2016. In the field of medical and health sciences, female researchers account for 61% of total researchers, contrasting with the field of engineering and technology where female researchers account for 28%.

Figure 13: Female and male FTE researchers, 2016



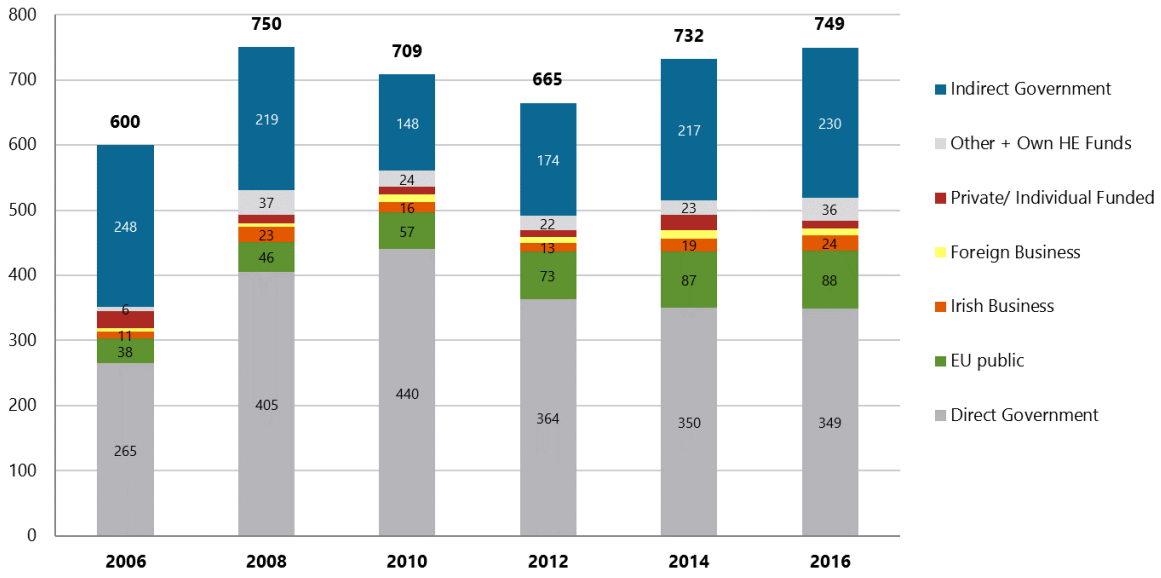
Source: DBEI HERD Data

Chapter 3: Source of funding of HERD expenditure

Direct government funding comes via various government departments and agencies to fund research projects which are performed in the higher education sector. Direct government funding amounted to €349m in 2016, accounting for 47% of the total HERD. Since 2010, there has been a significant reduction in direct government R&D funding of €91m (-21%). However, the overall amount of funding was relatively unchanged between 2014 and 2016.

Indirect government funding is distributed by the Higher Education Authority (HEA) to the universities in the form of an annual "block grant". The allocation of this funding to the universities is for a variety of purposes on behalf of the Department of Education and Skills. The size of the R&D component of the academic part of the block grant is based on the the proportion of time spent on research at the institution by academic staff, and applying that proportion to the overall funding of departmental R&D activities. This is standard practice in all OECD countries that operate a dual system of higher education funding – direct and indirect (General University Funding). This system follows the guidelines set out in the OECD's Frascati manual.

Figure 14: Sources of research funding[8], 2006-2016, in current prices (€ millions)



Source: DBEI HERD Data

[8] Total funding of R&D amounted to €749.4m and expenditure amounted to €748.8m. This difference can be explained by timing differences between the year in which funding is received and that in which related expenditure is incurred.

Table 5: Sources of research funding, 2006-2016, in current prices (€ millions)

	2006	2008	2010	2012	2014	2016
Direct Government	265	405	440	364	350	349
Indirect Government	248	219	148	174	217	230
EU public	38	46	57	73	87	88
Irish Business	11	23	16	13	19	24
Foreign Business	5	6	11	9	13	10
Private/ Individual Funded	26	13	12	10	23	12
Other + Own Funds	6	37	24	22	23	36
Total	600	750	709	665	732	749

Source: DBEI HERD Data

Direct government funding amounted to €349m in 2016, accounting for 47% of the total HERD. Since 2010, there has been a significant reduction in direct government R&D funding of €91m (-21%). However, the overall amount of funding was relatively unchanged between 2014 and 2016.

