National R&I Monitoring Report

2018

Prepared by
The Malta Council for Science & Technology

Executive Summary

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The main aim of this report is to monitor the implementation of the actions in the National Research and Innovation Strategy 2020 and the R&I Action Plan 2015-2020. A comprehensive set of indicators covering the three Pillars and Action Lines were established with the support of the European Commission's Horizon 2020 Policy Support Facility (PSF). Data was collected from NSO, Eurostat and directly from stakeholders.

A set of seven headline indicators was established to monitor the overall inputs and outputs of the national R&I system. This report compares the latest available figures with the 2020 targets for these indicators. The target for number of PhD holders as a percentage of active population has been achieved and the data collected on the number of researchers (expressed in full-time equivalents, FTE) shows an upward trend towards achieving the 2020 target. The figures for employment in knowledge-intensive activities as a percentage of total employment also show an upward trend, however data trends for all other indicators have faltered.

Several recommendations are made regarding the indicators at Action Line level since data confidentiality and the restructuring of data sources (such as the Community Innovation Survey) were major obstacles in the data collection process. This was especially noted for the Smart Specialisation Areas. These obstacles made it difficult to reach robust conclusions and improvements to the system will be considered for future reports.

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Methodology

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Following the strategic decision by the Malta Council of Science and Technology (MCST) to establish a dedicated monitoring system for the National R&I Strategy and the R&I Action Plan, MCST sought the support of the European Commission's Policy Support Facility (PSF) within Horizon 2020 for the required external expertise to support the design of the monitoring system.

The PSF exercise took place between late 2015 and mid-2016 and the final PSF report (entitled 'Monitoring the Maltese National Research and Innovation Strategy') was based on the extensive analysis of the Maltese National Research and Innovation Strategy, the Action Plan and its Action Lines and Measures, and on information and views collected from experts and key stakeholders during the two field visits that took place.

The data presented in Chapters 2 and 3 of this report was gathered using different methodologies due to the different data sources and the PSF recommendations provided, as explained further hereunder.

With regard to Chapter 2, since the indicators were already established at the time of the Strategy's launch, the only requirement to set up the monitoring system was regular updating of the data using the same sources that were initially utilised - the EUROSTAT database and data obtained directly from NSO.

With regard to Chapter 3, the PSF Report identified result indicators for all the Action Lines under each of the Strategy Pillars. As a follow-up on the PSF exercise, each of the identified indicators were then evaluated internally to assess whether adequate data was available, and if not, indicators were developed which made use of the data presently available. The main data sources were the following – EUROSTAT, data received directly from NSO, Global Competitiveness Report, data received directly from the University of Malta and the Malta Aquaculture Research Centre, CORDIS, Global Talent Competitiveness Index, JRC and the RIO Country Report 2017: Malta.[1]

In order to facilitate the collection and management of data from several sources, an online data collection system was also devised. However, this system was still in its preliminary stages during the data collection process for this monitoring report and therefore was not utilised in its entirety. The online system will however be utilised to its full potential in future monitoring reports.

[1] The full set of data sources for the indicators in Chapter 2 and 3 can be found in Annex 1 of this report.

Introduction

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In 2014, MCST launched the National Research and Innovation Strategy 2020 with the following aims:

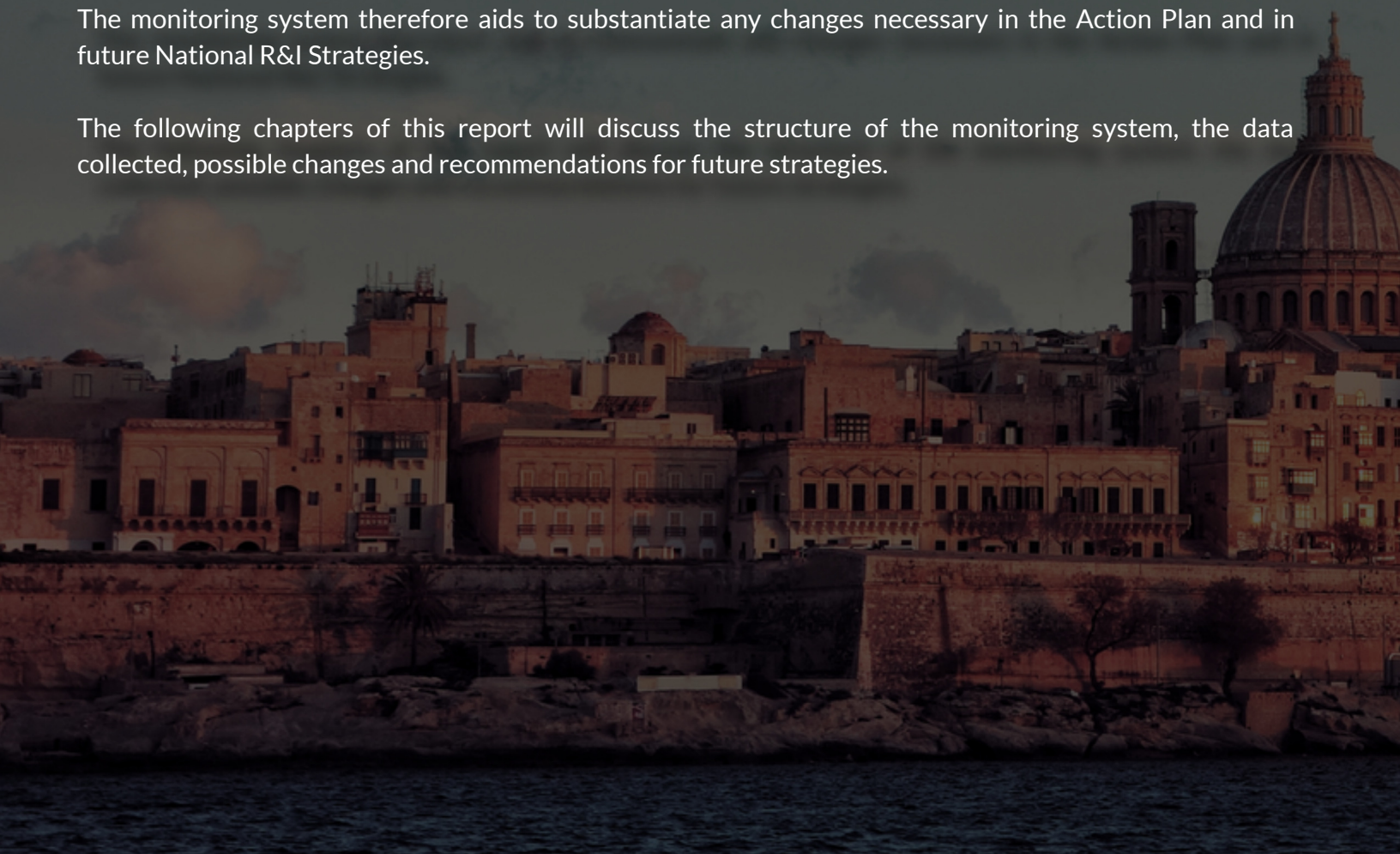
- To embed research and innovation at the heart of the Maltese economy in an effort to spur knowledge-driven and value-added growth.
- To sustain improvements in citizens' quality of life.

Three fundamental pillars were outlined in the Strategy in order to strengthen and enhance research and innovation activities in Malta across all sectors. The first two pillars seek to bolster the research and innovation ecosystem and improve the knowledge base. The third pillar is a strategy in itself - the Smart Specialisation Strategy - which identified a limited number of economic niches in Malta that demonstrated a potential for growth through innovation. Smart Specialisation is linked to the Structural and Investment Funds 2014-2020 as an ex-ante conditionality.

In addition to the National R&I Strategy, a dedicated Action Plan 2015-2020 was developed to clearly identify the measures needed to achieve the objectives of the Strategy, together with the principal actors and the required budgets for these. In order to achieve a holistic understanding of the implementation status and progress towards the Strategy's overarching KPIs, the need was felt to establish a dedicated monitoring system for the implementation of Malta's National R&I Strategy and its related Action Plan.

The monitoring system therefore aids to substantiate any changes necessary in the Action Plan and in future National R&I Strategies.

The following chapters of this report will discuss the structure of the monitoring system, the data collected, possible changes and recommendations for future strategies.



1 The Maltese National R&I Strategy and Action Plan

This chapter provides a holistic overview of how the measures and projects analysed fall within the three pillars of the R&I strategy in a tabulated format.

Monitoring System

The monitoring system covers the full range of actions foreseen under the Maltese National Research and Innovation Strategy 2020, which builds on three pillars representing its three overarching goals:

- Pillar 1: Achieving a comprehensive R&I support ecosystem
- Pillar 2: Achieving a stronger knowledge base
- Pillar 3: Achieving smart and flexible specialisation.[2]

Each pillar is divided into actions (8 in total), which are themselves divided into 26 different Action Lines (labelled from A to Z in the tables below). Each Action Line is then covered by measures or projects that aim to address the respective Action Line. The Action Plan lists 52 measures or projects.

[2] This pillar includes the Smart Specialisation Strategy for Malta.

Pillar 1: A comprehensive R&I support ecosystem

Overarching Pillar	- Private R&D expenditure (€ total and of GDP) - Business enterprise researchers (FTE) per thousand labour force - Total expenditure in innovation - Share of high-tech exports/ total exports								
Actions	Increasing the effectiveness of the delivery system			Strengthening the capacity of entrepreneurial actors to innovate			Ensuring a seamless chain of support		
Action Lines	**A**: Up-scaling, extending & coordinating the level of support provided to business	**B**: Monitoring & evaluation	**C**: Embedding a culture for innovation, creativity, risk taking & entrepreneurship	**D**: Using inward investment to leverage indigenous R&I	**E**: Improved access to knowledge	**F**: Improved transfer of knowledge	**G**: Open access to publications	**H**: Financial support for enterprises	**I**: Internationalisation support for enterprises
Indicators corresponding to Action Lines	- Number of SMEs involved in R&D & innovation projects. - Funding support provided by Government towards R&D expenditure in the private sector	- Annual Monitoring Report	- Results from the Global Competitiveness Report in relation to the Innovation Capacity Pillar	- Amount of R&D spent by local companies due to leveraging of funds from foreign firms - Private funds spent by foreign companies in Malta as a percentage of total business R&D expenditure in Malta	- Number of firms that are engaging in R&D collaborative projects	- Number of formalised commitments taking place between public research organisations & business firms - Number of applications for co-patents by firms	- Share of publications available in Open Access mediums as a percentage of total publications -Development of institutional repositories for Open Access publications	- Percentage of public funding for R&D performed by the business sector - Amount of private funds leveraged by public funding schemes for enterprises involved in R&D	- Competitive EU funds attracted by Maltese private organisations (not including Structural Funds) - Number of Maltese companies participating in EU competitive schemes

Overarching Pillar	*Pillar 1: A comprehensive R&I support ecosystem*								
Measures	- Competence Centre for Manufacturing & Integrated Design - Tax Credits for RD&I - Enterprise Europe Network (EEN) - B.Start - Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster - National Policy for Open Access	- Evaluation of implementation of Action Plan measure and updates -Development of new indicators -National Policy for Open Access -Coordination of the implementation of the Strategy -Monitoring of Existing indicators Internationalisation Review -Framework Programme Evaluation Study on Internationalisation in Academia	- Competence Centre for Manufacturing and Integrated Design - Science in the City -Esplora- the National Interactive Science Centre -Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster -Supporting procurement for innovation -National Policy for Open Access	- B.Start - Supporting procurement for innovation -National Policy for Open Access	- Competence Centre for Manufacturing and Integrated Design - FUSION - Esplora: the National Interactive Science Centre - National Policy for Open Access	-Competence Centre for Manufacturing and Integrated Design - FUSION - Esplora: the National Interactive Science Centre - Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster - National Policy for Open Access	- FUSION - National Policy for Open Access	- FUSION - Tax Credits for RD&I - Enterprise Europe Network (EEN) -B.Start - Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster - Public Sector Innovation Fund - Supporting procurement for innovation	- Schemes proposed by Malta Enterprise - Enterprise Europe Network (EEN) - Public Sector Innovation Fund

Pillar 2: Stronger knowledge base

Overarching Pillar	- Global Talent Competitiveness Index - EU Indicator of Research Excellence							
Actions	**Investing in human capital**					Investing in Research Infrastructure		**Capacity building for excellence**
Action Lines	**J**: An education system which adequately shapes future human capacity in R&I	**K**: Supporting graduates to become researchers	**L**: Strengthen links between academia & the private sector for effective knowledge transfer	**M**: Supporting international collaboration (human capital)	**N**: Embedding a culture which is supportive of science, research & innovation	**O**: Strengthening local research infrastructures	**P**: Increased international cooperation (infrastructures)	**Q**: Capacity building for excellence in climate change adaptation
Indicators corresponding to Action Lines	- Number of tertiary graduates in STEM per 1000 population aged 20-29	- Number of researchers working within the Government sector and Higher Education sector - Number of graduates that are conducting R&D activities in the private sector and the Government sector	- Amount of public R&D financed by the private sector - Number of public-private scientific co-publications per million population - Number of researchers that are employed by the business sector - Number of innovative firms cooperating with research organisations	- Competitive EU funds attracted by Maltese public organisations for R&I (excluding Structural Funds) - Number of proposals presented to H2020 involving Maltese research institutions - Number of internationally co-authored scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country - Number of international scientific co-publications per million population - Number of foreign researchers working in Malta's public research organisations	- Public understanding of science	- Percentage of scientific publications within the 10% most cited scientific publications worldwide when compared with the total scientific publications of the country	- Rate of access of Maltese researchers to infrastructures part of ESFRI - Assessing the internationalisation initiatives administered by MCST	- Number of scientific publications (top tier journals) on climate change as a percentage of total number of publications

Measures	- Esplora – the National Interactive Science Centre - Post-Doctoral Scholarship Scheme (REACH HIGH)Research Centre of Excellence in Molecular Medicine & Bio-Banking - Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex - R&I Centre on Agriculture & Environment Management	- Science in the City - Esplora- the National Interactive Science Centre - Get Qualified - Post-Doctoral Scholarships -Research Centre of Excellence in Molecular Medicine & Bio-Banking - Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex -R&I Centre on Agriculture & Environment Management -France-Malta Scholarships	- Esplora – the National Interactive Science Centre - Post-Doctoral Scholarship -Research Centre of Excellence in Molecular Medicine & Bio-Banking -Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex -R&I Centre on Agriculture & Environment Management -Support for R&I participation in Internationalisation initiatives -Bi-lateral R&I Initiatives -Membership to international initiatives such as JPI's, Art. 185's, etc.	-Competence Centre for Manufacturing and Integrated Design -Internationalisation Review -Study on Internationalisation in Academia -Centre of Excellence in Molecular Medicine & Bio-Banking -Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex -R&I Centre on Agriculture & Environment Management -Support for R&I participation in Internationalisation initiatives -Bi-lateral R&I Initiatives -Membership to international initiatives such as JPI's, Art. 185's, etc.Bi-regional R&I initiatives- France-Malta Scholarships	-Competence Centre for Manufacturing and Integrated Design -Science in the City -Esplora- the National Interactive Science Centre -Post-Doctoral Scholarships -Research Centre of Excellence in Molecular Medicine & Bio-Banking -Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex -R&I Centre on Agriculture & Environment Management -Bi-Regional R&I Initiatives	-Competence Centre for Manufacturing and Integrated Design -Esplora: the National Interactive Science Centre -Competence Centre for Pharmaceutical Technology -Malta Aquaculture Research Centre -Sustainable Living Complex -Research Centre of Excellence in Molecular Medicine & Bio-Banking -Transdisciplinary Research & Knowledge Exchange (TRAKE)R&I Centre on Agriculture & Environment Management -Innovation Centre of Excellence for Blood, Tissue and Cell Banking (ICE-BTC)Schemes proposed by Malta Enterprise -Aquaponics -Life Sciences Park and Expansion Area	-Competence Centre for Pharmaceutical Technology -Sustainable Living Complex -Research Centre of Excellence in Molecular Medicine & Bio-Banking -Transdisciplinary Research & Knowledge Exchange (TRAKE) Complex -R&I Centre on Agriculture & Environment Management -Innovation Centre of Excellence for Blood, Tissue and Cell Banking (ICE-BTC)Schemes proposed by Malta Enterprise -Life Sciences Park and Expansion Area	-ESMERALDA

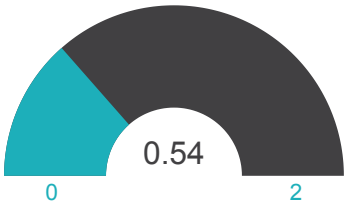
Pillar 3: Smart and flexible specialisation

Overarching Pillar	- Value-added in knowledge-intensive activities as a share of total value-added - Value-added in S3 areas as a share of total value-added								
Actions	**The role of ICT**		**Thematic Specialisation Area**						
Action Lines	**R**: ICT as an enabler	**S**: ICT-based innovation	**T**: Tourism Product Develop	**U**: Maritime Services	**V**: Aviation & Aerospace	**W:** Health	**X**: Resource-efficient buildings	**Y**: High-value added manufacturing with focus on processes & designs	**Z**: Aquaculture
Indicators corresponding to Action Lines	- Percentage of SMEs using e-commerce - Percentage of households with access to broadband lines with speed above 10 MBps	-Percentage of public funding expenditure allocated to ICT technologies (both in the public and private sector) -Number of innovative firms in ICT related NACE codes -Share of ICT in EU-funded research projects awarded to Maltese actors	-Value added in relevant S3 NACE codes -Exports in relevant S3 NACE codesJobs in relevant S3 NACE codes -Number of SMEs introducing innovation in relevant S3 NACE codes as a percentage of total SMEs introducing innovation -Turnover from innovation in relevant S3 NACE codes as a percentage of total turnover -Number of researchers in relevant S3 NACE codes -Number of researchers in the private sector working within the relevant S3 areas as a percentage of the total number of researchers in the private sector -Number of patents filed under the relevant S3 NACE codes -Foreign Direct Investment (FDI) in S3 relevant NACE codes						
Measures	- Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster	- Implement a mobile innovative solution to improve the tourism experience in Gozo - Scheme to enhance the tourism sector - R&I-2013-039 – Cloud HMI – Development of a framework to put human-machine interfaces (HMI) in the cloud Inationalisation in Academia	- Implement a mobile innovative solution to improve the tourism experience in Gozo - Scheme to enhance the tourism sector		- National Aerospace Centre	- Competence Centre for Pharmaceutical Technology - Research Centre of Excellence in Molecular Medicine & Bio-Banking - Innovation Centre of Excellence for Blood, Tissue and Cell Banking (ICE-BTC) - Life Sciences Park and Expansion Area - KENUP	- Benchmarking and Competitiveness Reinforcement Initiative (CRI) for the Valletta Design Cluster - Sustainable Living Complex - ESMERALDA	- Competence Centre for Pharmaceutical Technology	- Malta Aquaculture Research Centre - Aquaponics

2 Headline Indicators

Headline Indicators

The headline indicators were included in the Maltese National R&I Strategy as a way to provide a balanced assessment of both the inputs and the outputs of the national research and innovation system. Targets were also set for these indicators. The complete list of headline indicators together with their 2020 targets and their latest available figures can be found in Figure 1 below.