The most significant reductions in direct government funding in 2016 were:

- €16m – PRTLI current funding
- €16m – PRTLI capital funding
- €5.6m – Health Research Board (HRB)
- €3.6m – Enterprise Ireland

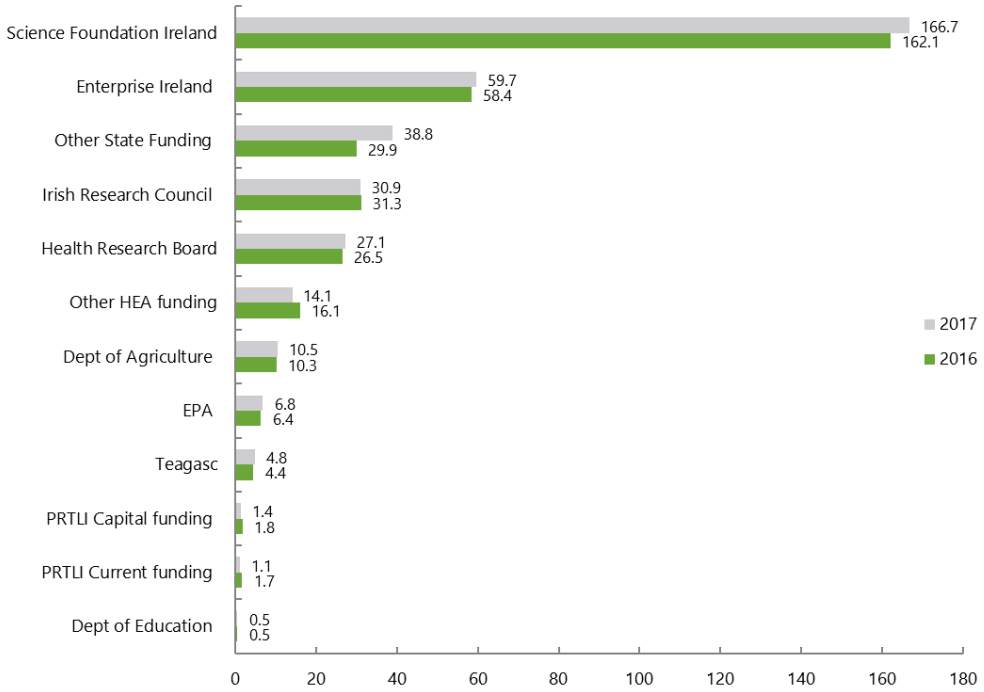
However, there was increased funding from:

- €13m – other HEA funding (non-PRTLI and not including the Block Grant, e.g. HEANET, E-Journals and the Irish Centre for High End Computing)
- €24m – Science Foundation Ireland
- €5m – Other State funding

- Since 2006, direct government funding went from €265m to €349m (+32%)
- The portion of the block grant allocated to research (indirect Government funding) increased by 6% since 2014 from €217m to €230m. Indirect funding accounted for 31% of total funding for HERD in 2016, similar to the 30% share in 2014.
- EU funding increased slightly between 2014 and 2016 and has increased more than twofold since 2006.

- Funding by Irish and foreign business amounted to €24m and €10m respectively in 2016, together accounting for 4.5% of total HERD.
- Private funding dropped €11m since 2014 to €12m in 2016, and Other and Own Funds (which includes portion of private fees from students allocated to R&D) accounted for €36m in 2016.

Figure 15: Sources of direct government research funding (€ millions) 2016 and 2017 (estimate)

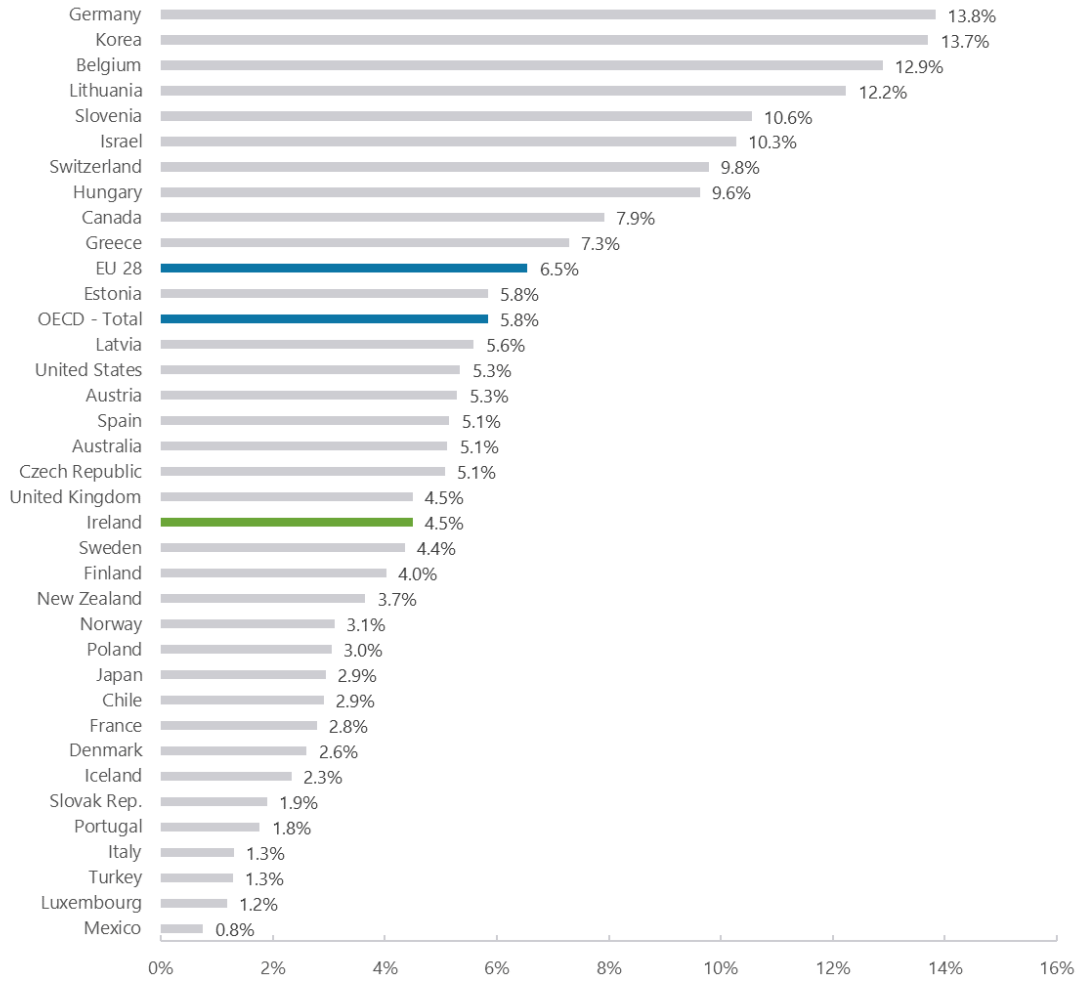


Source: DBEI HERD Data

Figure 15 shows the breakdown of direct government funding by its main sources for the academic years 2016 and estimates for 2017.

- The largest amount of funding for research in the third-level sector in 2016 came SFI with 46% of total direct government funding (€162.1m).
- Funding from Enterprise Ireland amounted to over €58m in 2016, accounting for 17% of total direct Government funding.
- The Health Research Board funded R&D to the value of €26.5m in 2016.
- Research funded by the Irish Research Council amounted to €31.3m in 2016.
- Other State funding amounted to almost €30m in 2016.
- PRTLI capital funding was €1.8m in 2016 and PRTLI current funding was €1.7m.

Figure 16: Percentage of HERD financed by industry - OECD Countries, 2016 or latest data



Source: OECD, Main Science and Technology Indicators and DBEI calculations, May 2019

- 4.5% of total HERD in 2016 was financed by industry in Ireland, almost unchanged since 2014 (4.4%) and below the EU28 average of 6.5% and the OECD average of 5.8%. Germany reported the highest proportion of R&D at 13.8%. It is worth noting that some of the countries with the highest R&D intensities e.g. Sweden, Finland and Denmark had an even lower level of R&D financed by industry than Ireland.

Table 6: Sources of research funding by field of science (€ millions), 2016

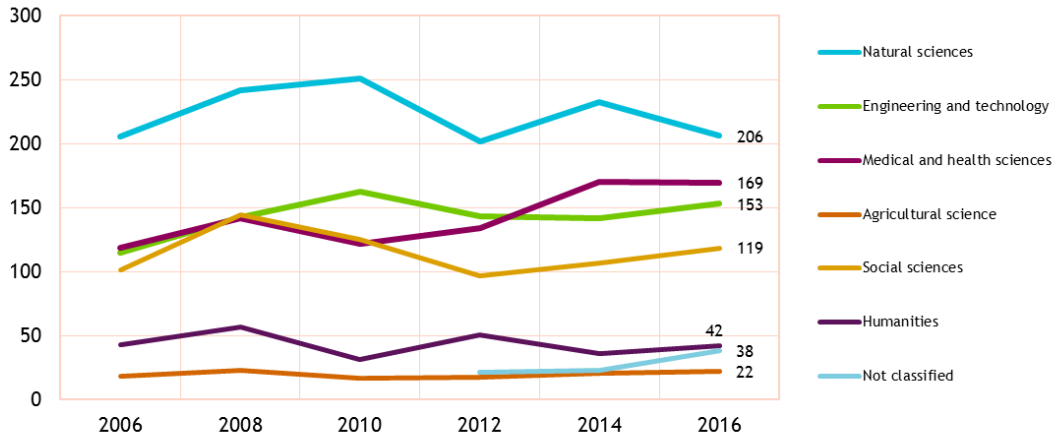
Field of Science	Direct Sources of Funds				Indirect Government (HEA Block Grant)	Total
	Irish Public Research	EU	Industry	Other and Own		
Natural Sciences	113.7	33.4	10.5	7.4	40.5	205.5
Engineering and Technology	89.4	22.3	8.8	5.7	27.0	153.2
Medical and Health Sciences	75.6	13.9	10.0	22.8	47.0	169.3
Agricultural Sciences	10.6	2.5	1.1	0.3	7.4	21.9
Social Sciences	26.1	11.6	1.5	5.3	75.1	119.6
Humanities	9.2	3.4	0.1	0.9	27.3	41.0
Not classified	24.8	1.3	1.9	5.4	5.7	39.0
Total	**349.4**	**88.4**	**33.9**	**47.7**	**230.0**	**749.4**
% of Total	46.6%	11.8%	4.5%	6.4%	30.7%	100%