1. Gross R&D expenditure as a percentage of GDP (2017)

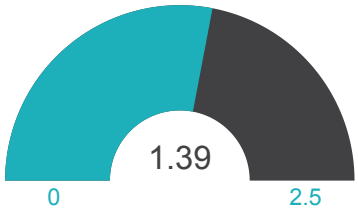
2020 Target: 2%

2. Number of PhD holders as a percentage of active population (2017)

2020 Target: 0.60%

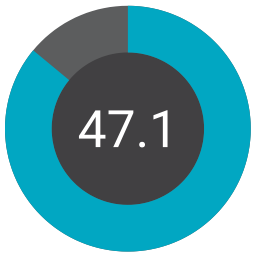
3. Number of researchers (expressed in full-time equivalents, FTE) (2017)

2020 Target: 900



4. Innovation expenditure as a percentage of GDP (2016)

2020 Target: 2.5%



5. Employment in knowledge-intensive activities as a percentage of total employment (2017)

2020 Target: 55%

6. Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation) as a percentage of total enterprises (2016)

2020 Target: 50%

7. Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation) in the Core NACE codes as a percentage of total enterprises (2016)

2020 Target: 60%

Figure 1: List of headline indicators together with their 2020 targets and latest available figures

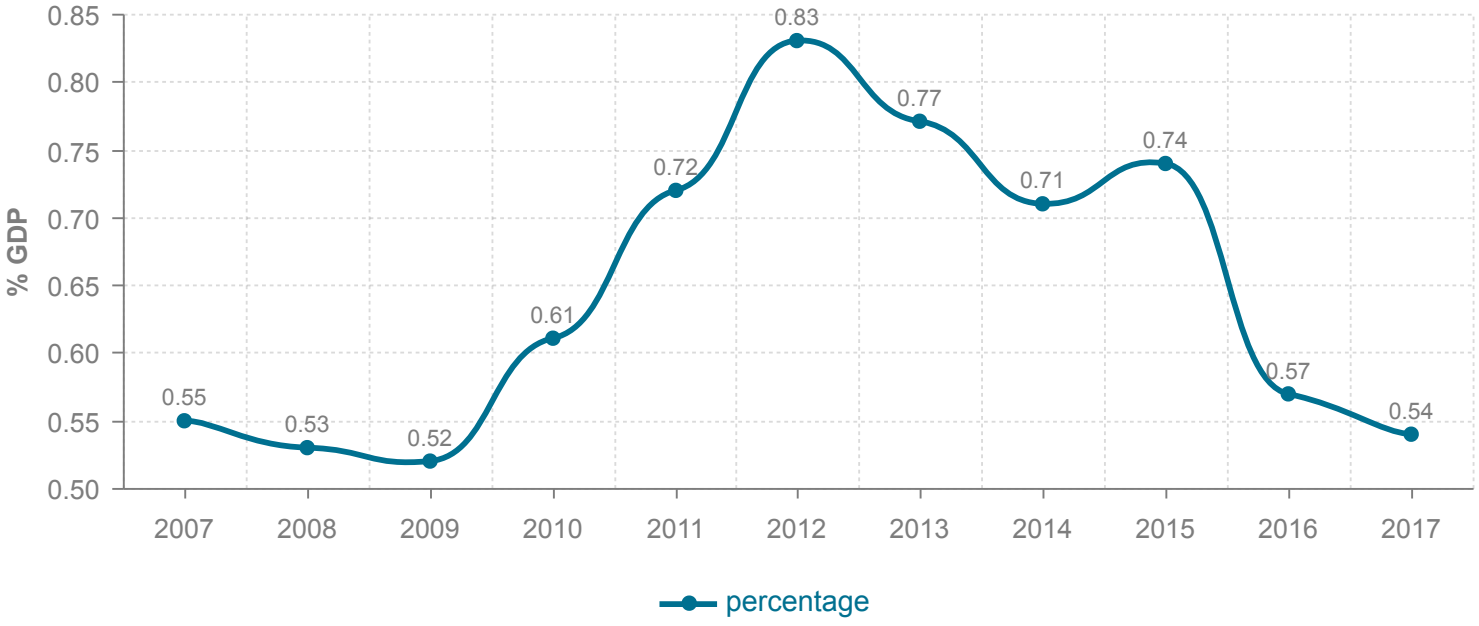
The only target which has been achieved to date is that relating to the number of PhD holders (headline indicator 2). Trends also suggest that the target for indicator number three regarding the number of researchers is also likely to be achieved and possibly surpassed. Each headline indicator is discussed in more detail in the following sections.

Gross R&D expenditure as a percentage of GDP – 2020 Target = 2.0%

At EU level, Malta has committed to a 2% R&D expenditure target by 2020. The values for this headline indicator show increasing divergence from the 2020 target value during recent years. Figure 2 below provides a graphical representation of the results of this indicator over a ten-year period from 2007 till 2017. The value of the indicator increased steadily from 2009, peaking at 0.83% in 2012. However, from 2013 onward a decline was observed, particularly in 2016 when the value declined to 0.57% from 0.74% in 2015. This decline continued in 2017. The substantial increase in the GDP during the last few years contributed to the decrease in this indicator value. In fact, the GDP in 2017 amounted to €11,313.3 million euro, an increase of €969.2 million euro or 9% when compared to the 2016 value. However, this factor does not fully explain the decline observed. Upon analysis of the R&D expenditure in real terms (rather than as a percentage of the GDP), a significant decrease can nevertheless be observed especially in 2016 where the R&D expenditure decreased by €12.789 million and subsequently remained stable in 2017.

Figure 2

Distribution of Gross R&D expenditure as a percentage of GDP over a ten-year period

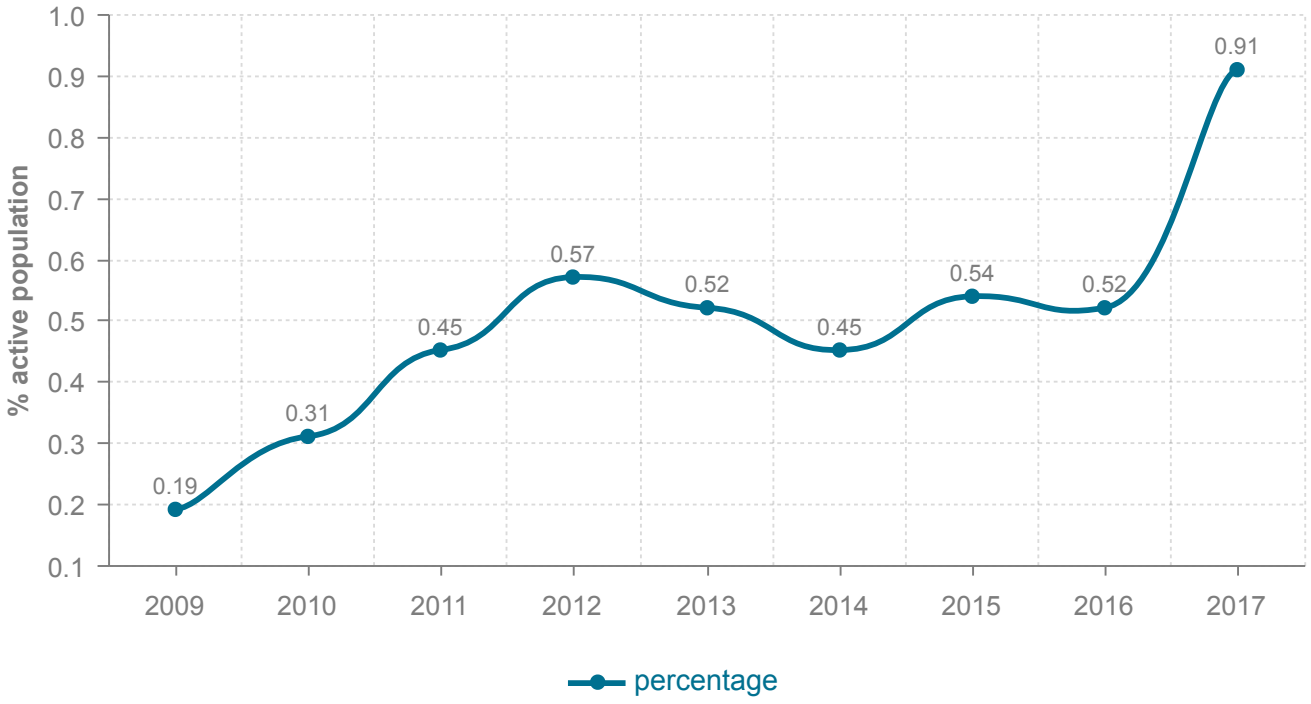


Number of PhD holders as a percentage of active population – 2020 target = 0.6%

The number of PhD holders as a percentage of the active population (refer to Annex II for definition of term) increased between 2009 and 2012, and then stabilised from 2012 to 2016. This was followed by a significant increase in the number of PhD holders in 2017, reaching a total value of 2,012. In real terms, the number of PhD holders in 2017 was over double the number in 2016. Additionally, the active population increased by almost 5% over the same time period. The 2020 target for this indicator has thus been reached. Preliminary figures for the 2018 figure for PhD holders indicate similar values to the 2017 figure. Figure 3 provides a graphical representation of the results of this indicator from 2009 to 2017.

Figure 3

Number of PhD holders as a percentage of the active population from 2009 till 2017

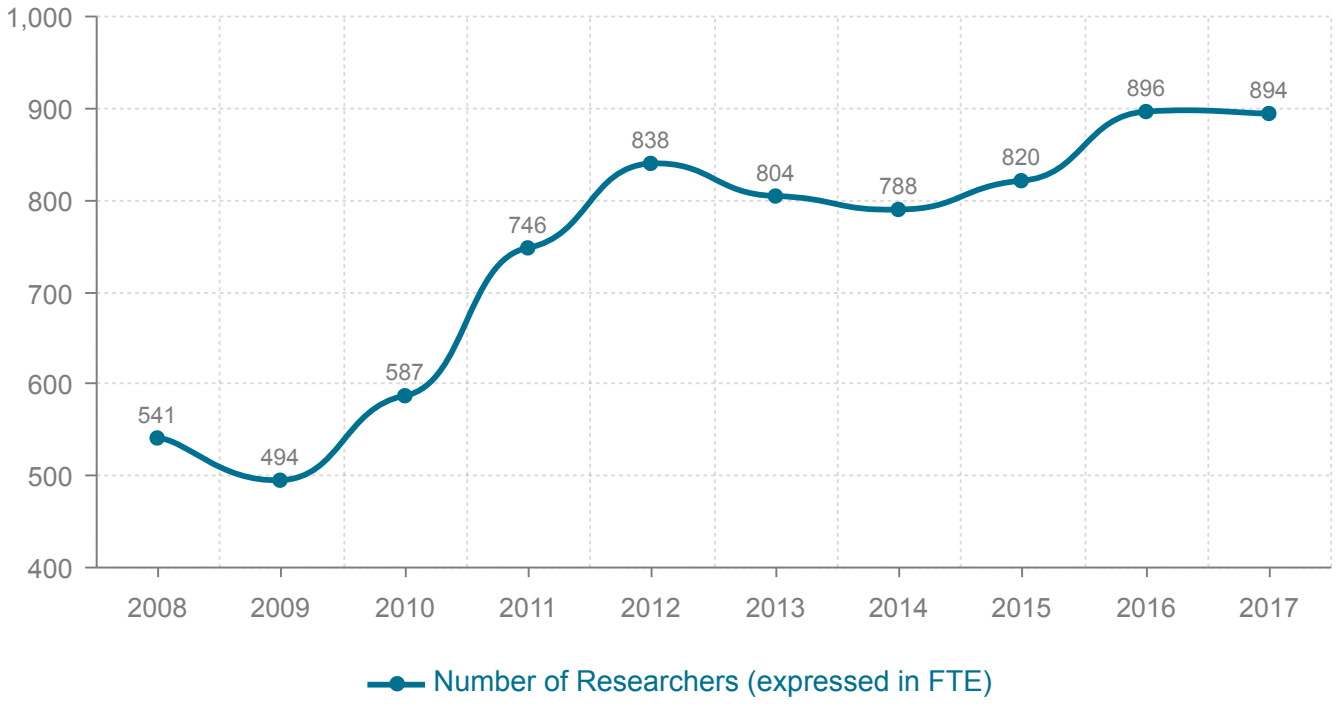


Number of researchers (expressed in full-time equivalents, FTE) – 2020 target = 900

The latest available figure (2017) for this indicator is at 894 FTE, showing a very positive inclination towards the achievement of the 2020 target.

Figure 4

Graph showing Number of Researchers expressed in FTE



Innovation expenditure as a percentage of GDP – 2020 target = 2.50%

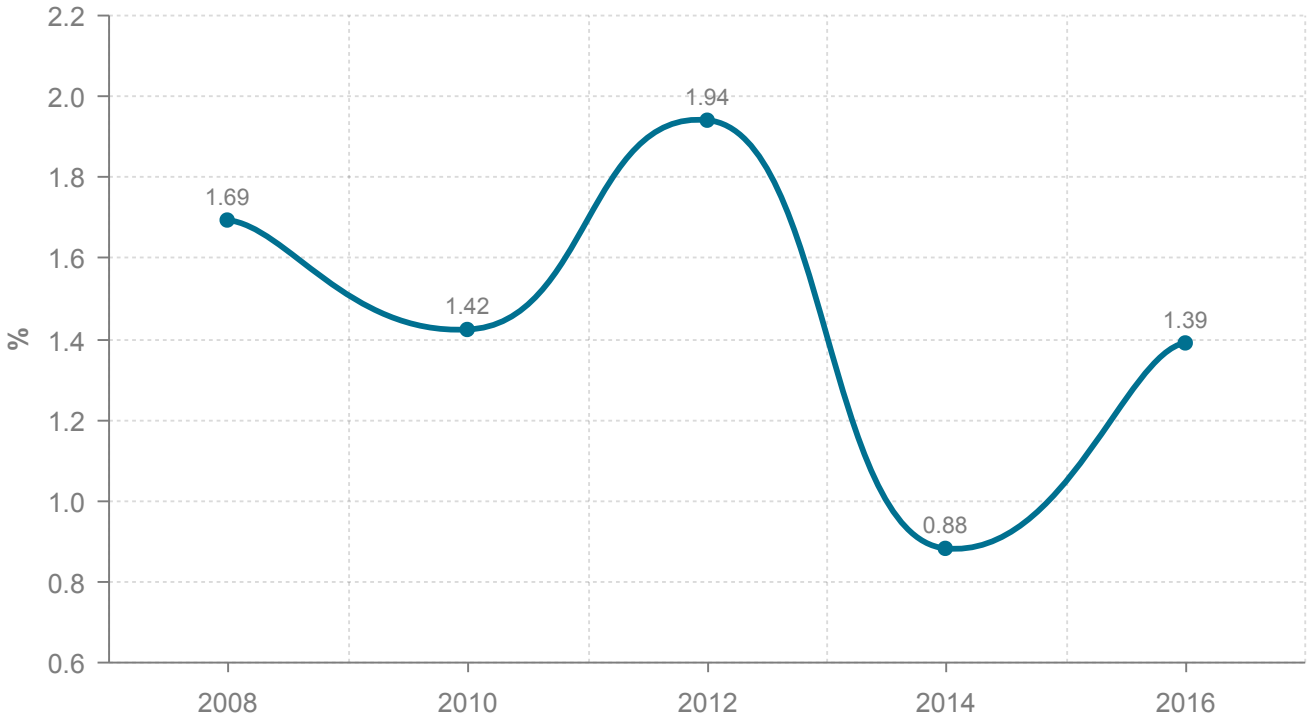
Figure 5 provides a graphical representation of this indicator from 2008 to 2016. A significant upward trend was observed in 2012; however, this did not continue in 2014, showing a decline in the indicator value by more than 1%. This decline was caused by a number of one-time large investments undertaken in 2012, which were not repeated in 2014. Furthermore, the increase in GDP does not explain the reduction in the indicator figure, since real-term figures indicate an actual reduction of almost €65 million when compared to the 2012 innovation expenditure figure.

On a positive note, the indicator value for 2016 increased by more than 0.5% compared to 2014, even though the GDP also increased by almost 15% in 2016 when compared to the 2014 GDP figure. Indeed, when analysing the innovation expenditure figures for 2016 in real terms, there was an increase of more than €60 million compared to 2014. In spite of this, the overall trend shows a general decrease in expenditure since 2008.

An important factor that may have contributed to data fluctuation is the variations in the data collection methodology followed in the innovation survey. This methodology tends to change with each edition of the innovation survey. This makes it difficult to identify patterns with confidence since the variation in expenditure might be influenced by the modifications in the data collection methodologies and differences in definitions.

Figure 5

Distribution of Innovation Expenditure as a percentage of GDP

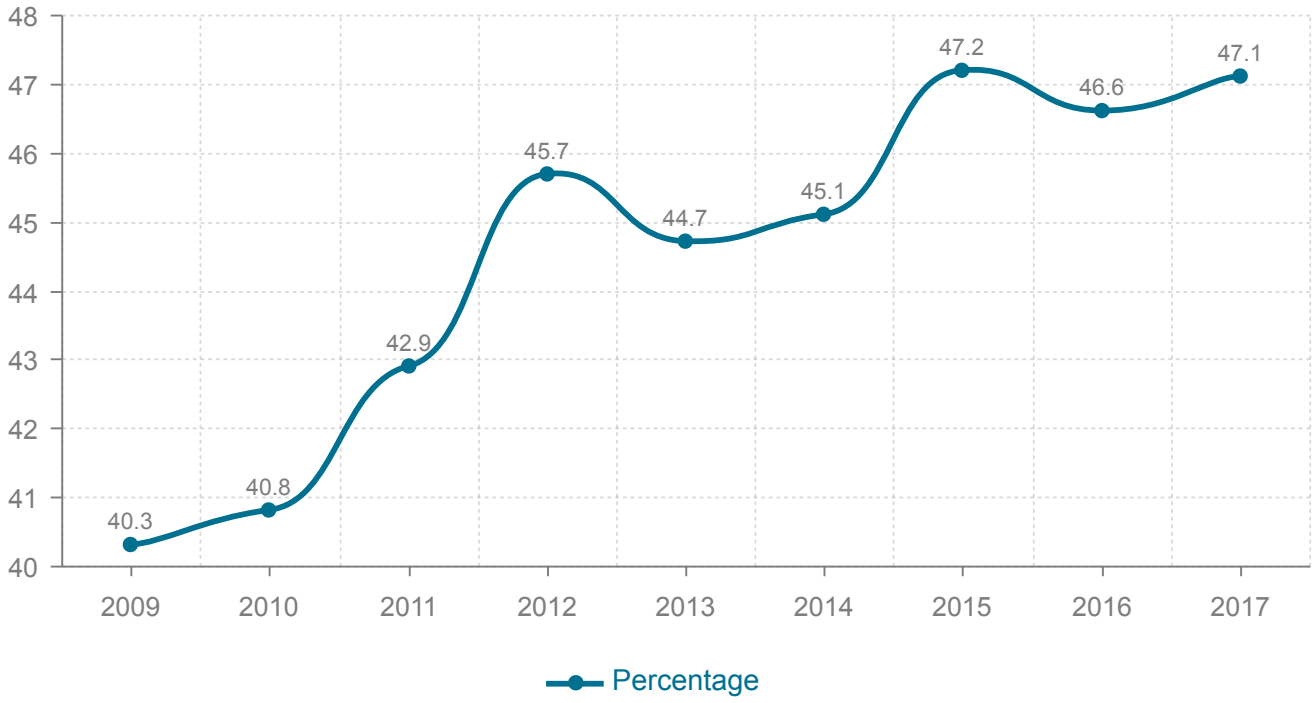


Employment in knowledge-intensive activities as a percentage of total employment – 2020 target = 55%

Figure 6 provides a graphical representation of the indicator's results from 2009 to 2017. Data between 2009 and 2012 shows a steady increase at an average rate of 1% per year, plateauing in more recent years. An analysis of employment in knowledge-intensive industries shows that the value is on the increase. In fact, there was an increase of 6,600 employees in 2017 working within knowledge-intensive industries compared to 2016. Moreover, an average increase of more than 5,000 employees working within knowledge-intensive industries per year was observed annually since 2011. In spite of this numerical increase, the indicator percentage value is plateauing nonetheless, since the total employment number is increasing at a higher rate than the employment number in knowledge-intensive industries. For further information on the economic activity sectors that are defined as providing employment in knowledge-intensive industries, please see Annex I (Glossary of Terms).

Figure 6

Employment in knowledge-intensive activities as a percentage of total employment

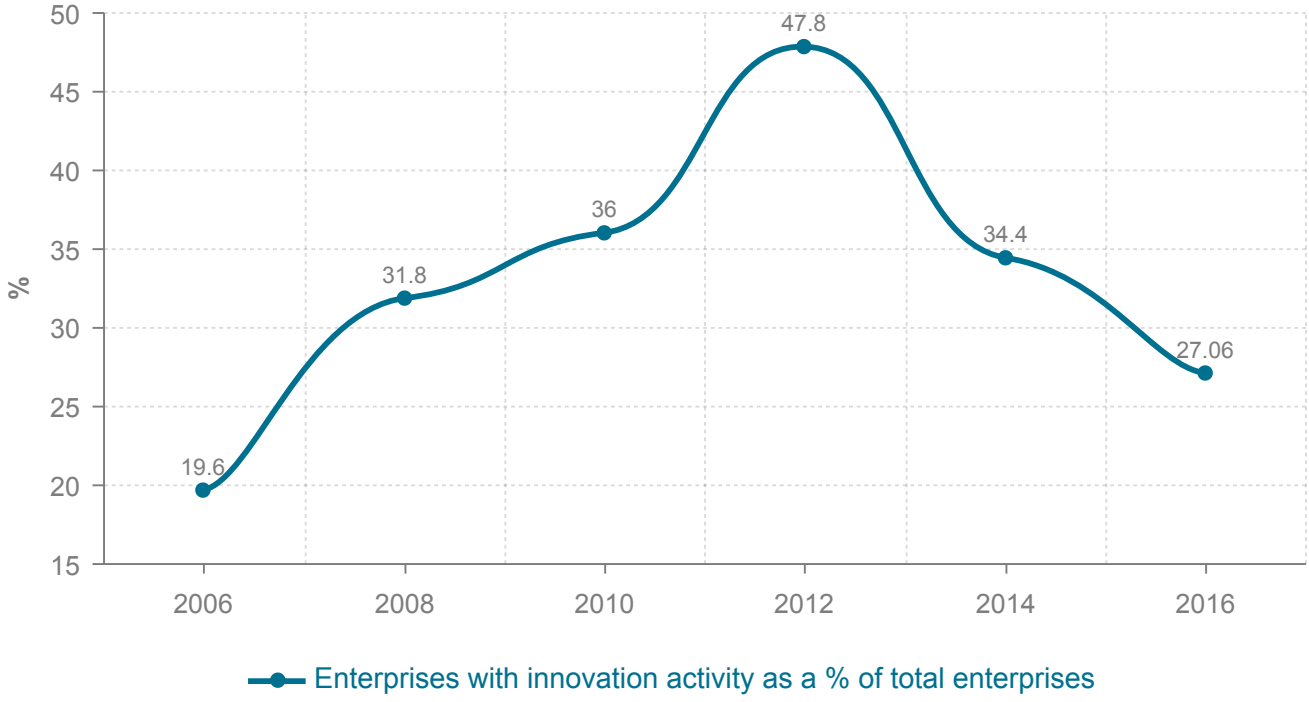


Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and market innovation) as a percentage of total enterprises – 2020 target = 50%

Figure 7 provides a graphical representation of the indicator's results from 2006 to 2016. The indicator demonstrates a steady increase from 2006 to 2012, reaching 47.8% by 2012. However, a decrease was observed in 2014, and this decline continued in 2016.

Figure 7

Enterprises with innovation activity as a percentage of total enterprises

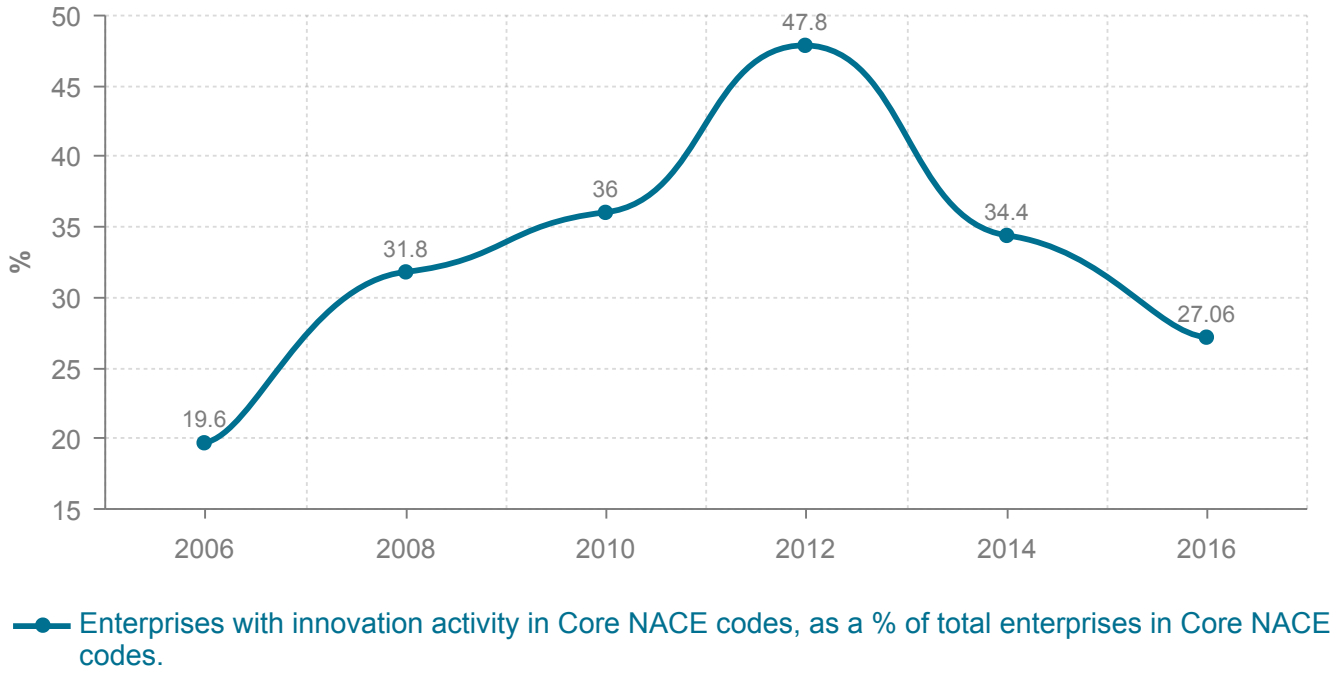


Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation) in the Core NACE Codes as a percentage of total enterprises – 2020 target = 60%

The trends for the above indicator closely followed the previous indicator's trajectory -'Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and market innovation) as a percentage of total enterprises'- in that an increase was observed in 2012 with a subsequent decrease being observed in 2014 and 2016. Figure 8 provides a graphical presentation of this indicator.

Figure 8

Distribution of enterprises with innovation activity in Core NACE codes, as a % of total enterprises in Core NACE codes.



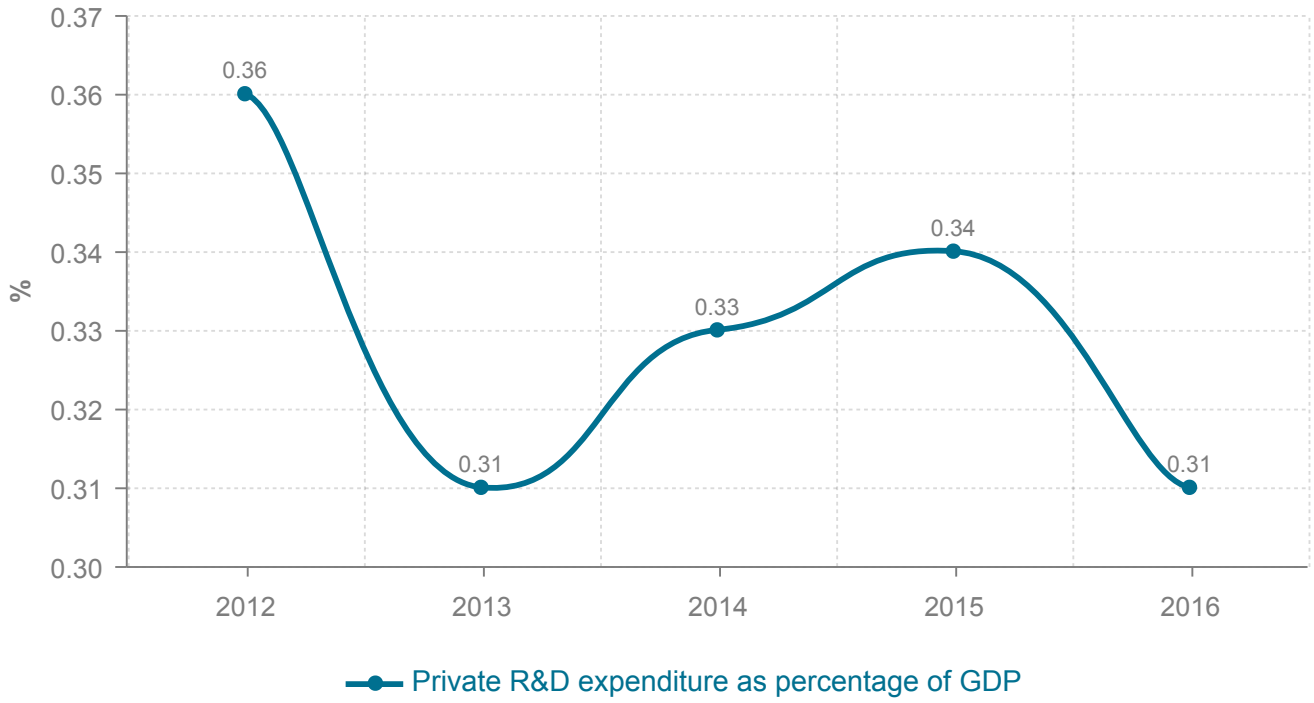
3 Main findings from the Result Indicators of the Pillars and Action Lines

Pillar 1: Comprehensive R&I support system

The overarching result indicators for this pillar mainly focused on obtaining more information on the resources that were put forward by the private sector so as to analyse the extent of the private sector's engagement within Malta's R&I landscape. **Private R&D expenditure** proved to be stable from 2012 and 2016. The latest available figure (from 2016) of €31,974,000, accounted for 0.31% of the GDP in 2016. Figure 9 provides a graphical representation of private R&D expenditure as a percentage of GDP over time.

Figure 9

Private R&D expenditure as a percentage of GDP



The **total expenditure in innovation** was also analysed. This data was obtained from the Community Innovation Survey (CIS) which is compiled every two years. Due to the numerous changes between one edition of the survey and another, as well as data confidentiality issues for certain NACE codes, and ultimately to ensure consistency in the data, the figures provided only reflect the innovation expenditure that was put forward for 'Innovation Core Activities'. The latest available figure is that for 2016, which showed an increase of almost 50%, when compared to its corresponding figure in 2014.

Furthermore, upon analysing the expenditure on innovation between 2014 and 2016 within the different NACE codes, there appears to be a considerable increase (more than 50%) in the expenditure on innovation between 2014 and 2016 in:

- NACE Code G (wholesale and retail trade)
- NACE Code I (accommodation and food service activities)
- NACE Code J (information and communication)

Moreover, innovation expenditure within NACE Code L (real estate activities) more than doubled in 2016 when compared with 2014.

A comparison for two other predominant areas, manufacturing and construction, could not be made since the innovation expenditure figure for 2014 in these areas was classified as confidential on the EUROSTAT database.

When it comes to the **number of researchers (full time equivalents or FTEs) per thousand labour force working within the private sector,** the most recent data shows a figure of 2.35 for 2017. Compared to 2012's value (3.43), an average reduction of 7% in the indicator value from 2012 till 2017 is noted. A possible explanation for this is the fact that although employment has increased by 9.3% between 2012 and 2017[3], the number of researchers has remained stable, with 559 and 510 FTEs in 2012 and 2017 respectively. Thus, while employment has increased over the past years, the type and quality of this employment was not related to R&D .

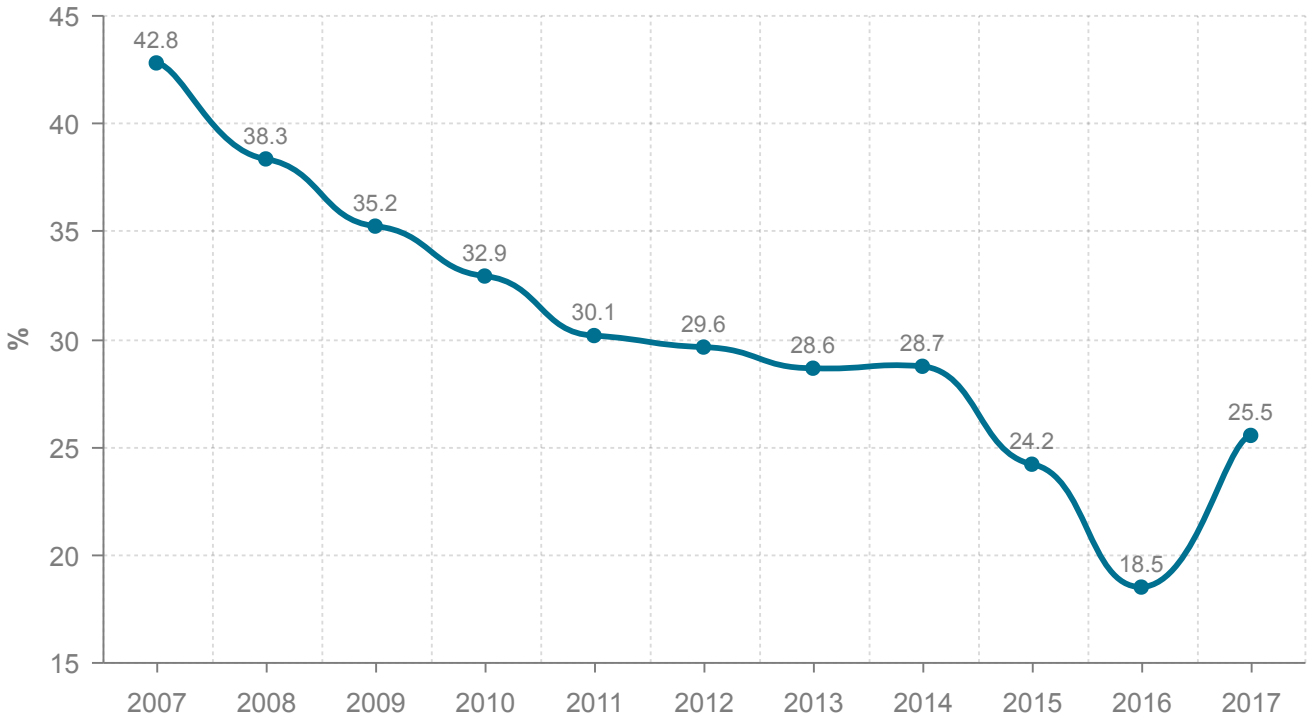
The share of **high-tech exports[4] as a percentage of total exports** has decreased during the last 10 years, showing an overall reduction since 2007. Figure 10 provides a graphical representation of the data distribution for this indicator over an eleven-year period. Upon analysing this data, it was noted that this decrease was due to a combination of two issues, namely an average decrease in the actual number of high-tech exports per year from 2011 to 2017 and an average increase in the total exports per year during the same period. The combination of both these issues led to an overall reduction in this indicator value. It is worth highlighting that the exports under consideration for this indicator refer to extra-EU and intra-EU exports.

[3] Source: Labour Force Survey Revision: 2012-2017 Link:
https://nso.gov.mt/en/News_Releases/View_by_Unit/Unit_C2/Labour_Market_Statistics/Documents/2018/News2018_153.pdf

[4] High-tech exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery.

Figure 10

Share of high-tech exports as a percentage of the total exports



Action Line A – Upscaling, extending and coordinating the level of support provided to business

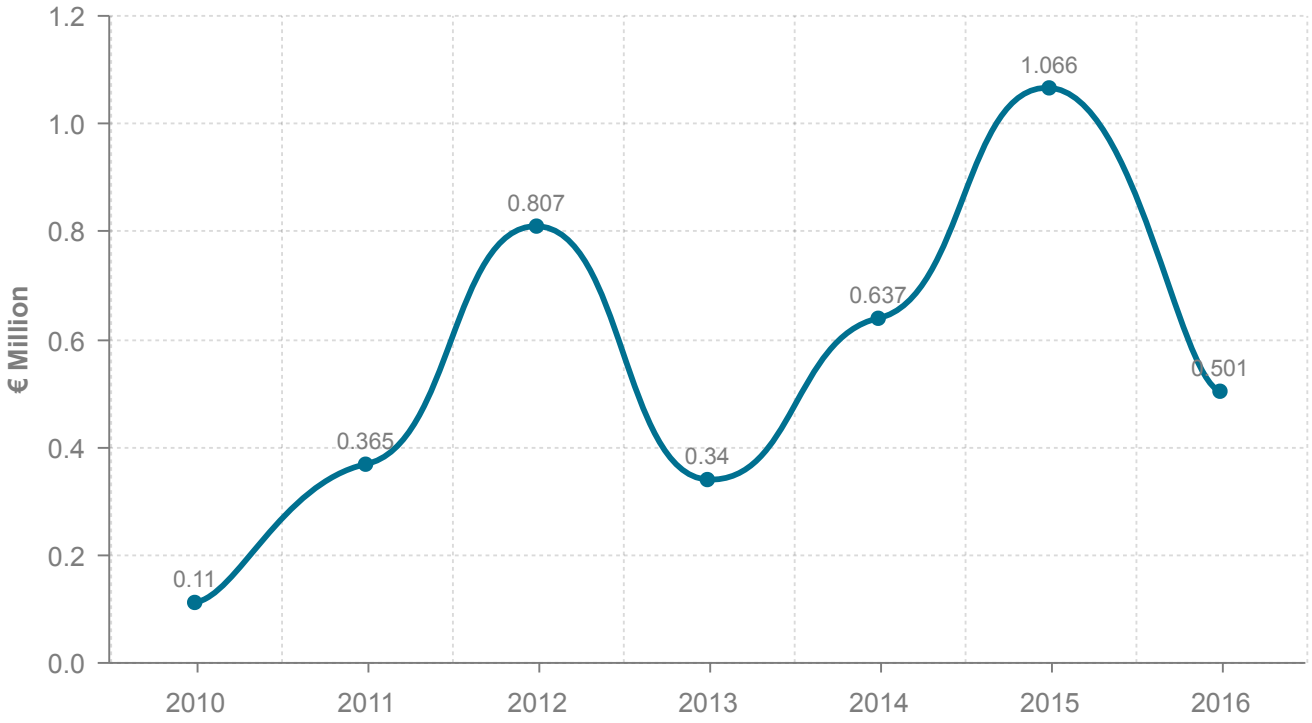
Data on the number of **SMEs involved in R&D and innovation projects** was also obtained from the CIS. By analysing the figures for the last three monitoring periods of the survey (i.e. 2012, 2014 and 2016), an average reduction of approximately 13% was observed for each reporting period, with 214 SMEs being involved in RD&I projects in 2016.

With regards to the **funding support provided by Government towards R&D expenditure within the private sector**, an average increase of more than €3.5 million euros was observed from 2013 till 2015, with a subsequent reduction in 2016 of slightly more than half a million euros from the previous year.

Figure 11 provides a graphical presentation of the Government allocation for R&D activities within the private sector.

Figure 11

Government allocation for R&D activities within the private sector (in million euros)



Action Line B: Evaluation and Monitoring

This Monitoring Report fulfils the objectives of Action Line B. The monitoring outcomes from this Report will feed into the updating process of the R&I Strategy post-2020. The methodology that was undertaken to develop and implement the monitoring system is explained in more detail in this report's methodology chapter.