Source: DBEI HERD Data

- Overall, 46.6% of total HERD is funded from direct Government sources, 30.7% from the HEA Block Grant, 11.8% from EU funds, 6.4% from Other and Own and 4.5% from Industry.
- For most fields of science, the majority of funding for R&D was from Irish public research sources in 2016, with the exception of social sciences and humanities where the majority of funding came from the HEA block grant.
- EU funding accounted for 15% of total funding for Engineering and Technology and 16% of funding for Natural Sciences.
- €32.8m of funding for R&D in Medical and Health Science (19%) was from Industry and Other Sources in 2016.

Chapter 4: HERD Expenditure by Field of Science

Figure 17: HE expenditure on R&D by field of science in current prices, (€millions), 2006-2016



	2006	2008	2010	2012	2014	2016
Natural sciences	206	242	251	201	232	206
Engineering and technology	115	142	163	143	142	153
Medical and health sciences	118	142	122	134	170	169
Agricultural science	18	23	16	18	20	22
Social sciences	102	145	125	96	106	119
Humanities	43	56	32	50	36	42
Not classified[9]	No data	No data	No data	21	23	38
Total	601	750	708	664	730	749

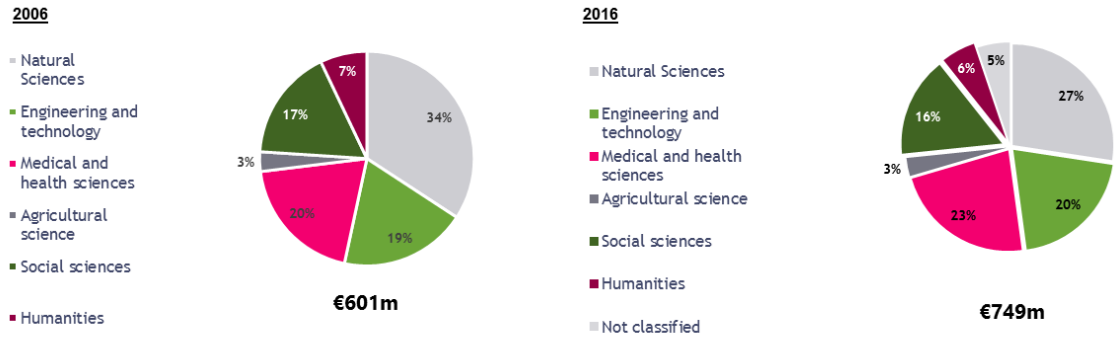
Source: DBEI HERD Data

- The largest proportion of R&D expenditure was in the field of Natural sciences in 2016, a constant trend since 2006.

[9] Examples of 'Not Classified' include Research Office, Office of VP for Research, President's Office, etc. This category was added in the 2012 HERD Survey.

- Medical and Health Sciences accounted for the next highest proportion of total R&D expenditure in 2016 with €169m, slightly lower than the 2014 figure of €170m. Note that the level of R&D expenditure in the Medical Sciences has been increasing since 2010.
- Engineering and technology had the third largest R&D expenditure by field of science increasing by €11m between 2014 and 2016 for a total of €153m.
- R&D expenditure in the field of social science increase by 17.6% since 2006 to €120m. This should be regarded with caution, as previously the 'other' or 'not classified' category was coded under 'Social Sciences'.
- Expenditure on R&D in the Humanities field amounted to €41m in 2016, an increase of €5m since 2014.
- Agricultural Sciences have experienced a slow but steady increase in the last decade, increasing from €18m in 2006 to €22m in 2016 (+22%).