Action Line C: Embedding a culture for innovation, creativity, risk taking and entrepreneurship

Malta has improved its **Global Competitiveness Index (GCI) Ranking**, placing 40th in 2016 and 36th in 2018. This index assesses the microeconomic and macroeconomic foundations of national competitiveness in 140 countries, including Malta. The overall Index is a composite indicator composed from the results of twelve different pillars:

Pillar 1: Institutions;
Pillar 2: Infrastructure;
Pillar 3: ICT adoption;
Pillar 4: Macroeconomic stability;
Pillar 5: Health;
Pillar 6: Skills;
Pillar 7: Product market;
Pillar 8: Labour market;
Pillar 9: Financial system;
Pillar 10: Market size;
Pillar 11: Business dynamism;
Pillar 12: Innovation capacity.

Further information on the GCI methodology can be found in the Global Competitiveness Index Report. When looking specifically at the data for Pillar 12: Innovation Capacity, Malta experienced an overall increase when compared to the findings in the previous report's edition. The main increases were seen in the following areas - International co-inventions, number of scientific publications, number of patent applications, R&D expenditure, quality of research institutions and buyer sophistication.

A reduction was noted in the following areas; diversity of workforce, state of cluster development and multi-stakeholder collaboration.

The number of trademark applications remained constant.

According to the 2017-2018 edition of the report, the most problematic factors for doing business in Malta were mainly inefficient government bureaucracy, an insufficient capacity to innovate, an inadequate supply of infrastructures, access to financing and an inadequately educated workforce. Moreover, with regards to Malta's ranking in relation to Pillar 12, this has also gone up by seven places from the 41st to the 34th position from 2016 to 2018.

Action Line D: Using inward investment to leverage indigenous R&I

The **amount of R&D spent by local companies due to leveraging funds from foreign firms** was analysed and this peaked between 2011 to 2013, with a subsequent reduction in 2014, 2015 and 2016.

The same can also be said for **private R&D funds spent by foreign companies in Malta as a percentage of the total business R&D expenditure in Malta**, where the same pattern was observed. Figures 12 and 13 provide a graphical representation of both these indicators respectively.

Figure 12

Amount of R&D spending by local companies leveraged by foreign firms' R&D expenditure (in million euros)

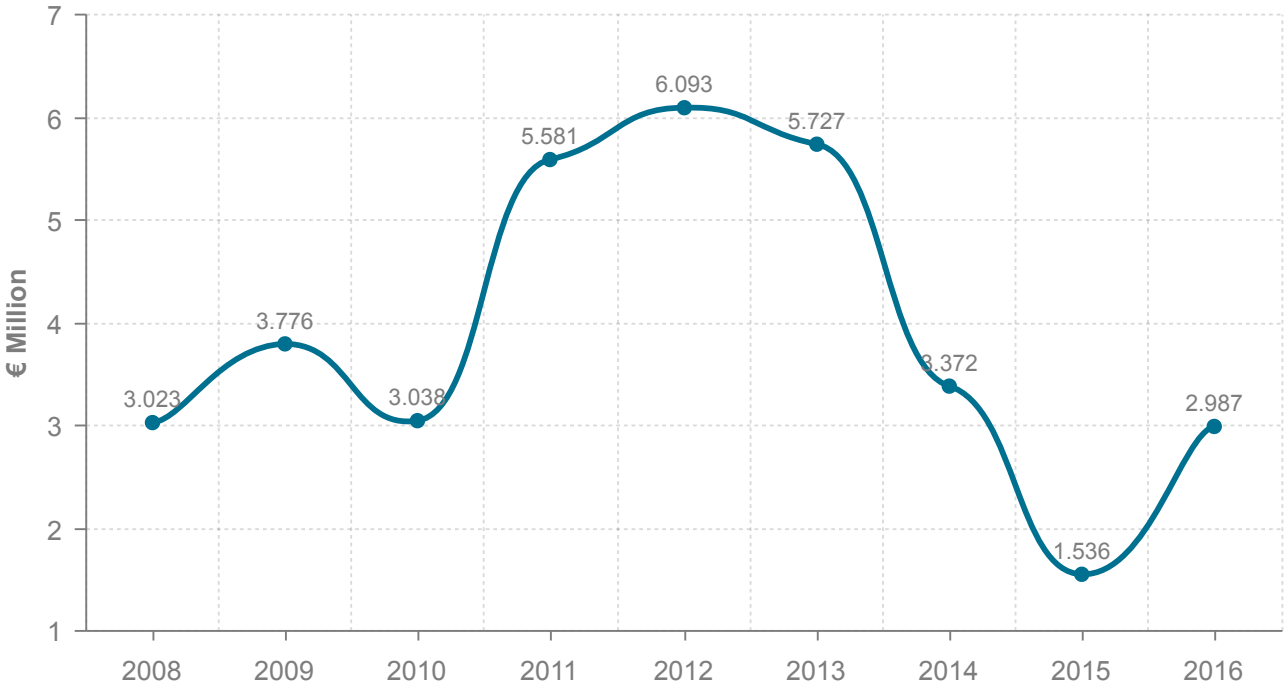
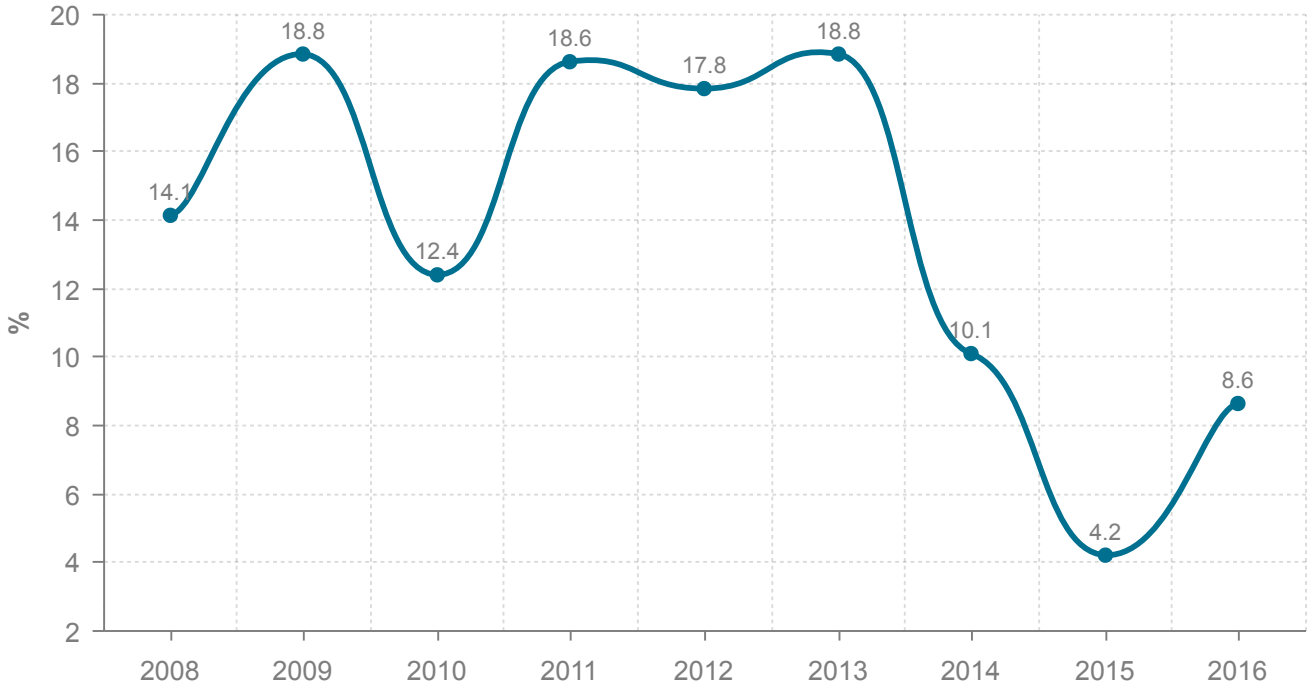


Figure 13

Private R&D funds spent by foreign companies in Malta as a percentage of the total business R&D expenditures in Malta.



Action Line E: Improved access to knowledge

The PSF monitoring exercise had recommended that one way of analysing this Action Line would be to look at the **number of firms that engage in R&D collaborative projects**. However, the data corresponding to this indicator is not currently available. Discussions are currently ongoing with NSO to incorporate an additional question within the Business R&D survey to capture the required data for this indicator.

Action Line F: Improved transfer of knowledge

Data from the University of Malta (UM) and the Malta Aquaculture Research Centre (MARC) was obtained to determine the **number of formalised commitments taking place between public research organisations and business firms**. Formalised commitments are ones that bind involved parties through a formalised partnership agreement such as contracts, cooperative agreements, Memoranda of Understandings (MOUs) or Memoranda of Agreements (MOAs).

The Table below provides the data in relation to this indicator from 2014 till 2017. No pattern can be deducted from this data since the data set is very limited.

2014	2015	2016	2017
16	7	30	7

Figure 14: Number of formalised commitments between public research organisations and business firms.

The **number of spin-off companies**[5] is still very low in Malta. Data collected from the UM indicates that since 2014, only one spin-off company was formed in 2017.

The analysis of co-patents is also another way of assessing the extent of knowledge transfer. The **number of patent applications to the European Patent Office (EPO) with foreign co-inventors by priority year** was analysed and data for the period 2004 to 2013 was available (EUROSTAT data on patent applications is only available up to 2013).

[5] For the purposes of this report, spin-off companies are defined as innovative start-ups founded by staff and/or capital from public research institutions.

The Table below provides the data for this indicator, which indicates that figures have been largely stable over the past few years. The very small numbers involved add to the difficulty of interpreting this dataset.

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
7	6	4	4	1	4	1	1	3	3(p)

Figure 15: Number of patent applications to the European Patent Office (EPO) with foreign co-inventors by priority year.

Action Line G: Open access to publications

In recent years, the UM has steadily increased its share of Open Access publications, ranging from 97 in 2014 to 145 in 2017. The **share of publications available in Open Access media as a percentage of total publications** has remained stable since the number of total publications has also steadily increased. Thus, this indicator value for UM ranges from 15.7% in 2014 to 20.8% in 2015, 20.6% in 2016 and 17.7% in 2017. Furthermore, the total number of publications increased by almost 25% in 2017 compared to 2014.

The **implementation of institutional repositories for Open Access publications**, gives rise to multiple benefits for researchers as well as research institutions. In 2017, the UM launched its Open Access Policy which has served to ensure that research outputs produced under its auspices are made freely available through the Institutional Repository - OAR@UM[6]. This open access repository is the University's Institutional Repository (IR) operating as an online archive that collects, preserves and disseminates the intellectual output of the University. It is also a vital tool for scholarly communication, preservation of knowledge and an important resource to enhance the visibility of the research carried out at the UM. Apart from providing round the clock access, all the publications that are uploaded on OAR@UM are harvested by Google and Google Scholar thus enhancing the dissemination process at an international level, increasing the opportunity for transnational collaborations.

As of December 2018, there were over 32,229 items on the OAR@UM, with the highest number of publications deposited by the Faculty of Medicine and Surgery (n=1870), followed by the Faculty of Science (n=1591) and the Faculty of Arts (n=1302). OAR@UM is also OpenAIRE compliant. The OpenAIRE initiative aims to support the implementation of Open Access in Europe[7].

[6] OAR@UM allows users to search for publications according to the different communities registered within the repository and also has advanced search filters to search by issue date, by name of author, by title, by subject and also by the type of documentation.

[7] Link: https://www.openaire.eu/

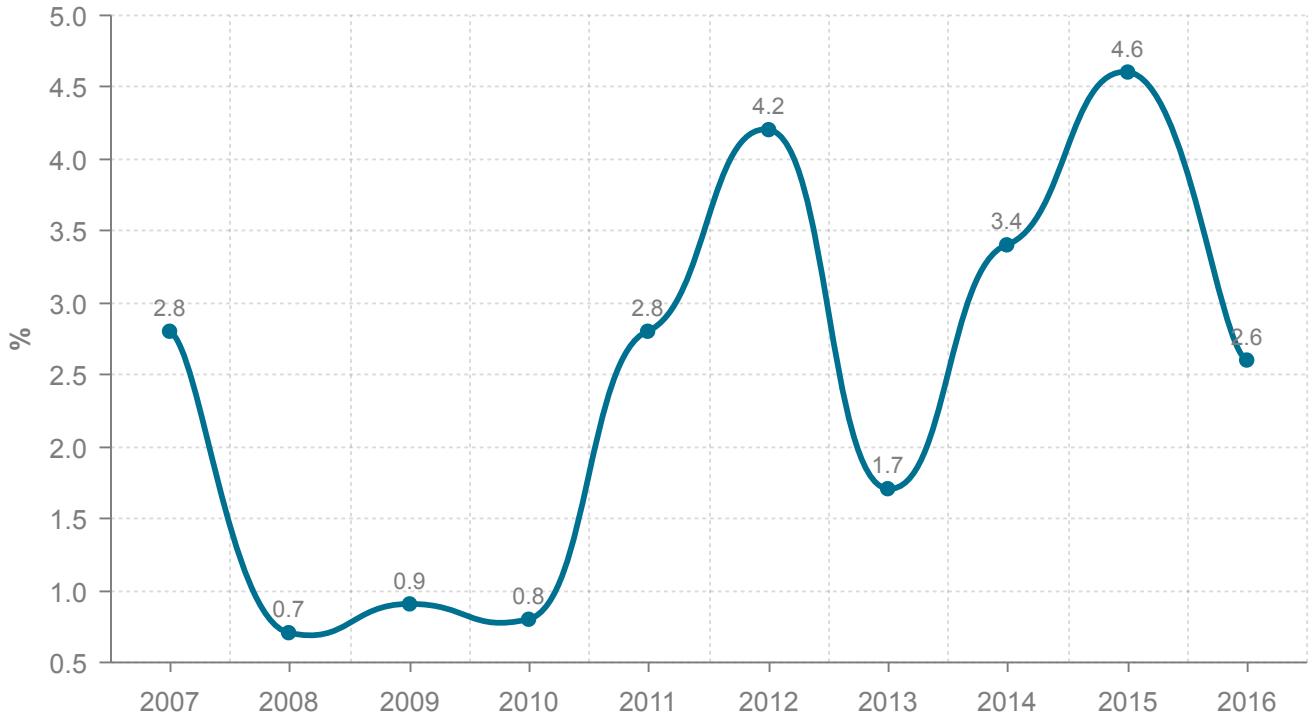
Action Line H: Financial support for enterprises

The availability of public funding is an important incentive which supports enterprises to undertake more RD&I activities. One way of analysing this is to assess the **percentage of public funding for R&D performed by the business sector**. Figure 16 provides a graphical representation of this indicator value from 2007 to 2016. It can be noted that although there was an increase from 2010 till 2012, the pattern continued to fluctuate from then onwards, with another peak observed in 2015.

Looking at the trends for the indicator on the **amount of private funds leveraged by public funding schemes for enterprises involved in R&D** it is noted that there was a substantial increase of more than 95% in 2017 (€624,178) in leveraged funds when compared to 2014 (€22,950).

Figure 16

Percentage of public funding for R&D performed by the business sector



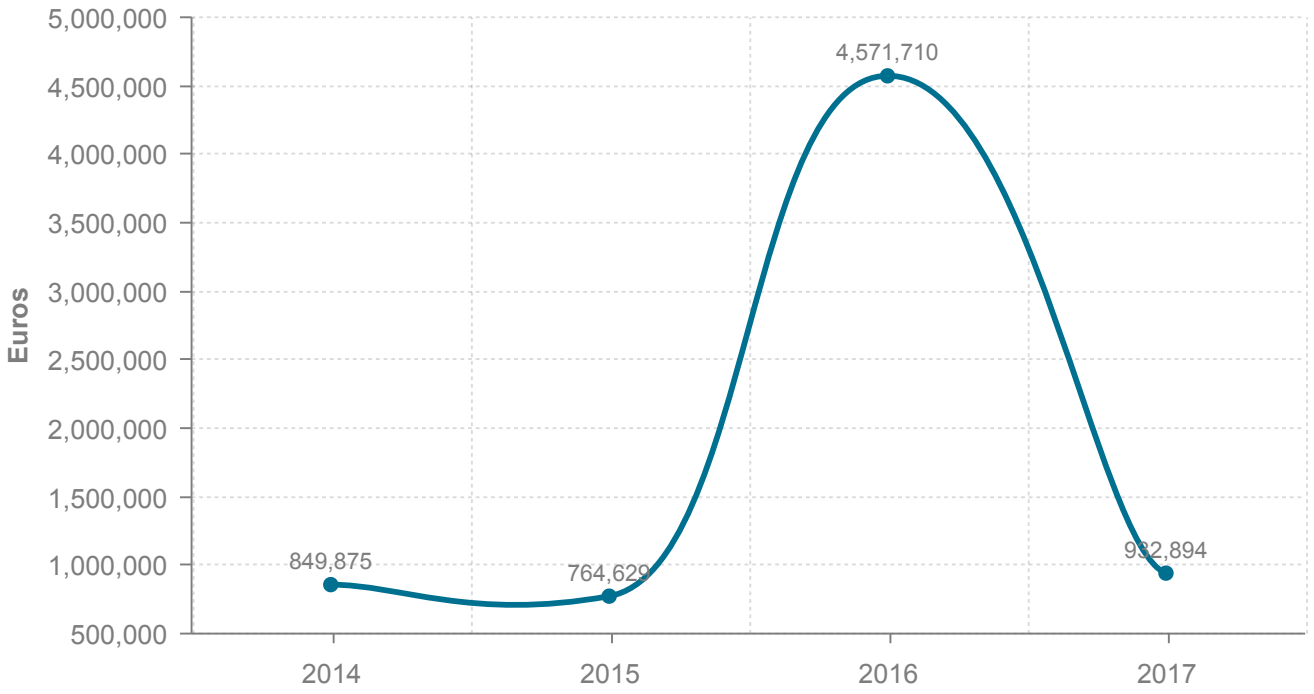
Action Line I: Internationalisation support for enterprises

The level of EU funds being attracted by Maltese private entities to undertake R&I (apart from Structural Funds) was analysed. This mainly constituted the funding amounts being attracted through Horizon 2020 funds. **The number of Maltese companies participating in Horizon 2020** has remained relatively low, ranging from three private entities taking part in 2014 to eight private entities in 2018. The total amount of funds attracted by private entities till 2018 was €9,237,166 compared to the €21,261,324 being attracted overall. Thus, 43% of the Horizon 2020 funds being attracted by Malta went towards funding R&I in the private sector.

Figure 17 provides a graphical representation of this funding trend from 2014 to 2017.

Figure 17

Total competitive EU funds attracted by Maltese private organisations –through Horizon 2020



Pillar 2: Stronger Knowledge Base

The overarching result indicators for this pillar mainly focused on data from two main sources; the Global Talent Competitiveness Report and the Adjusted Research Excellence Index 2018.

The **Global Talent Competitiveness Index (GTCI)** is a global benchmark for issues related to talent competitiveness and the future of the workforce. The GTCI is a composite index based on an Input-Output model of six pillars – ENABLE, ATTRACT, GROW, RETAIN, SKILLS and GLOBAL KNOWLEDGE SKILLS.

Figure 18 provides an overview of the GTCI scores for Malta from 2015 till 2017, together with its country ranking and regional ranking respectively.

	2015/2016	2017
GTCI Score	54.53	57.43
Overall Country Ranking	28	26
Regional Ranking (within the EU-28)	19	17

Figure 18: GTCI Scores, overall and regional ranking for Malta

The Adjusted Research Excellence Index is a composite indicator selected by the European Research and Innovation Committee (ERAC) as the headline measure to monitor country performance with respect to ERA Roadmap Priority 1, 'Effective National Research Systems' (European Commission, 2017).

It combines four dimensions that characterise effective research systems, in terms of scientific and technological research excellence. These are the level of high-impact publications and valued patents, the ability of institutes to attract outstanding research grants, participation in research exchanges that pave the way to future excellence and the development of efficient research capacity.

The methodology used to compute the latest 2018 scores can be found in the JRC Methodology Report for The Adjusted Research Excellence Index 2018. When looking at the Compound Annual Average Growth Rate (CAGR) of Malta with respect to its Adjusted Research Excellence Scores for 2018, Malta exhibited the highest CAGR from all the 43 countries (EU-28 and Associated Countries) analysed. In fact, Malta's CAGR score was that of 17% when compared to the 10% CAGR score obtained by Luxembourg, the next country with the highest CAGR score recorded. Also, 3% was the average recorded CAGR score for the EU-28 average. It is worth noting when analysing such data, that growth rates tend to fluctuate more readily in small countries than in larger ones.

Action Line J: An education system which adequately shapes future human capacity in R&I

The **number of tertiary graduates in STEM per 1000 population aged 20-29** was analysed and a decrease was observed in 2016.

The Table below provides the relevant data for this indicator from 2013 to 2016 (the latest available data).

2013	2014	2015	2016
15.8	15.7	15.3	13.6

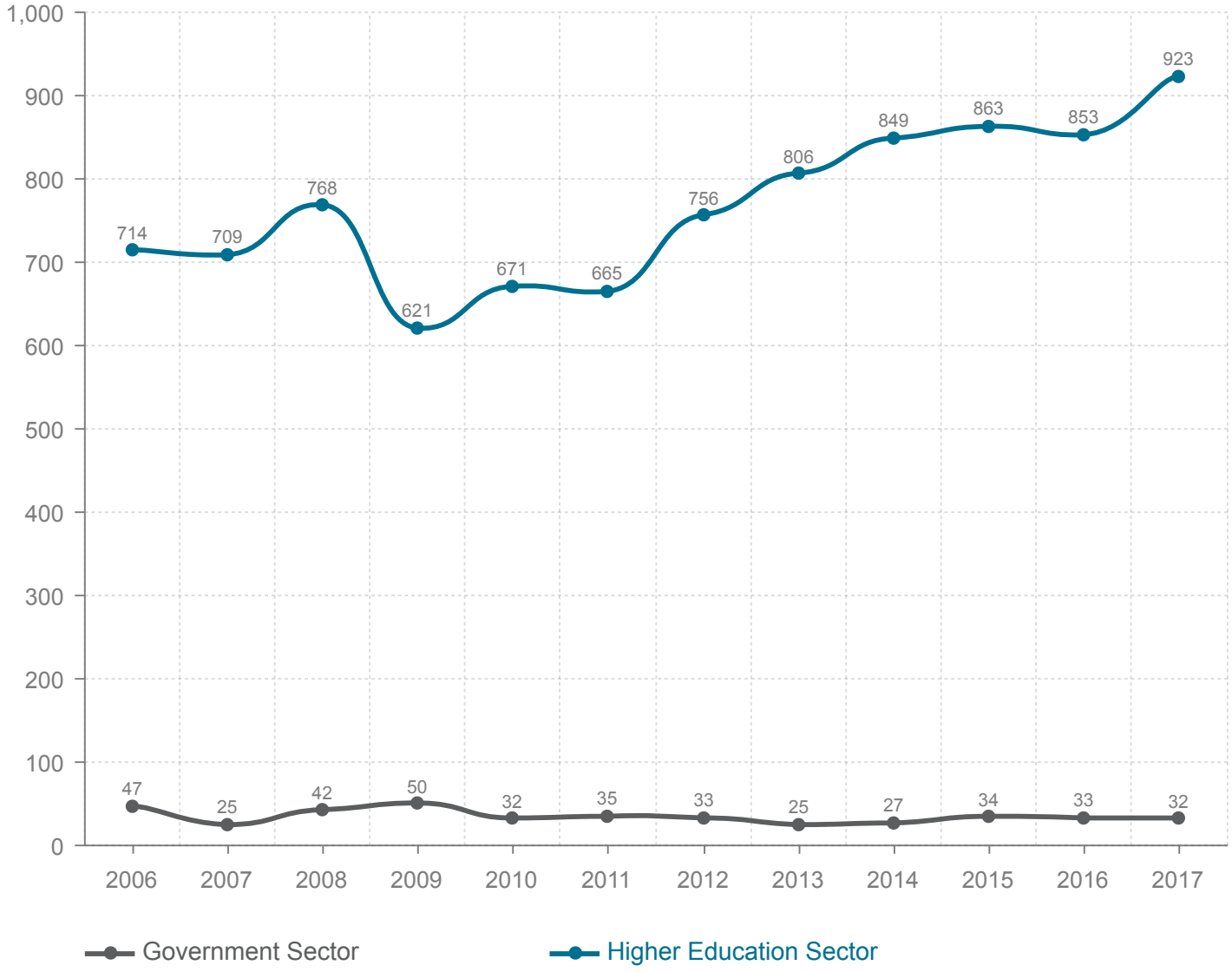
Figure 19: Number of tertiary graduates in STEM per 1000 population aged 20-29

Action Line K: Supporting graduates to become researchers

Figure 20 provides a graphical representation of the **number of researchers working within the Government sector and the Higher Education sector (mainly public sector)** in Malta over a 10-year period. The figures have remained largely stable in recent years for both the Government and the Higher Education Sectors. The number of researchers working within the Government sector remains comparatively low.

Figure 20

Number of researchers working within the Government sector and the Higher Education Sector

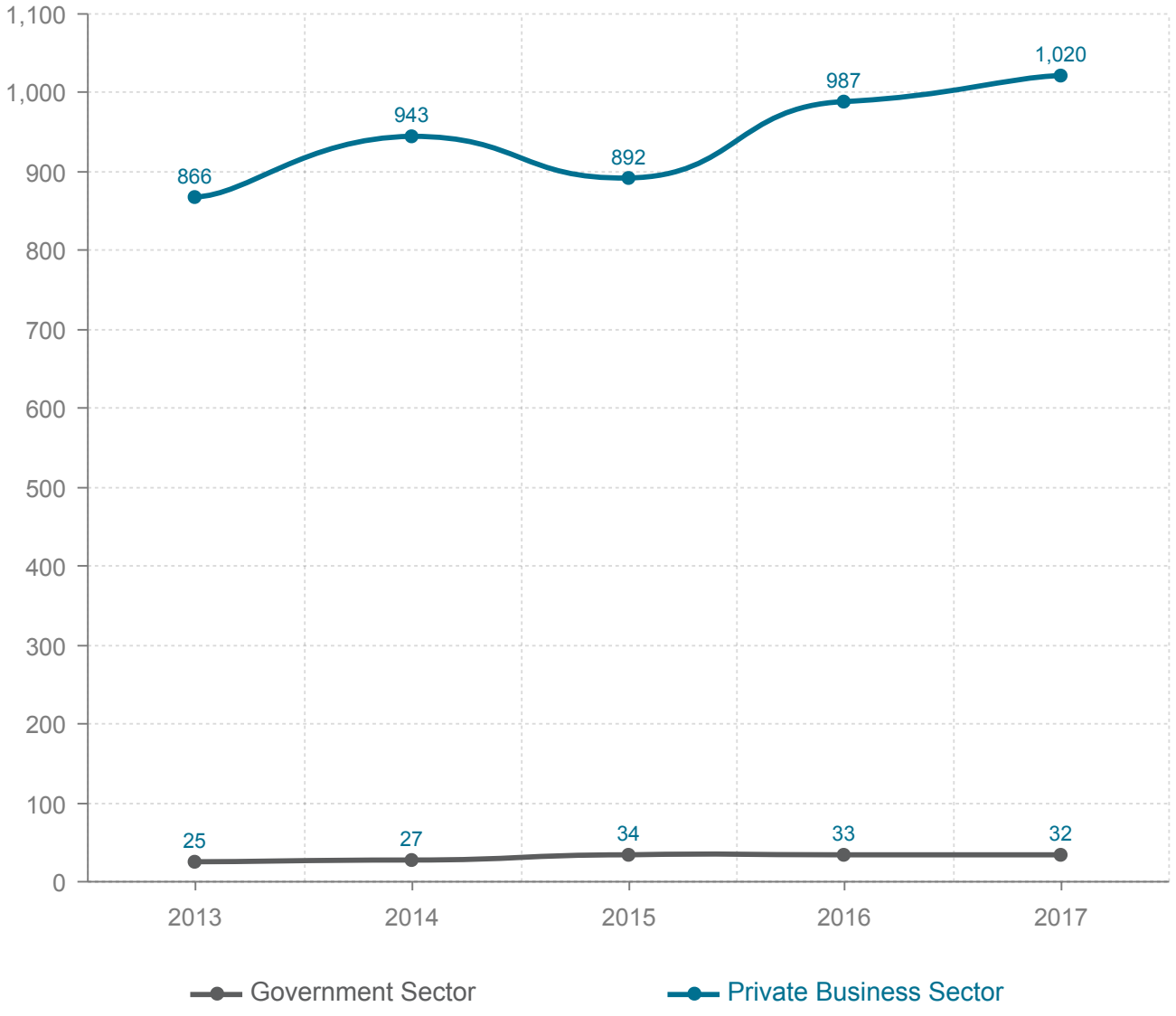


There is also a big discrepancy when analysing the trends of graduates that are conducting R&D activities in the private sector as opposed to the Government sector.

Figure 21 provides a graphical representation of this trend for the latest four-year period (2016 providing the latest available data for this indicator).

Figure 21

Number of graduates conducting R&D activities. Split between public (Government) and private (business sector)

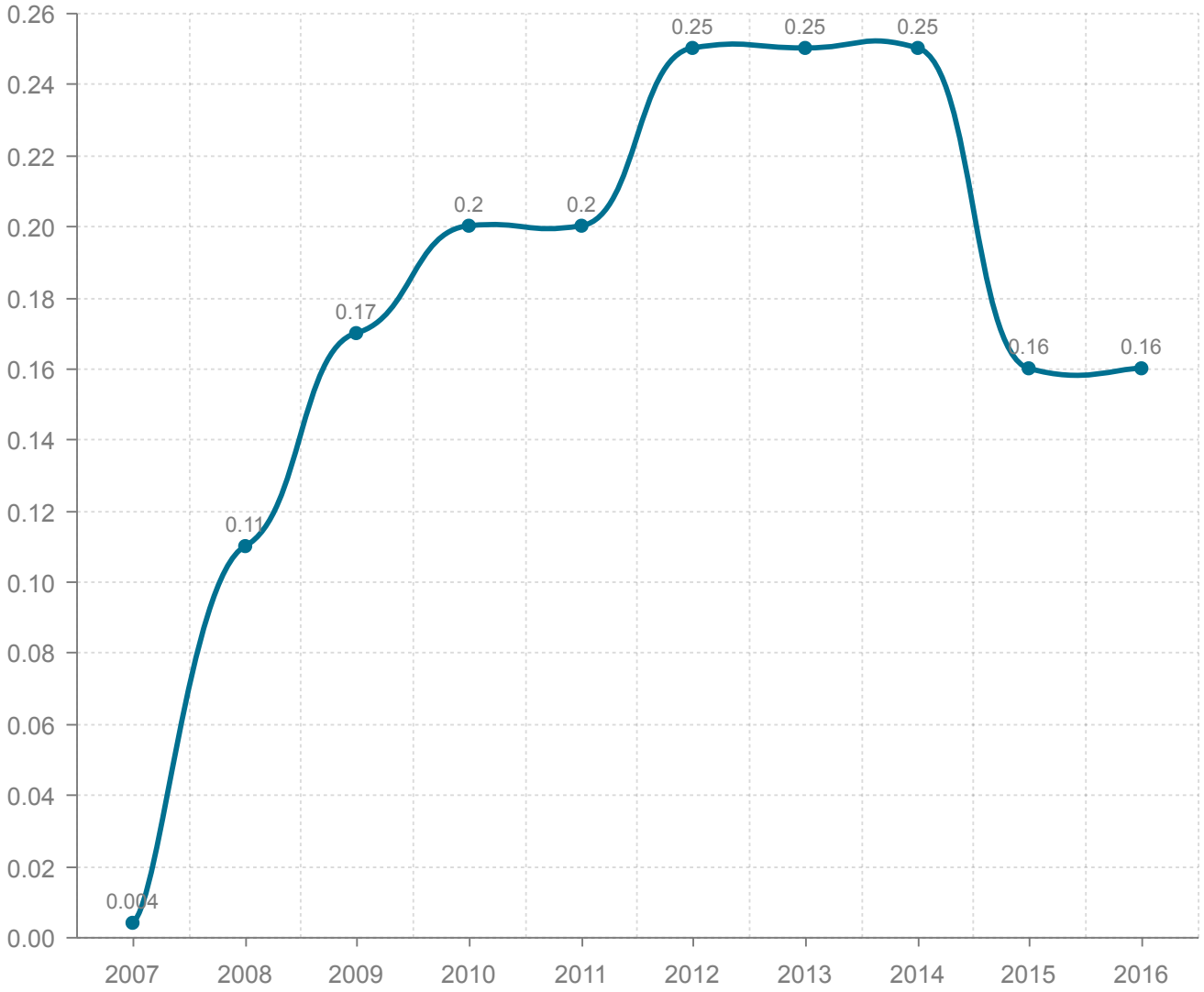


Action Line L: Strengthening links between academia and the private sector for effective knowledge transfer

For this Action Line, the **amount of public R&D financed by the private sector** was analysed. The data shows that there was an increase observed from 2007 to 2012, plateauing till 2014 and a subsequent decrease in 2015. However, it is worth noting that in absolute terms, the discrepancies of the figures in question are very small, thus observed changes are of a limited scope. Figure 22 provides a graphical representation of this data over a ten-year period.

Figure 22

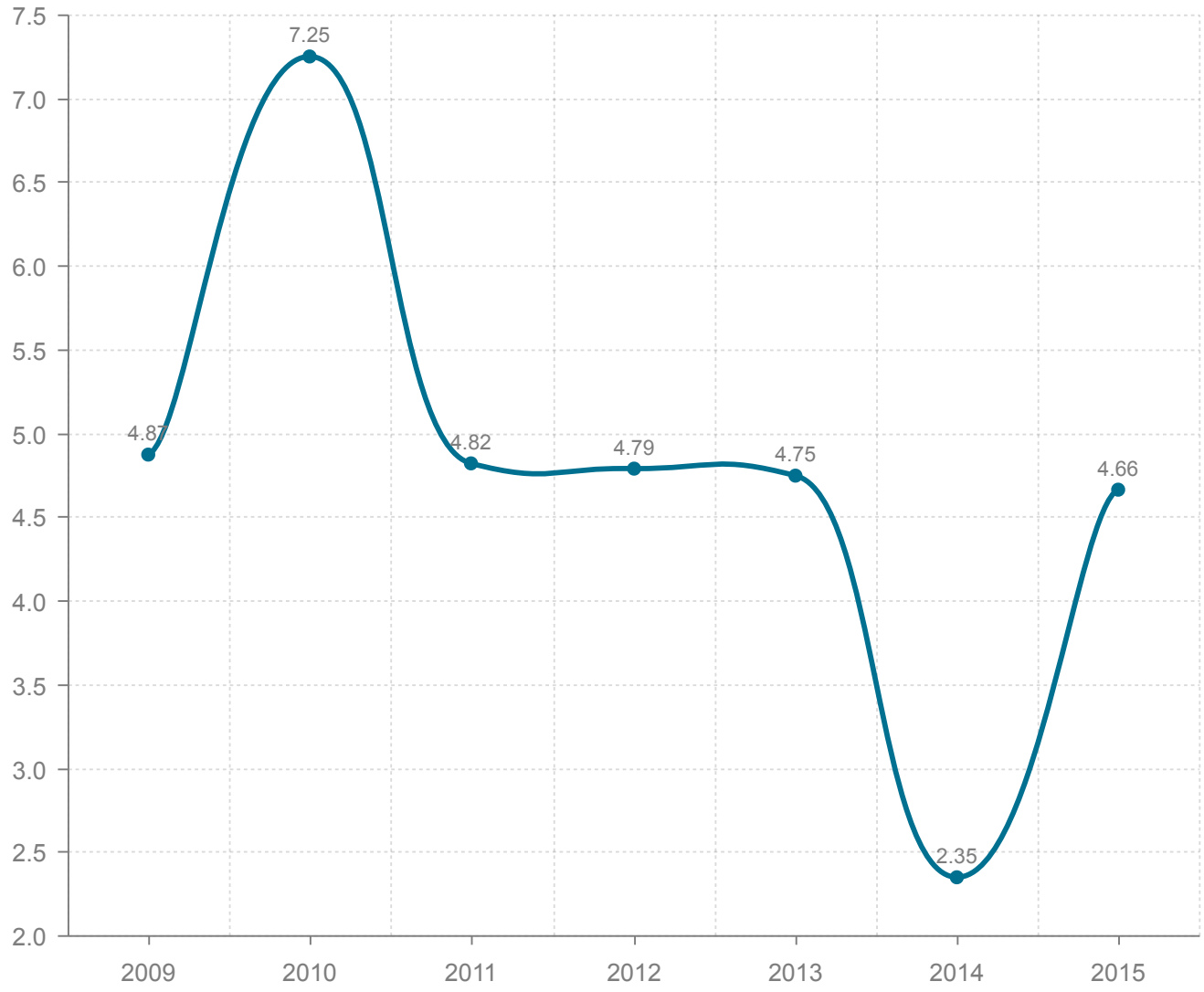
Public R&D financed by the private sector



The **number of Public- Private scientific co-publications per million population** was also analysed to assess the level of scientific public-private collaborations being undertaken. The data shows that this indicator value has remained rather stable since 2009 (figure 23 provides a graphical representation of this trend). This data was obtained from the RIO Country Report 2017 of Malta.