Figure 18: Share of total R&D expenditure by field of science, 2006 and 2016



Source: DBEI HERD Data

- In absolute terms, the HERD has increased from **€601m** in 2006 to **€749m** in 2016, and expenditure is higher or equal for all fields of science (except Humanities) in 2016 than in 2006.
- When comparing the share of HERD by field of science in 2006 and 2016:
  - Natural Sciences dropped from 34% to 27%;
  - Engineering and Technology increased from 19% to 20%;
  - Medical and Health Sciences increased from 20% to 23%;
  - Agricultural Science remained the same at 3%;
  - Social Sciences decreased from 17% to 16%;
  - Humanities decreased by one percentage point from 7% to 6%;
  - The 'Not classified' category refers to Department/Schools that were not readily classified into a field of science.

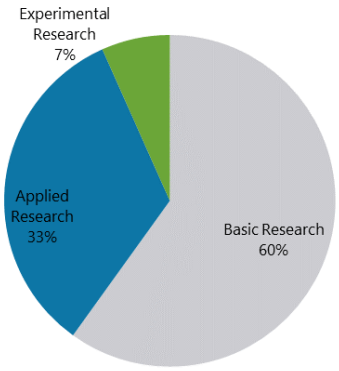
Chapter 5: Types of research

To ascertain the type of research undertaken by the universities and the institutes of technology, participants were asked to classify which type of research they were engaged in.

The Frascati Manual is the internationally recognised methodology for collecting and using R&D statistics. It provides the following definitions for the three areas of research:

- **Basic research** – experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
- **Applied research** – also original investigation undertaken in order to acquire new knowledge, it is however, directed primarily towards a specific practical aim or objective.
- **Experimental research** – is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Figure 19: Percentage of total HERD budget by research type, 2016 (Total = €749m)

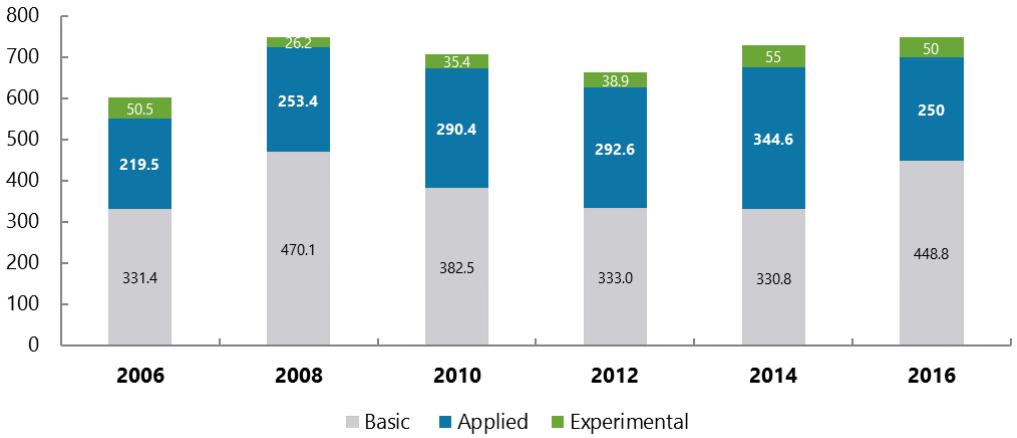


Source: DBEI HERD Data

- In 2016, 60% was spent on basic research activities, applied research accounted for 33% of all research spend in the higher education sector, while experimental research accounted for 7% of the total HERD budget[10].

[10] The increase in Basic research from 45% in 2014 to 60% in 2016 is due to a number of HEIs which reclassified a large proportion of their research from Applied to Basic.

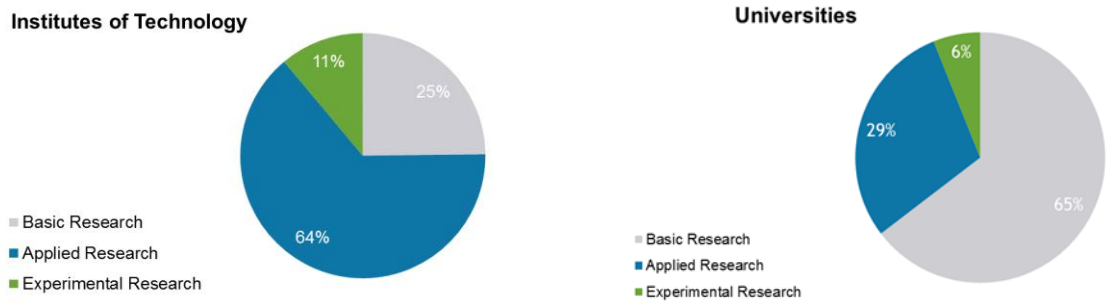
Figure 20: Distribution of total HERD budget by research type, 2006 – 2016



Source: DBEI HERD Data

- Figure 20 shows the trend in HERD by type of research since 2006. After nearly a decade of decline, basic research increased by 35.7% between 2014 and 2016, amounting to €448.8m.
- In 2014, almost half of all research undertaken in the HEIs was applied research; this share has decreased to one third in 2016.
- The share of Experimental research varied throughout the last ten years but is now back to the level it was in 2006.