Figure 23

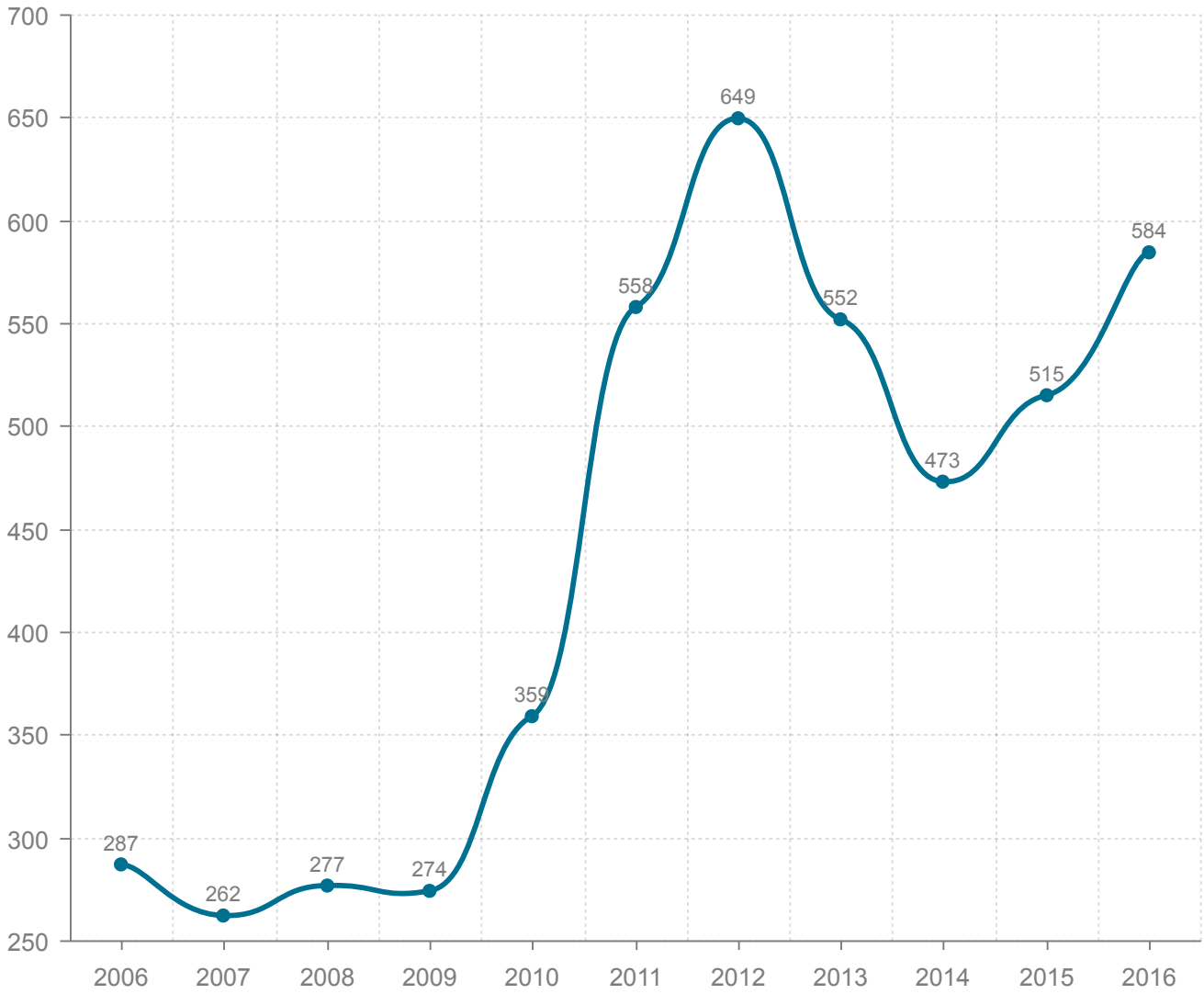
Number of Public-Private scientific co-publications per million population



On the other hand, when analysing **the number of researchers that are employed by the business sector**, an increase of more than 35% was observed in 2011, fluctuating around a mean of 589 researchers from then onward (latest available figure is from 2016). Figure 24 provides a graphical representation of this.

Figure 24

Number of researchers employed by the business sector.



An analysis of the indicator on the number of innovative firms cooperating with public research organisations could not be undertaken since data was not available. Instead, data on the **number of innovative firms cooperating with research organisations** (and not just public ones) was collected. Even in this case, the data is very limited and is only available for 2006, 2008, 2010 and 2014, where it increased from 3 in 2006 to 7 by 2014.

Action Line M: Supporting international collaboration

When analysing the **competitive EU funds attracted by Maltese public organisations for R&I (excluding Structural Funds)**, it was found that in 2016 there was the highest amount of funding awarded through Horizon 2020, amounting to €2,959,273. This showed an increase of almost 75% from the funds that were attracted in the previous year (2015 - €773,802). The latest available figure is that for 2017 and this amounted to €452,026. On the other hand, the highest **number of proposals submitted under H2020 involving Maltese research institutions** was recorded in 2015, with a total number of 81 proposals, followed by 71 in 2016 as well as 53 and 52 proposals in 2014 and 2017 respectively.

The **number of international scientific co-publications per million population** shows that the indicator value in question had risen sharply from 205 in 2010 to 555 in 2016 and now also exceeds the EU average (EU-28 = 493).

Data from the University of Malta and the Malta Aquaculture Research Centre was provided to assess the **number of foreign researchers working in Malta's public research organisations.** The data shows that the indicator value doubled from 2014 to 2017, increasing from 23 to 45 respectively.

Action Line N: Embedding a culture which is supportive of science, research and innovation

A specific survey is to be developed to **assess the public understanding of science**.

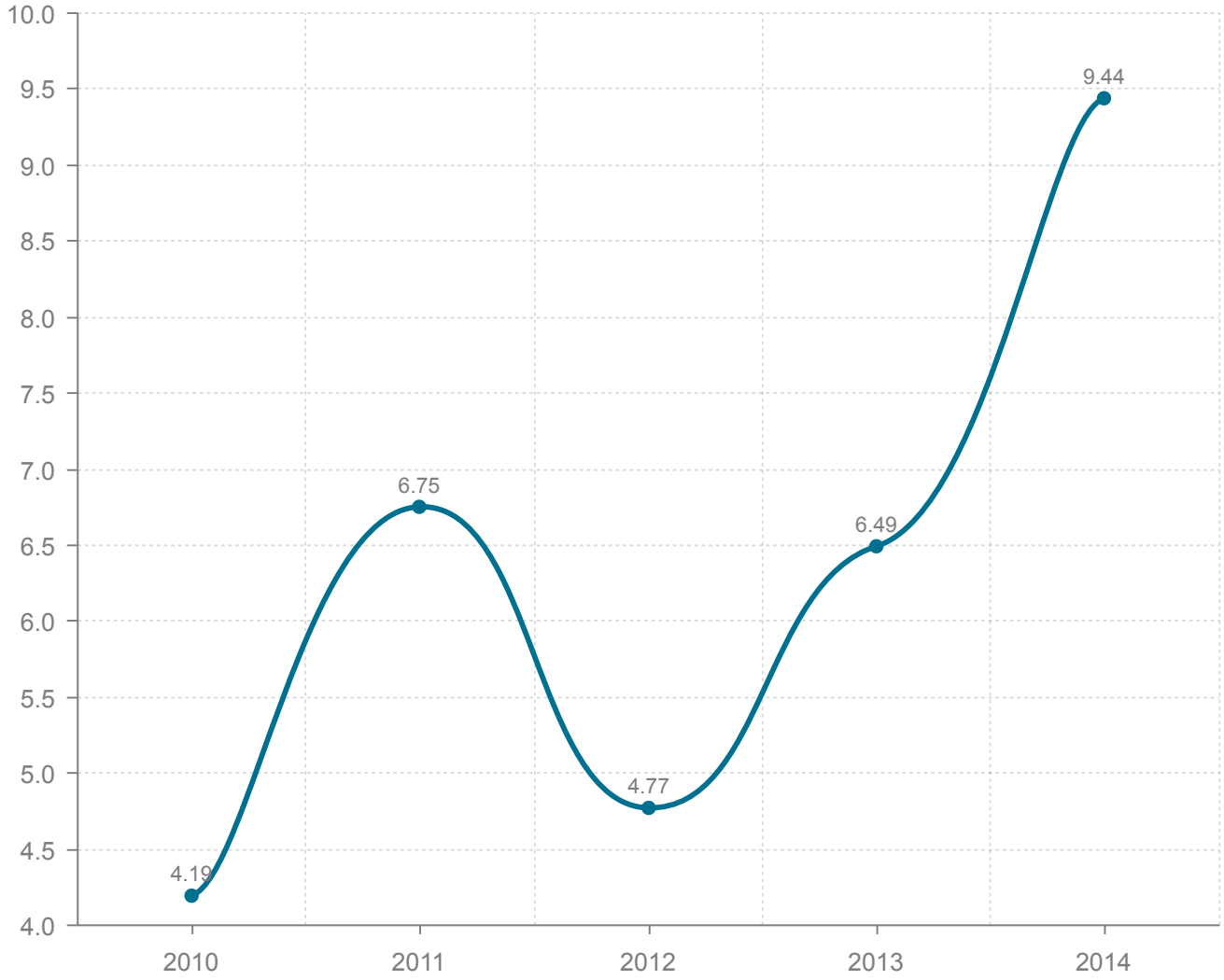
Action Line O: Strengthening local research facilities

In 2014, the **percentage of scientific publications within the 10% most cited scientific publications worldwide** when compared with the total scientific publications of the country, had risen by almost 3% from 2013.

Figure 25 provides a graphical representation of the trend for this indicator.

Figure 25

Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country



Action Line P: Increased international cooperation (infrastructures)

No data was available for the indicator associated with this action line **(rate of access of Maltese researchers to infrastructures part of ESFRI)**. Nevertheless, with regards to Malta's official participation in research infrastructures, it is presently participating in the BBMRI-ERIC[8]and the DARIAH-ERIC[9].

[8] Link: http://www.bbmri-eric.eu/

[9] Link: https://www.dariah.eu/

BBMRI-ERIC is a European research infrastructure for biobanking whilst the DARIAH-ERIC is a pan-European infrastructure for arts and humanities scholars working with computational methods. Although not a member, Malta collaborates with the SHARE-ERIC[10] which surveys health, ageing and retirement in Europe.

Action Line Q: Capacity building for excellence in climate change adaptation

The **number of scientific publications (top tier journals) on climate change as a percentage of total number of publications** was analysed. This indicator data was provided by UM. The figure fluctuated from 0.49% in 2014 to 1.1% in 2015, 0.42% in 2016 and 0.73% in 2017.

Pillar 3: Smart, flexible specialisation

The first step in the analysis of the smart specialisation areas was to pair up the corresponding seven Smart Specialisation Areas (S3) with their relevant NACE codes. The specific NACE codes Rev 2 (down to Section, Division, Group or Class level) identified to correspond to the S3 Areas of the R&I Strategy can be found in Figure 26.

[10] Link: http://www.share-project.org/home0.html

Smart Specialisation (S3)	Corresponding NACE codes
Manufacturing	Section C (Excluding Division 12 Manufacture of tobacco products)
ICT	Section J – Group 58.2; Division 61; Class 62.01; Group 63.1; Class 63.99
Health	Section Q
Resource-efficient Building	Section F Section M - Division 71
Aviation and Aerospace	Section H - Division 51
Tourism Product Development	Section I Section R except Division 92
Maritime Services	Section H - Division 50
Aquaculture	Section A - Class 03.2
Cross-cutting across all smart specialisation areas	Section M - Division 72; Group 74.1; Group 74.9 Section P - Class 85.42

Figure 26: The NACE codes that correspond to the S3 areas

EUROSTAT datasets do not tend to go down to the Group or Class level (which, as can be seen in figure 27, is sometimes required in order to identify a specific S3 area) but instead are mostly found up to the Division or Section level. Therefore, a proxy had to be followed in which mostly the data for each S3 NACE code was retrieved up to the Division or Section Level.

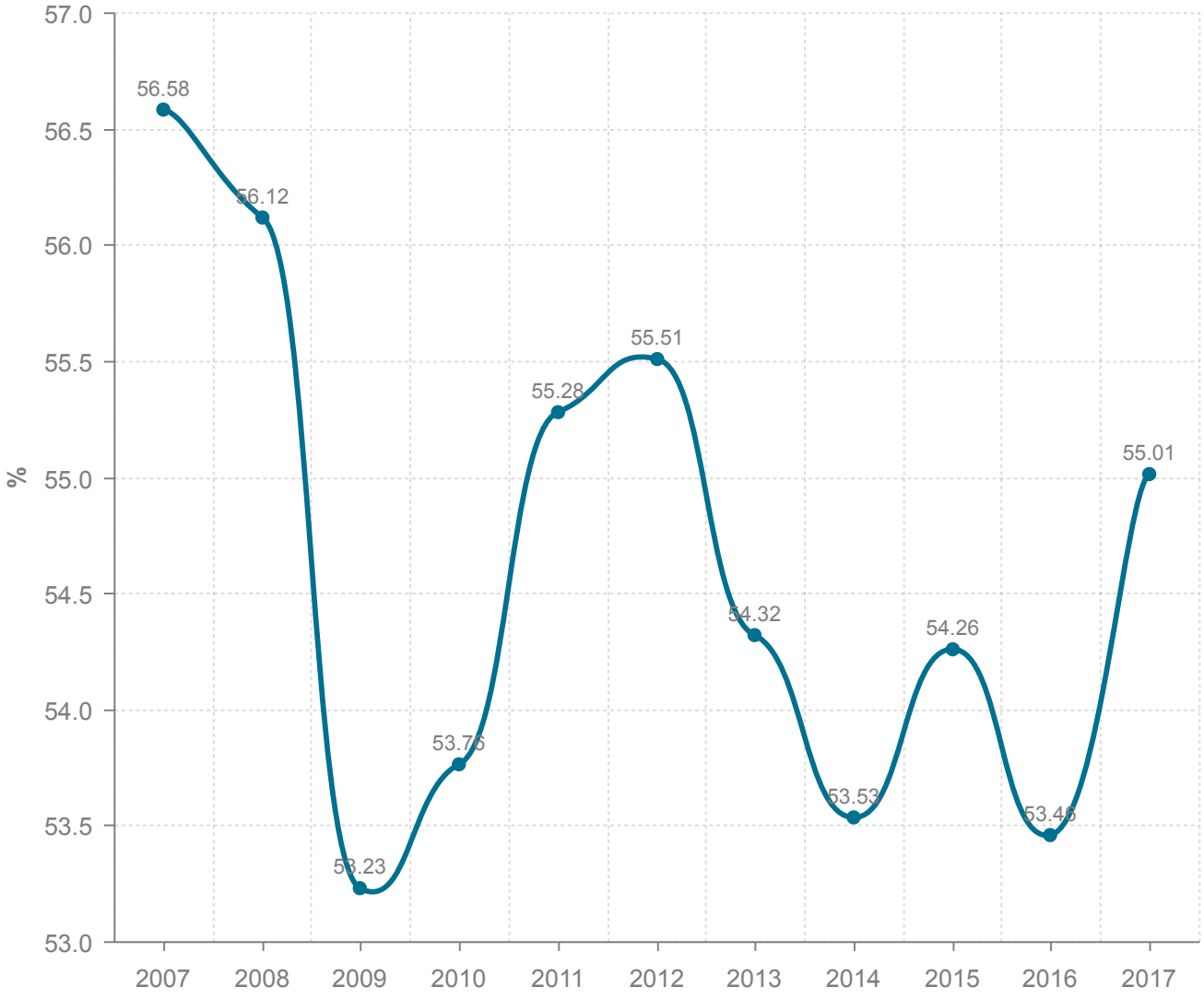
Also, within the Innovation Sector, the S3 area of Health is not included in the CIS data.

Using data from the Structural Business Statistics of the EUROSTAT database, the **value-added in knowledge-intensive activities as a share of total value-added** was found for 2013 and 2015. The indicator value showed an increase of more than 25% in 2015 (€1,573,800).

Figure 27 provides a graphical representation for **value-added in S3 areas as a share of the total value-added.**

Figure 27

Value-added in S3 areas as a share of the total value-added.



The following NACE code data was deemed confidential and thus did not contribute to the value-added figures for the S3 areas:

	2010	2011	2012	2013	2014	2015
Confidential NACE Codes	L,E,D,C,B	N,J,E,D,C,B	E,D,C,B	E,D,C,B	E,D,C,B	E,D,C

Action Line R: ICT as an enabler

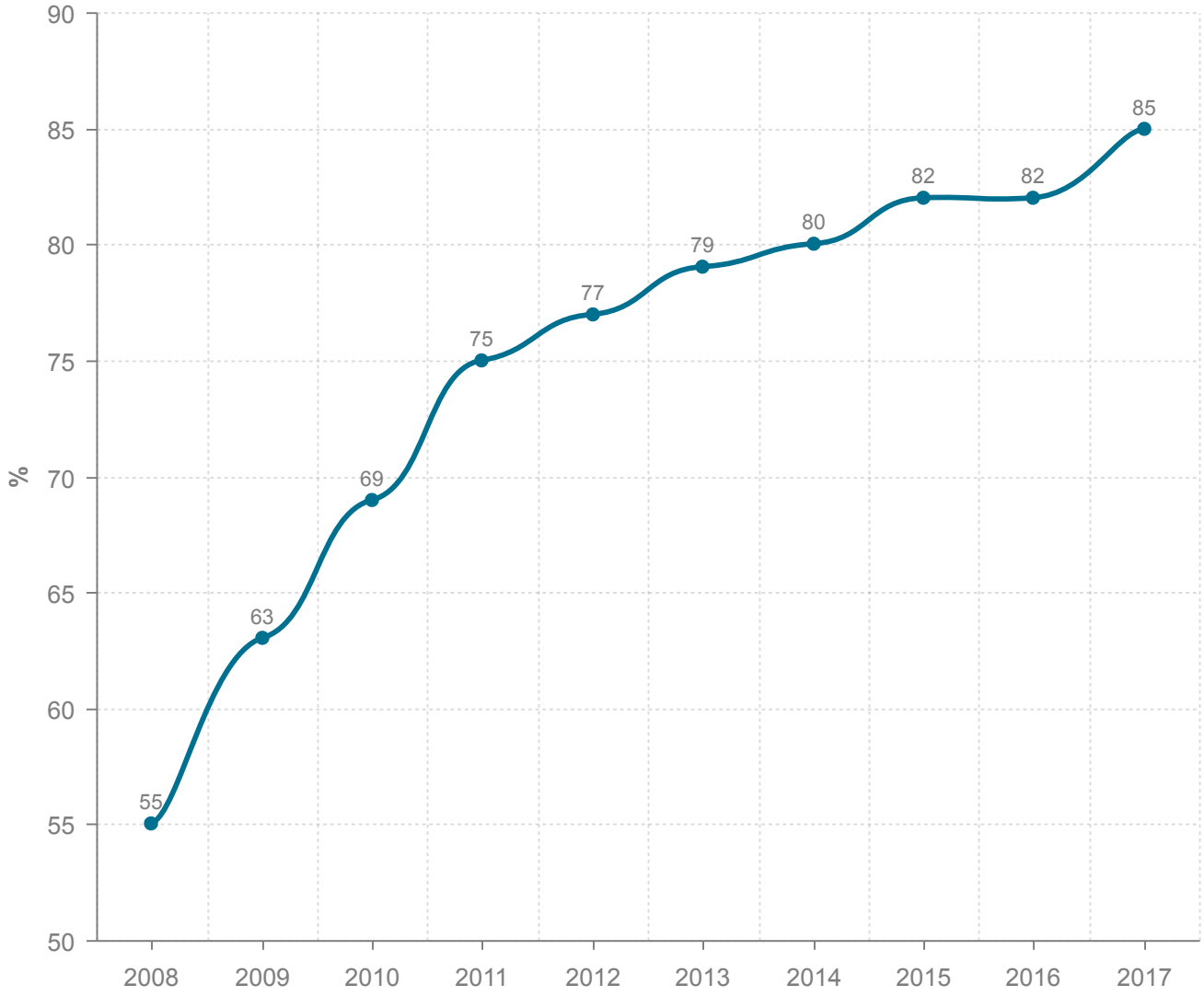
A slight increase (average annual increase of 1%) was observed for the **percentage of SMEs using e-commerce** from 2011 to 2016. During 2013, the number of SMEs engaged in e-commerce solutions had decreased by about 32% from 2012 leading to an overall decrease in the indicator value.

The indicator value for the **percentage of households with access to broadband lines with speed above 10MBps** showed a gradual increase from 55% in 2008 to 85% in 2017 (working on the assumption that all local internet providers are all providing speeds that are higher than 10MBps).

Figure 28 provides a graphical representation of this upward trend.

Figure 28

Percentage of households with access to broadband lines with speed above 10MBps



Action Line S: ICT-based innovation

The methodology for collecting data on the percentage of public funding expenditure allocated to ICT technologies (both in public and private sector) is still being developed.

A gradual increase was observed for the **number of innovative firms in ICT related NACE codes** (the following divisions were taken into consideration – J58, J61, J62 and J63). In fact an average annual increase of more than 25% was observed since 2008 (data set available was for 2008, 2010, 2012 and 2014).