Figure 21: Type of research carried out by Universities and IoTs in 2016



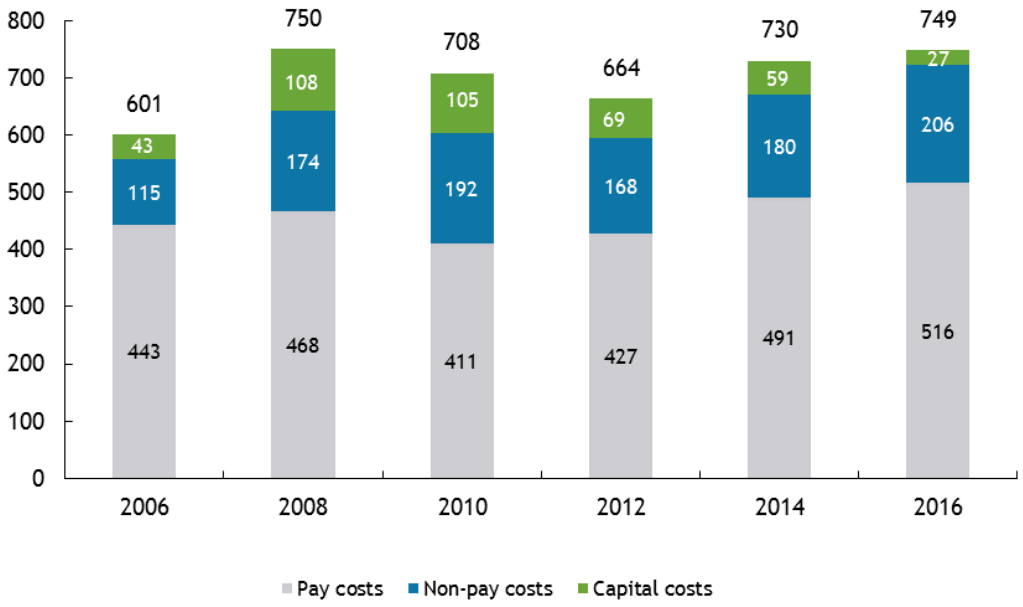
Source: DBEI HERD Data

- Figure 21 clearly demonstrates that the main focus of research for the Universities in 2016 was basic research (65%) while 29% of research undertaken was applied.
- In contrast, the focus for the Institutes of Technology in 2016 was applied research, accounting for 64% of research undertaken.

Chapter 6: Type of Costs

This chapter breaks out research expenditure by type of cost, i.e. pay costs, non-pay and capital costs.

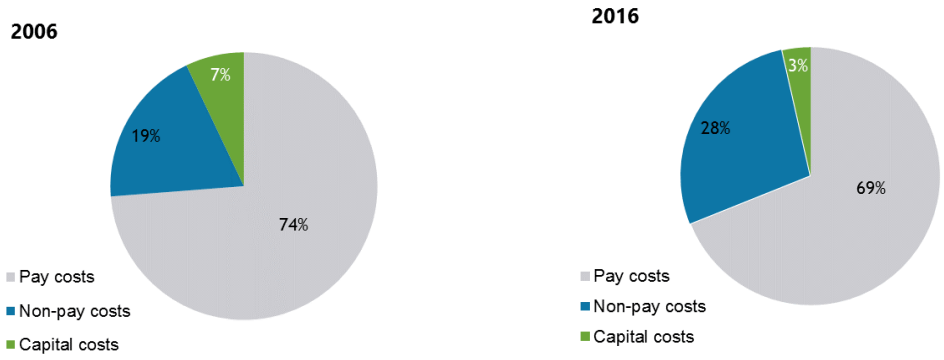
Figure 22: Distribution of research expenditure by type of costs, 2006-2016 (€ million)



Source: DBEI HERD Data

- Figures 22 and 23 show that Pay expenditure fluctuated between 2006 and 2016 with the majority of research expenditure going towards pay costs, accounting for €516m in 2016 (69% of total costs).
- Non-pay costs increased by 14% in 2016 compared to 2014, amounting to €206m. Non-pay costs refer to non-capital purchases of materials, supplies and equipment to support R&D, and accounted for a third of total costs in 2016.
- After peaking at €108m in 2008, capital expenditure on R&D has been declining ever since to reach €27m in 2016. This is primarily due to the reduction in funding under the Higher Education Authority's Programme for Research in Third Level Institutions (PRTLI).

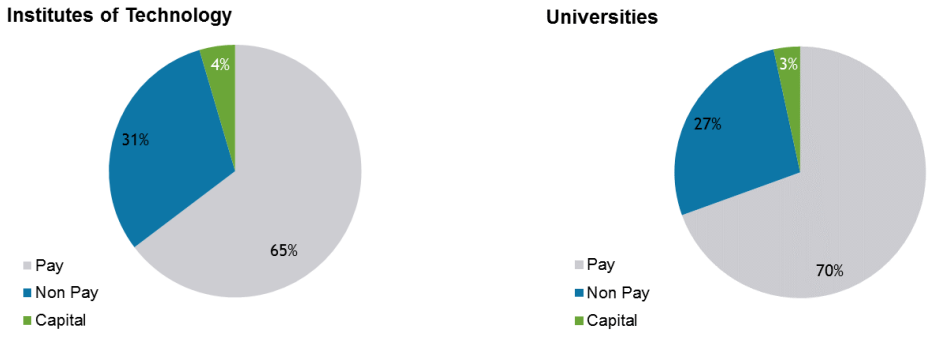
Figure 23: Percentage share of type of costs, 2006 and 2016



Source: DBEI HERD Data

- Figure 23 shows the breakdown of costs for R&D in the higher education sector in 2006 and 2016.
- The split varies slightly in both years, with pay costs accounting for 74% in 2006 compared to 69% in 2016 and non-pay costs having a larger share of the total R&D budget in 2016.

Figure 24: Percentage share of type of costs by Universities and IoTs, 2016



Source: DBEI HERD Data

- Figure 24 allows a more detailed examination of the three different types of costs, broken down for Institutes of Technology and Universities, with both sectors spending roughly the same portion of their budget on capital costs (4% and 3%, respectively) in 2016.

- Pay costs account for two thirds of the R&D budget for both Institutes of Technology but slightly higher for Universities (70%) in 2016.
- Non-pay costs accounted for slightly over a quarter of the R&D budget in the university sector compared with almost a third in the IoT sector in 2016.

Table 7: Types of costs by fields of science, 2016 (€ million)

	Pay costs	% of total	Non-pay costs	% of total	Capital costs	% of total	Total
Natural Sciences	133	64%	60	29%	13	6.2%	206
Engineering and Technology	104	68%	43	28%	6	4.2%	153
Medical and Health Sciences	119	70%	45	27%	5	2.9%	169
Agricultural Sciences	16	75%	5	22%	1	3.3%	22
Social Sciences	95	80%	23	20%	1	0.5%	119
Humanities	35	84%	7	16%	0	0.1%	42
Not classified	14	37%	23	61%	1	2.5%	38
Total	**516**	**69%**	**206**	**28%**	**27**	**3.5%**	**749**

Source: DBEI HERD Data

- Within each field of science pay costs account for the largest proportion of R&D costs in 2016; ranging from 84% for Humanities to 64% for Natural Sciences.
- Excluding the 'Not Classified' category, the fields of Natural Science (29%) and Engineering & Technology (28%) accounted for the highest proportion of non-pay costs.
- The field of Natural Sciences had the highest proportion of capital costs, accounting for over 6% of the R&D spend in 2016.

Appendix 1: Acronyms

BERD	Business Expenditure on Research & Development
EI	Enterprise Ireland
EPA	Environmental Protection Agency
EU	European Union
FOS	Field of Science
FTE	Full-time equivalent (1 FTE = R&D 40 hours per week)
GDP	Gross Domestic Product
GERD	Gross expenditure on Research & Development
GNP	Gross National Product
HE	Higher Education
HEA	Higher Education Authority
HERD	Higher Education Expenditure on R&D
HRB	Health Research Board
HSE	Health and Safety Executive
ICT	Information and Communications Technology
IoTs	Institutes of Technology
IRC	Irish Research Council
OECD	Organisation for Economic Co-operation and Development
OPW	Office of Public Works
PRTLI	Programme for Research in Third Level Institutes
R&D	Research and Development
SFI	Science Foundation Ireland
STI	Science, Technology & Innovation