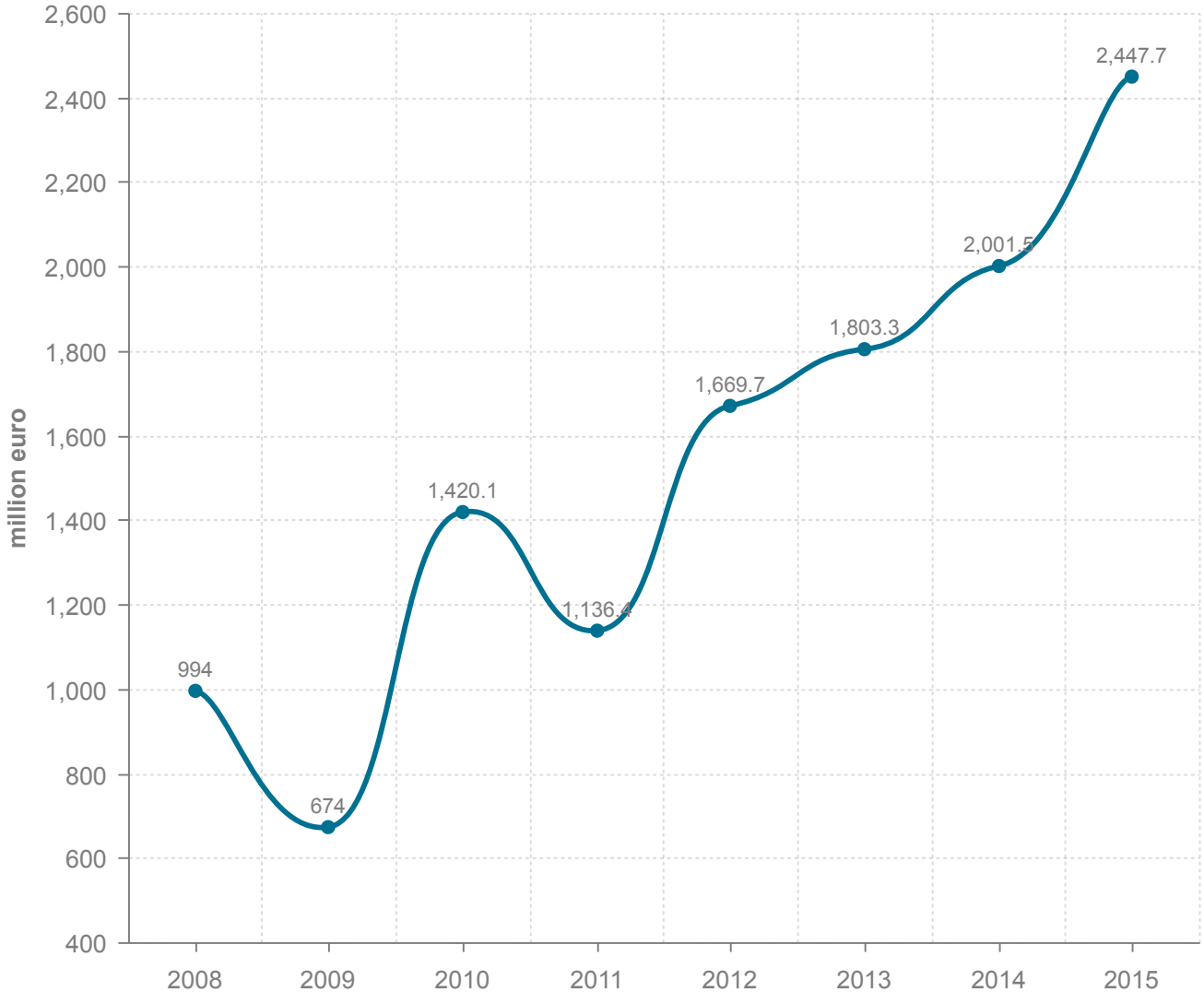
The **share of ICT in EU-funded research projects awarded to Maltese actors** is still very low, with only very small figures recorded in 2014 (0.44%) and 2016 (1.05%).

Action Line T – Z (T: Tourism Product Development; U: Maritime Services; V: Aviation and Aerospace; W: Health with a focus on healthy living, active ageing and e-health; X: Resource-efficient buildings; Y: High value-added manufacturing with focus on processes & design; Z: Aquaculture)

The results for the **value-added in relevant S3 NACE codes** have showed a steady increase since 2008. In fact, figure 29 provides a graphical representation of the upward trend for this indicator.

Figure 29

Value-added in relevant NACE codes (in million euros)



The NACE code data in EUROSTAT for this indicator was only available up to section level. Thus, the following NACE code section data was taken into consideration – J, F, H, I, M. Data for NACE code section C was confidential for all the years analysed, NACE code sections Q and A were not available, whilst data for NACE code sections R and P were not applicable for this indicator. All individual NACE code results recorded a gradual increase in their individual value-added figures since 2008.

The relevant data for the **exports in relevant S3 NACE codes** was only available for 2013 and 2014 (with the 2015 data deemed almost completely confidential). The following NACE code sections were taken into consideration – C excluding Division 12, J, F, H, A and M.

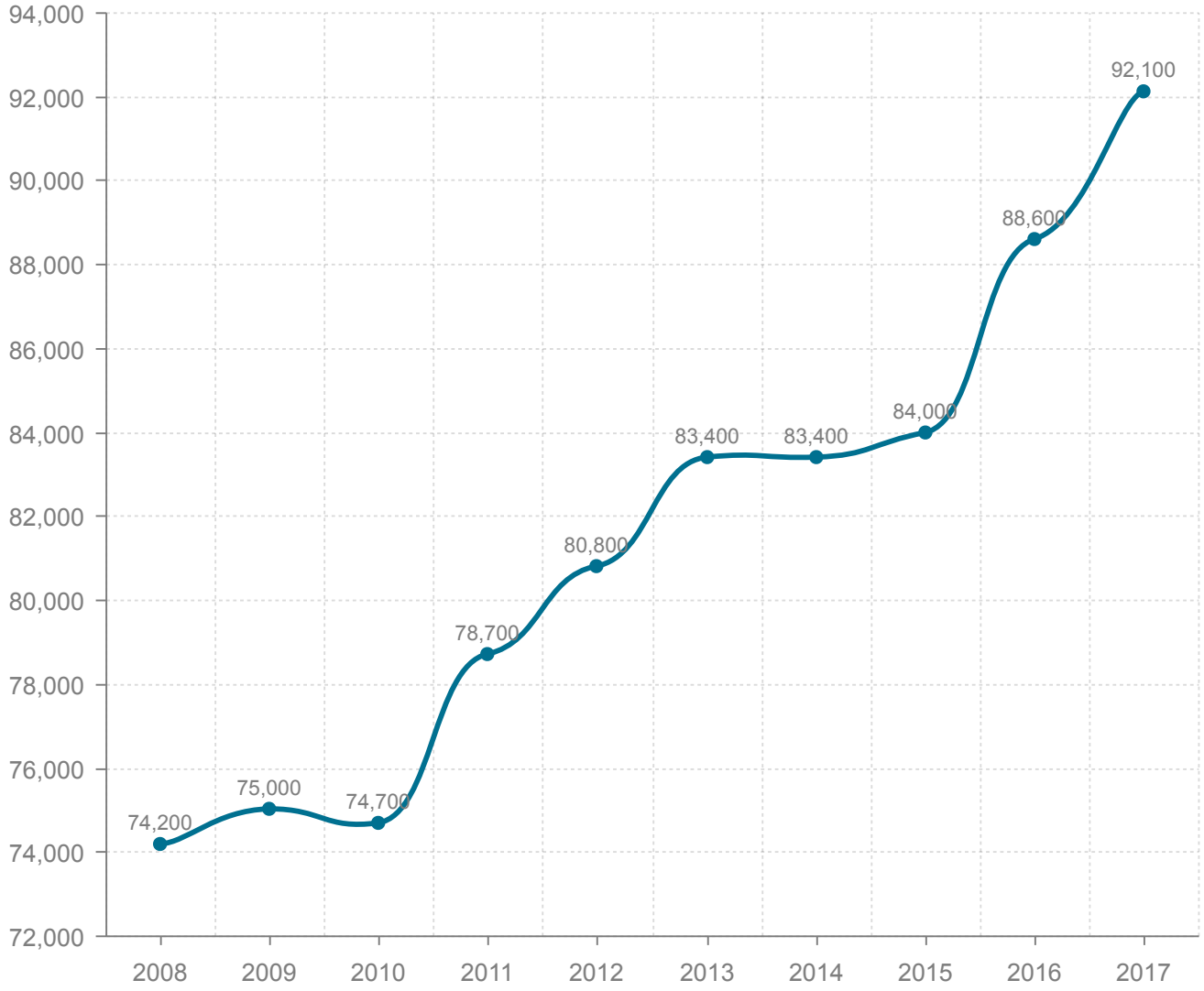
Data for NACE codes sections Q, I and R was not available. The overall indicator value decreased from €1,759,085.81 in 2013 to €1,682,828.25 in 2014. In fact, a decrease in the individual NACE code sections was observed for NACE code sections C (Manufacturing), J, H and A.

The average annual registered increase in the number of **jobs in the relevant S3 NACE codes** was almost 2.5%, increasing from 74,200 jobs in 2008 to 92,100 jobs by 2017. The highest number of jobs recorded in 2017 was in NACE code section C (Manufacturing – 24,300 jobs) whilst the lowest was in NACE code section A (Agriculture, Forestry and Fishing – 2,200 jobs). The following NACE code sections were taken into consideration – A, C, H, I, J, M and Q and R whilst data for NACE code sections F and P was not available.

Figure 30 provides a graphical representation of the trend for this indicator.

Figure 30

Number of jobs in S3 NACE Codes



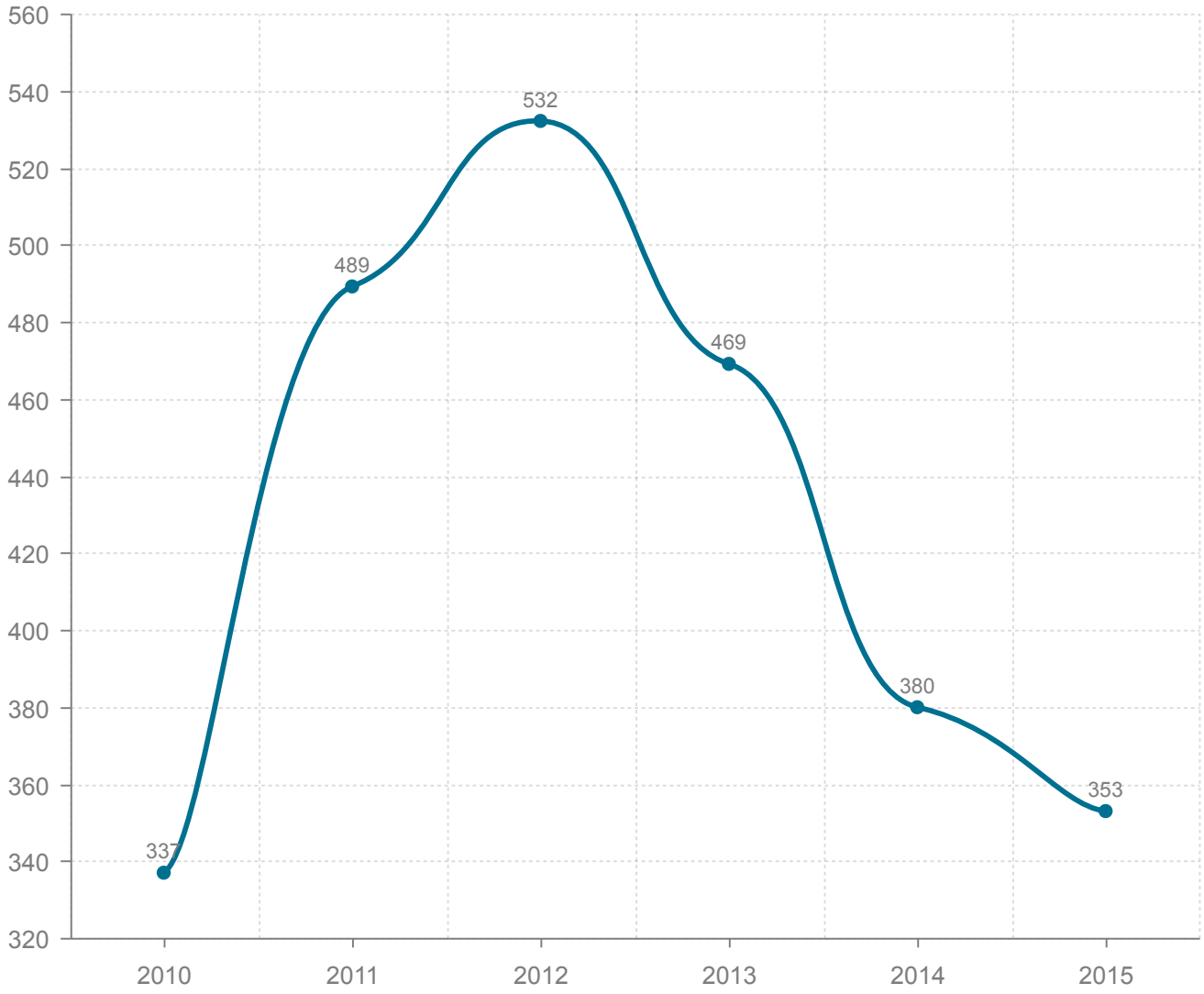
Limited data was available to deduce the **number of SMEs introducing innovation in relevant S3 NACE codes as a percentage of total SMEs introducing innovation**. The indicator value for 2014 was 69.7%. The following NACE codes were taken into consideration – C Division 10-33 excluding Division 12, J, F, H Division 50-51, I, A Division 03, M Division 71-72 and 74 whilst data for NACE code section Q was not available. The **turnover from innovation in relevant S3 NACE codes as a percentage of total turnover** was also recorded at 24.4% in 2014. The main limitation for both indicators is mainly due to the issue of data confidentiality.

When trying to analyse the **number of researchers in relevant S3 NACE codes, split by public and private sector**, Eurostat provided a breakdown according to NACE codes for the private sector only. The following NACE codes were taken into consideration – A, C, F, H Division 50-51, I, J Division 58, J Division 61-63, R, Q, M Division 71-72.

Figure 31 provides a graphical representation, mainly showing a gradual decrease since 2012.

Figure 31

Number of researchers in relevant S3 NACE codes



When looking at individual NACE code data, in 2015, the highest number of researchers in the private sector was observed in NACE code J division 58 (Information & Communication – Publishing Activities) with 252 researchers.

The Table below compares the number of researchers within the individual NACE codes under consideration.

When comparing the number of researchers in the private sector working within the relevant S3 areas as a percentage of total number of researchers in the private sector, it was noted that the value has always been very high, with an average annual value of 86% for 2010 to 2014. A reduction was however observed in 2015, where the indicator value decreased to 69%.

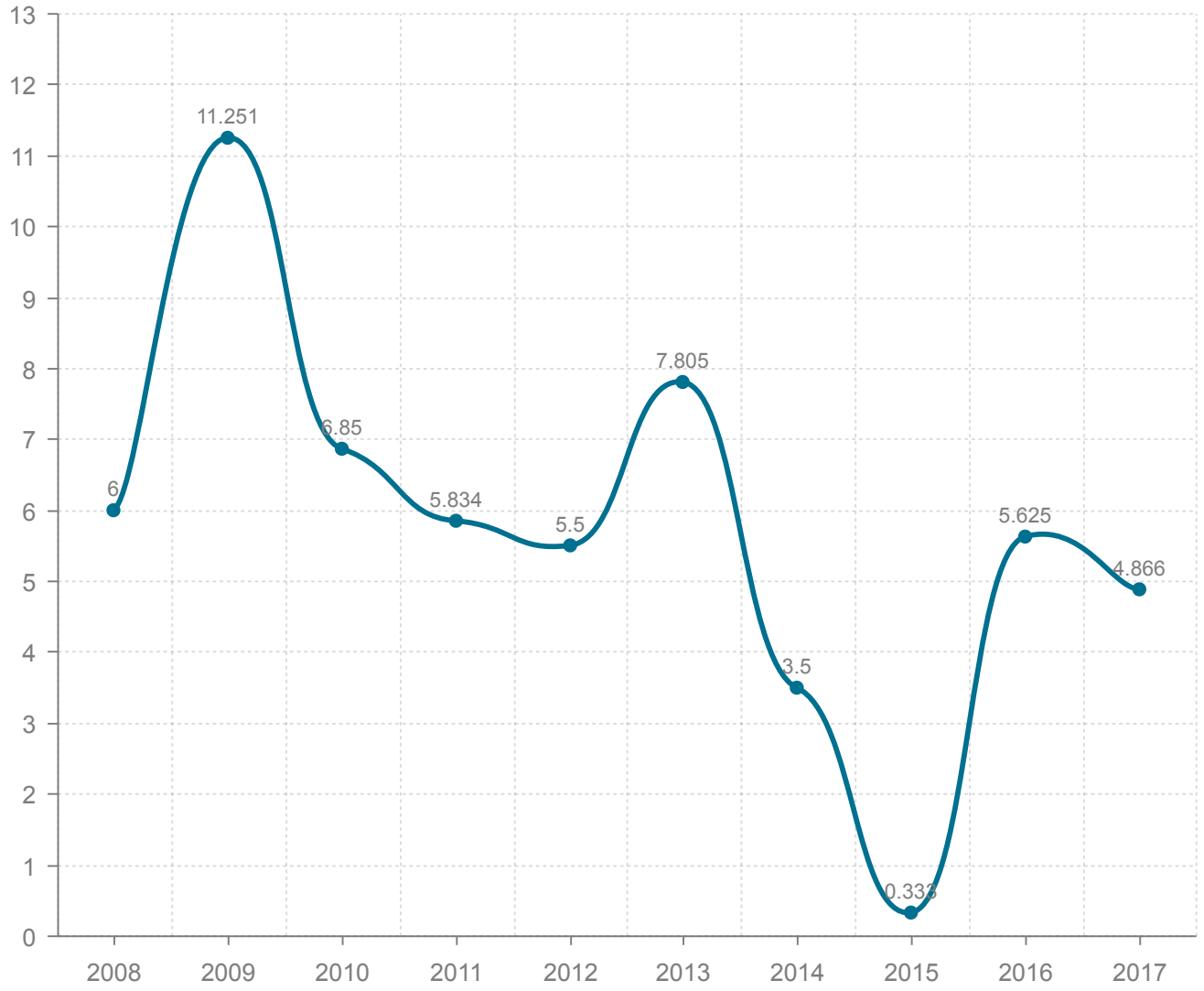
NACE Codes	A	C	F	H51	J58	Q	M71-72
2010	1	144	3	0	163	29	1
2011	2	176	0	5	255	56	2
2012	3	172	7	5	282	75	3
2013	2	179	1	3	243	41	2
2014	3	116	0	5	218	38	3
2015	2	99	0	2	252	38	2

Figure 32: Number of researchers in the private sector within the individual S3 NACE codes (Data for NACE codes – H50, I, J58, J61-63 and R was not included because no researchers were recorded under these NACE codes).

With regards to the **number of patents that were filed under the relevant S3 NACE codes**, figure 33 provides a graphical representation for this indicator .

Figure 33

Number of patents filed in relevant NACE codes



Data for measuring the **Foreign Direct Investment (FDI) in S3 relevant NACE codes** was very limited mainly because of the confidentiality issue that was encountered. In fact, only data for the following NACE codes was available – C, J Division 58, J Division 62-63, F, I, R 90-91, H50, M Division 71-72, M Division 74-75 and P Division 85. Data for NACE codes A, H Division 51 and Q was deemed as confidential. An average annual increase of 5% was observed in the overall indicator figure (in million euros) from 2008 to 2012, with an increase registered in 2017 for NACE codes C (Manufacturing); consolidated result for J58, 62 and 63 (Publishing Activities, Computer Programming, Consultancy and Related Activities' Information Service Activities); F (Construction) and I (Accommodation and Food Service Activities).

A reduction was observed for H50 (Water Transport) and in the consolidated result for M71-72, M74-75 and P85 (Architectural and Engineering Activities – Technical Testing and Analysis; Scientific Research and Development; Other Professional, Scientific and Technical Activities; Veterinary Activities; Education).