Appendix 2: Detailed Fields of Science Tables

	Fields of Science	€m
Natural Sciences	Mathematics	11.0
	Computer and information sciences	57.2
	Physical sciences	20.7
	Chemical sciences	42.8
	Earth and related environmental sciences	18.3
	Biological sciences	52.5
	Other natural sciences	3.7
		206.2
Engineering and Technology	Civil engineering	10.7
	Electrical, electronic and information engineering	28.9
	Mechanical engineering	33.3
	Chemical engineering	3.5
	Materials engineering	7.3
	Medical engineering	0.2
	Environmental engineering	11.8
	Environmental biotechnology	0.0
	Industrial biotechnology	2.2
	Nano-technology	46.9
	Other engineering and technologies	8.2
		152.9
Medical and Health Sciences	Basic medicine	73.4
	Clinical medicine	37.9
	Health sciences	48.2
	Health biotechnology	5.1

	Other medical sciences	4.9
		169.5
Agricultural Sciences	Agriculture, forestry and fisheries	10.3
	Veterinary Medicine	3.2
	Veterinary science	8.4
		21.9
Social Sciences	Psychology	9.6
	Economics and business	39.9
	Educational sciences	19.6
	Sociology	5.5
	Law	8.6
	Political science	5.0
	Social and economic geography	19.7
	Media and communications	7.8
	Other social sciences	2.9
		118.5
Humanities	History and archaeology	10.3
	Languages and literature	16.9
	Philosophy, ethics and religion	4.1
	Art (arts, history of arts, performing arts, music)	7.6
	Other humanities	2.9
		41.7
Not classified		**38.1**
HERD		**748.8**

Source: DBEI HERD Data

Appendix 3: Note on GDP, GNP and GNI*

Background

Globalisation presents significant challenges in terms of measuring economic activity. While this is the case in most advanced economies, the issues are particularly acute in an Irish context, given the large multinational footprint.

For policy-makers, there are additional challenges, most notably related to interpreting the real-time information embedded in standard, internationally recognised metrics such as Gross Domestic Product (GDP) and Gross National Income (GNI). Movements in these aggregates have become increasingly disconnected from actual trends in living standards in Ireland.

New Irish-specific measures of activity – most notably 'modified Gross National Income' or GNI* – attempt to control for (part of) the impact of globalisation on Irish macro-economic statistics.

From GDP to GNI*

GDP measures the total output of the economy in a period i.e. the value of work done by employees, companies and self-employed persons. This work generates incomes - the total income remaining with Irish residents is the GNP and it differs from GDP by the net amount of incomes sent to or received from abroad. In Ireland's case, the amount belonging to persons abroad has exceeded the amount received from abroad, due mainly to the profits of foreign-owned companies, and therefore, GNP is less than GDP.

Gross National Income (GNI) is a very similar concept to that of GNP – the main difference between the two aggregates is that GNI adjusts domestic incomes for subsidies from and taxes paid to the EU.

Modified GNI (or GNI*) is defined as GNI less the effects of the profits of re-domiciled companies and the depreciation of intellectual property products and aircraft leasing companies.

Because the modified GNI aggregate is a better approximation of the size of the Irish economy, it is an important indicator for fiscal purposes, especially for 'ratio analysis' where it provides significant added value. For example, the Department of Finance has frequently highlighted the shortcomings of the debt-to-GDP ratio as a measure of the debt burden. Now that the modified measure is available, the Department of Finance supplements the Government's European budgetary requirements with debt-to-GNI* figures. Similarly, in this report, R&D expenditures as a percentage of GNI* are calculated to see the trend over time and to provide a more reliable benchmark against other countries. This is in addition to the calculations as a percentage of GDP and GNP.

In 2017, GNI* was approximately 61.5% of GDP in Ireland.

See full explanatory note on GDP and GNI* from the Department of Finance here:

https://www.finance.gov.ie/wp-content/uploads/2018/05/180504-GDP-and-ModifiedGNI-Explanatory-Note-May-2018.pdf.

Appendix 4: Guidelines on Doctoral/Master's students categories

For the 2016 survey, the Higher Education Institutes (HEIs) were asked to breakdown the data collected on the number of Doctoral/Master's students. Each HEI was sent the guidelines below as to the correct reporting categories when returning the data:

Internal R&D Personnel - Employed Students	• Doctoral/Master's Students employed by the R&D Reporting Unit i.e. on its payroll • Includes Doctoral/Master's students of R&D who are self-funding their studies and in receipt of a part-time contract of employment for tutoring/demonstrating/part-time lecturing duties
External R&D Personnel - Students receiving a grant from their host institution	• Doctoral/Master's students in receipt of a full/partial scholarship/grant from either a Research Centre or School
External R&D Personnel - Students that have secured competitive funding to complete their studies	• Doctoral/Master's students in receipt of a full scholarship/grant from a competitive scholarship scheme (eg IRC, SFI, EU grants, private businesses) • Doctoral/Master's students in receipt of a Marie-Cure scholarship • Doctoral/Master's students in receipt of a scholarship/grant from their home country (usually government funded)