Conclusion

Progress towards Headline Indicator Targets

When the National R&I Strategy was drafted, headline indicators were set to monitor the progress of its overall implementation and to follow up on whether certain key blocks of the R&I ecosystem have been addressed and whether Malta's system has improved.

When looking at the second pillar of the strategy, "Investing in a Stronger Knowledge Base", related headline indicators show positive progress. The target set for 2020 for increasing the number of PhD holders in Malta has already been achieved and the number of researchers in full time equivalents (FTEs) has progressed with Malta being close to achieving its set target. This could indicate that Malta has invested more in its human resources and in building more capacity for research.

Unfortunately, Malta's expenditure in both R&D and innovation has remained more or less stable over the past few years since the Strategy's launch, and it is unlikely that Malta will achieve its targets for 2020. The same can be said for the indicator measuring employment in knowledge intensive activities.

A growing concern is the trend observed in the indicator figures for the percentage of enterprises with innovation activity and enterprises with innovation activity in the core NACE codes. Since 2012, the figures for these indicators are on the decline, and the targets set for 2020 will not be achieved in time.

Pillar 1: A Comprehensive R&I Ecosystem

Improvements have been made when considering the steps taken on evaluation and monitoring the system. The culture for supporting innovation, creativity and risk taking has started to evolve in certain aspects, for example, progress has been noted in the quality of research institutions. However, more needs to be done to diversify the workforce, invest in cluster development, and multi-stakeholder collaborations. Initiatives need to be revisited in order to leverage foreign investment in R&D activities in Malta. Malta needs to continue investing in leveraging private financing from industry, and fostering stronger industry-academia collaborations and public-private partnerships to further knowledge transfer and strengthen our participation on an international level.

Pillar 2: A Stronger Knowledge Base

As stated above, progress has been achieved in terms of human capital and capacity building for researchers. This is also reflected in the increased number of scientific publications within the 10% most cited scientific publications worldwide, showing an improvement in research quality. However, Malta must continue to invest in an education system that supports STEM and human capacity in R&I at all levels of education, strengthen knowledge transfer, support more international collaboration, strengthen our local research facilities and overall, embed a more dynamic culture which is supportive of R&I.

Conclusion

Pillar 3: Smart, Flexible Specialisation

The issue of data confidentiality proved to be the major obstacle in the analysis of pillar three. Discussions with NSO were undertaken on this matter, however, due to the level of sensitivity of the microdata, certain data was omitted in order to secure the anonymity of the stakeholders that provided the data. Moreover, data in the EUROSTAT database is only provided up to the NACE code section or division, thus it was not always possible to assess the data in relation to the identified NACE codes. Due to the limited data available for each smart specialisation area, it is problematic to come to a robust conclusion regarding the progress or achievements for each relevant thematic area. The fact that structural funds linked to this pillar only started being disbursed in late 2018 or early 2019 adds another layer of difficulty. Despite these issues, it can be noted that the overall value-added in million euros in the smart specialisation areas has been increasing steadily and the number of jobs in the relevant NACE codes has also increased slightly.

Recommendations for the Monitoring System

This initial monitoring report has laid a solid foundation for future monitoring reports, however, it is not without its limitations. Data collection was one of the main issues encountered. As discussed in previous chapters, NSO's commitment to data confidentiality was an obstacle due to the issue of anonymised microdata; since the small numbers could easily lead to the identification of respondents. Moreover, data on Innovation Activities of Microenterprises was lacking, since the Community Innovation Survey (CIS), a main data source for this report, does not collect data on microenterprises.

Furthermore, data on Health as a Smart Specialisation area is not collected in the CIS. Overcoming this issue would entail developing new methods to collect data in this sector.

In light of these factors, an online data collection system was devised whereby data sources were able to fill in the requested information through a customised online link, as well as store retrospective data. However, at the time of data collection for this monitoring report, this online system was still in its preliminary stages and will be used to its full potential in future monitoring reports.

Another shortcoming of this report is that the data was not interpreted or extrapolated to identify recurring trends. This will be explored further in future reports.

Conclusion

On a different note, with regards to Action Line C, the PSF monitoring exercise had recommended that the amount of public funds spent on public procurement for innovation would be a suitable indicator to analyse Action Line C. However, further to consultations with the Department of Contracts, it results that to date, Malta has not carried out any Innovation Partnership Procurement [11]. Therefore, no statistics are currently available relating to this indicator.

Additionally, more bespoke indicators will need to be developed in order to ensure that Action Line A is being effectively monitored. The PSF monitoring exercise had suggested that a dedicated business survey could also be designed to assess, amongst other issues, the rate of satisfaction from businesses with respect to the existing innovation support system present. Future collaborations with other stakeholders such as the NSO and the Malta Chamber of Commerce will be sought to facilitate the data collection exercise for such a dedicated survey.

The PSF monitoring exercise had also suggested that an indicator on the analysis of the revenues from sales of R&D by public research organisations is included in the report as a key indicator. However, since the only registered public research organisation in Malta is the Malta Aquaculture Research Centre, the amount of data for this indicator is very limited and thus for the time being, it will not be recorded within the monitoring system.

With regards to the indicator for Action Line N it was suggested that a specific survey is developed to assess the public understanding of science. This suggestion will be discussed with ESPLORA during the next 12 months so that any related data will be collected and presented in the next Monitoring Report.

Another possible recommendation can be made with regards to Action Line R: ICT as an enabler. More appropriate indicators should be developed in order to provide a better picture of ICT as an enabler. The indicator value for the percentage of households with access to broadband lines with speed above 10MBps was used as a proxy in the absence of the appropriate data. New indicators will be developed for this Action Line supported by the design of a specific data capture exercise.

Data on the number of researchers in the public sector was not collected since EUROSTAT, the data source for this indicator, did not provide data according to the respective NACE codes on public sector researchers. Therefore devising a data collection method for the number of public sector researchers could be another possible recommendation for future monitoring reports.

[11] The term that is referred to in the Public Procurement Regulations LN 352 of 2016, whereby a Contracting Authority, once it receives the necessary approvals from the Director of Contracts, may utilise the Innovation Partnership Procurement procedure to procure products / services / works that are not readily available on the market.

Conclusion

An overarching recommendation that emerged from this monitoring report is that it would be beneficial to develop alternative data collection methods as well as new indicators regarding Smart Specialisation areas that reflect the reality of research, development and innovation activities in Malta. From the data collected for this report, it was observed that all individual NACE code activities in Malta recorded a gradual increase in their value- added figures in the past decade, meaning that there is potential for further growth. However, sufficient evidence is required to provide an exhaustive analysis of the Smart Specialisation areas within the National R&I Strategy and MCST will look into this for future monitoring reports.

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[13] Data set is no longer available, and data has been incorporated into other data sets.

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Annex 1 - Data Sources

Data sources for indicators in Chapter 2

Indicator	Source
Gross R&D expenditure as a percentage of GDP	Gross R&D Expenditure – EUROSTAT Database: Intramural R&D expenditure by sectors of performance GDP – NSO website
Number of PhD holders as a percentage of active population	Number of PhD holders – provided directly by NSO Active population – EUROSTAT Database: Labour Force Survey -> Employment and activity by sex and age
Number of researchers (expressed in full-time equivalents- FTEs)	EUROSTAT Database: Total R&D personnel by sectors of performance, occupation and sex
Innovation expenditure as a percentage of GDP	Innovation expenditure – EUROSTAT Database: Community Innovation Survey (CIS) on Innovation activities and expenditures GDP – NSO website
Employment in knowledge-intensive activities as a percentage of total employment	Employment in knowledge-intensive activities – EUROSTAT Database: High tech industry and knowledge intensive services -> employment in technology and knowledge-intensive sectors at national level Total employment – EUROSTAT Database: Labour Force Survey
Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation) as a percentage of total enterprises	CIS -> Enterprises by main types of innovation (choosing 'Innovative and non-innovative enterprises' under 'Breakdown by type of innovator'. For the 2012 and 2014 CIS data, it was assumed that the total number of enterprises is equal to the number of innovative and non-innovative enterprises
Enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation) in the Core NACE codes as a percentage of total enterprises	CIS -> Enterprises by main types of innovation (choosing the sum of the Core NACE codes data)

Annex 1 - Data Sources

Data sources for indicators in Chapter 3

Indicator	Source
Private R&D expenditure	EUROSTAT database: R&D expenditure at national and regional level -> Intramural R&D expenditure (GERD) by sources of funds and sectors of performance
Total expenditure in innovation	CIS -> Innovation activities and expenditure
Number of researchers (Full Time Equivalents FTEs) per thousand labour force working within the private sector	Number of researchers (FTEs) – EUROSTAT Database: Total R&D personnel by sectors of performance, occupation, sex Labour Force – EUROSTAT Database: (Labour Force Survey) Employment and activity by sex and age-annual data
Share of high-tech exports versus total exports	EUROSTAT table: High-tech exports (% of exports)
Number of SMEs involved in R&D and innovation projects	Assumption – in relation to innovation data, microenterprises (0-9 employees) are not included. Small enterprises are defined as those having 10-49 employees and Medium enterprises as those having 50-249 employees CIS -> Basic economic information on enterprises
Funding support provided by Government towards R&D expenditure within the private sector	EUROSTAT database: R&D expenditure at national and regional level -> Intramural R&D expenditure (GERD) by sources of funds and sectors of performance
Amount of R&D spent by local companies because of the leveraging of funds from foreign firms	EUROSTAT Database – R&D expenditure at national and regional level -> Total intramural R&D expenditure by sectors of performance & source of funds (source of funds – Abroad)

Annex 1 - Data Sources

Data sources for indicators in Chapter 3

Indicator	Source
Private funds spent by foreign companies in Malta as a percentage of the total business R&D expenditure in Malta	Private funds spent by foreign companies in Malta – EUROSTAT Database: Intramural R&D expenditure by sectors of performance and source of funds. Assumption: includes both the funds spent in-house by mother company to its subsidiary company in Malta as well as the funds spent by foreign companies to non-linked Maltese companies
Number of companies that were involved in Government subsidised collaborative projects at MCST	Data obtained directly from FUSION, MarTERA and ERANETMED programme managers at MCST
Number of formalised commitments taking place between public research organisations and business firms	Data directly obtained from University of Malta and the Malta Aquaculture Research Centre
Number of spin-off companies	Data directly obtained from University of Malta
Number of patent applications to the European Patent Office (EPO) with foreign co-inventors by priority year	EUROSTAT Database: Patent -> Patent applications to the EPO by priority year -> Ownership of inventions in EPO applications at national level -> Patent applications to the EPO with foreign co-inventors, by priority year
Share of publications available in Open Access mediums as a percentage of total publications	Data directly obtained from University of Malta
Percentage of public funding for R&D performed by the business sector	EUROSTAT Database: Total intramural R&D expenditure by sectors of performance and source of funds
The amount of private funds leveraged by public funding schemes for enterprises involved in R&D	Data directly obtained from FUSION, ERANETMED and Malta Enterprise Programme managers. The co-financing percentage provided by the private enterprises was requested
EU funds being attracted by Maltese private entities to undertake R&I (apart from Structural Funds)	Obtained directly from CORDIS
Number of Maltese companies participating in Horizon 2020	Obtained directly from CORDIS

Annex 1 - Data Sources

Data sources for indicators in Chapter 3

Indicator	Source
Number of tertiary graduates in STEM per 1000 population aged 20-29	EUROSTAT database: Population and Social Conditions -> Science and Technology graduates by sex
Number of researchers working within the Government sector and the Higher Education sector (mainly public sector)	EUROSTAT database: Total researchers by sectors of performance
Graduates that are conducting R&D activities in the private sector as opposed to the Government sector	EUROSTAT database: Total researchers by sectors of performance
Amount of public R&D financed by the private sector	EUROSTAT database: Total intramural R&D expenditure by sectors of performance and source of funds
Number of researchers that are employed by the business sector	EUROSTAT database: Total R&D personnel by sectors of performance, occupation and sex
Number of innovative firms cooperating with research organisations	CIS -> Types of cooperation of enterprises by NACE Rev2 activity and size class
EU funds attracted by Maltese public organisations for R&I (excluding Structural Funds)	Obtained directly from CORDIS
Number of proposals presented to H2020 involving Maltese research institutions	Obtained directly from CORDIS
Number of foreign researchers working in Malta's public research organisations	Obtained directly from University of Malta and the Malta Aquaculture Research Centre
Value-added in knowledge-intensive activities as a share of total value-added	EUROSTAT Database: Structural Business Statistics -> Annual enterprise statistics for special aggregates of activities (Economical indicator for structural business statistics – Value added at factor cost million euro; Classification of economic activities NACE Rev2 – Non-financial knowledge-intensive activities business industries)
Value-added in S3 areas as a share of the total value-added	EUROSTAT Database: Structural Business Statistics -> Value-added by NACE Rev2

Annex 1 - Data Sources

Indicator	Source
Percentage of SMEs using e-commerce	EUROSTAT Database: Science, Technology and Digital Society -> Digital economy and society -> ICT usage in enterprises -> e-commerce sales Total number of SMEs – EUROSTAT Database: Structural Business Statistics -Annual enterprise statistics by size class for special aggregates of activities
Percentage of households with access to broadband lines with speed above 10MBps	EUROSTAT Database: Science, Technology and Digital Society -> Science and Technology -> Digital economy and society -> ICT usage in households and by individuals -> Connection to the internet and computer use
Percentage of public funding expenditure allocated to ICT technologies (both in public and private sector)	Obtained directly from FUSION programme manager and University of Malta
Number of innovative firms in ICT related NACE codes	CIS: Enterprise by main types of innovation (the following NACE codes were chosen – J58, J61, J62, J63)
Share of ICT in EU-funded research projects awarded to Maltese actors	Obtained directly from CORDIS
Value-added in relevant S3 NACE codes	EUROSTAT Database: Structural Business Statistics -> Value added by NACE Rev2 (The following NACE codes were taken into consideration – C, J, H, I, M; data for the following NACE codes were not available – Q, R, A)
Exports in relevant S3 NACE codes	EUROSTAT Database: International Trade -> International trade in goods – trade by enterprise characteristics -> Trade by NACE Rev2 and enterprise size class (Change stock or flow to export and geographical entity to all countries in the world)(The following NACE codes were taken in to consideration – all C excluding 12, J, F, H, A, M; data for the following NACE codes was not available – Q, I, R)
Jobs in the relevant S3 NACE codes	EUROSTAT Database: Population and Social Conditions -Labour market -> Employment -> Employment by sex, age and economic activity(The following NACE codes were taken in to consideration – A, C, H, I, J, M, Q, R)

Annex 1 - Data Sources

Data sources for indicators in Chapter 3

Indicator	Source
Number of SMEs introducing innovation in relevant S3 NACE codes as a percentage of total SMEs introducing innovation	Data obtained directly from NSO
Turnover from innovation in relevant S3 NACE codes as a percentage of total turnover	EUROSTAT Database: Turnover by NACE Rev 2 (Table)
Number of researchers in relevant S3 NACE codes (private sector)	EUROSTAT Database: Total R&D personnel & researchers in business enterprise sector by NACE Rev2 activity & sex (The following NACE Codes were taken in to consideration – A, C, F, H50, H51, I, J58, 61, 62, 63, R, Q, M71,72)
Number of patents that were filed under the relevant S3 NACE codes	EUROSTAT Database: Patent applications to the EPO by priority year, by NACE Rev2 Activity
Foreign Direct Investment (FDI) in S3 relevant NACE codes	EUROSTAT Database: Balance of payments -> International transactions -> European Union direct investments -> EU direct investment positions, breakdown by country & economic activity (NACE Rev 2)(The following NACE codes were taken into consideration - C, J58, J62, J63, Q, F, H51, I, R90, R91, H50, A, M71, M72, M74-75, P85; data for the following NACE codes was confidential Q, H51, A)

Annex II - Glossary of Terms

Active population is the sum of employed and unemployed persons. Economically inactive persons, such as students and pensioners are not included.

Knowledge-Intensive Services (KIS) are defined in the following economic activity sectors (EUROSTAT definition):

- High-tech knowledge-intensive services:
- Motion picture, video and television programme production, sound recording and music publishing activities (59);
- Programming and broadcasting activities (60);
- Telecommunications (61);
- Computer programming, consultancy and related activities (62);
- Information service activities (63); Scientific research and development (72).

- Knowledge-intensive market services (excluding financial intermediation and high-tech services):
- Water transport (50); Air transport (51);
- Legal and accounting activities (69);
- Activities of head offices; management consultancy activities (70);
- Architectural and engineering activities; technical testing and analysis (71);
- Advertising and market research (73);
- Other professional, scientific and technical activities (74);
- Employment activities (78); Security and investigation activities (80).

- Knowledge-intensive financial services
- Financial service activities, except insurance and pension funding (64);
- Insurance, reinsurance and pension funding, except compulsory social security (65);
- Activities auxiliary to financial services and insurance activities (66).

- Other knowledge-intensive services:
- Publishing activities (58);
- Veterinary activities (75);
- Public administration and defence, compulsory social security (84);
- Education (85); Human health activities (86);
- Residential care activities (87);
- Social work activities without accommodation (88);
- Creative, arts and entertainment activities (90);
- Libraries, archives, museums and other cultural activities (91);
- Gambling and betting activities (92);
- Sports activities and amusement and recreation activities (93).

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About MCST

The Malta Council for Science and Technology (MCST) is the governmental body responsible for Research and Innovation (R&I), space, science and technology. MCST was established by central government in 1988 with the mandate of advising government on science and technology policy. Today its remit has developed and expanded to include responsibilities associated with R&I policy and strategy, science communication, as well as the management of various R&I programmes. It presently falls under the remit of the Parliamentary Secretariat for Financial Services, Digital Economy and Innovation within the Office of the Prime Minister.

MCST provides policy advice to government on local as well as EU developments, whilst it represents government in various EU fora related to R&I. It is also responsible for developing the national strategy on R&I, in collaboration with stakeholders. Furthermore, responsibilities extend to the management and administration of various R&I Programmes funded by Central Government, primarily FUSION: The R&I Programme.

It is an active member of a number of internationalisation initiatives, most notably PRIMA (Partnership for Research and Innovation in the Mediterranean Area) as well as other transnational joint actions and ERA-NETs.

Being the National Contact Organisation for relations with the European Space Agency (ESA), MCST has worked closely with ESA to create capacity-building opportunities within the local sector. These include the National Space Fund composed of educational and research funding streams. Through its relationship with Eurisy, as well as bilateral agreements with foreign space agencies, MCST continues to build on the internationalisation of local space research.

As the National Contact Point Organisation for the EU Framework Programme, Horizon 2020, MCST is responsible for creating awareness and providing hands-on support to local researchers and entities to actively participate in the Programme. Malta's priorities are also represented at EU level through the Programme Committee Members established for each area of Horizon 2020. MCST also manages and provides support for Malta's participation in COST – an intergovernmental organisation for European Cooperation in Science and Technology, which provides funding for the creation of research networks.

Within its science communication remit, MCST is responsible for the operations of the national interactive science centre, Esplora. Suited to visitors of all ages, it offers a highly enjoyable experience in a safe and friendly environment. Esplora features over 200 indoor and outdoor interactive science exhibits, hands-on workshops and engaging science shows.

The aim of Esplora is to make visitors aware that science is all around them and that they already use scientific reasoning and skills within their daily activities, including making science-based choices continuously. Esplora adopts an inquiry-based learning approach, whereby science investigations are fun, relevant, interactive and engaging Esplora aspires to cultivate a culture of scientific curiosity and creativity by igniting a passion for questioning, investigation and discovery by encouraging staff and visitors to Explore, Think and Imagine. The iconic colour space 4K theatre Planetarium, projects full-dome films and presenter-led live shows about the Earth and the Moon, the planets and the whole solar system, adventures in space, and also life here on Earth.Esplora Interactive Science Centre was part-financed by the European Union through the European Regional Development Fund.

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