



Specific Support to Slovenia Internationalisation of the science base and science-business cooperation

Horizon 2020 Policy Support Facility



Research and
Innovation

Specific Support to Slovenia – Internationalisation of the science base and science-business cooperation

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Specific Support to Slovenia

**Internationalisation of
the science base and
science-business
cooperation**

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THE PSF EXPERT PANEL

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The expert team was supported by **Maja Bučar** (University of Ljubljana) who prepared the background report. The experts were also supported by the PSF Team comprising project manager **Nikos Maroulis**, (Technopolis Group) and the Commission services (DG Research and Innovation, Unit A4 – ‘Analysis and monitoring of national research policies’) with **Andrea Hajas** as the contact point from DG Research and Innovation, who coordinated the exercise and ensured liaison with the Slovenian authorities. **Kimmo Halme** (4Front) carried out the quality review.

KEY POLICY MESSAGES

Slovenia has already reached a comparatively good position in research and innovation (R&I), especially in relation to some of its peers in central Europe. However, benchmarking in the latest European Innovation Scoreboard (EIS) still shows a gap vis-à-vis the most advanced Member States known as “innovation leaders”. According to the EIS, Slovenia is part of the second group, referred to as “strong innovators”. As the countries in this group strive to catch up with the leading group, Slovenia’s R&I policy system is being constantly challenged to upgrade both its system and its institutions, adapting the policy where needed and trying to learn from successful experiences in other countries. Two areas stand out as particularly relevant for Slovenia’s R&I system to catch up with the “innovation leaders”: the continued internationalisation of the science and research system and the fostering of science-industry links.¹

These two areas have been chosen by the Slovenian authorities as the focus of the support they requested from the Horizon 2020 Policy Support Facility (PSF). An independent panel of experts was appointed by the Commission (Directorate-General for Research and Innovation) to provide the PSF support. The starting point of the PSF project was a thorough analysis of the current situation and important recent developments in the Slovenian R&I system, published as a PSF background report (Bučar 2017). The PSF panel then produced its assessment of the Slovenian R&I system through a workshop with Slovenian experts and policymakers in Brussels (in December 2016) and an extensive three-day visit in February 2017. During a second two-day visit to Slovenia in May 2017, the panel discussed its preliminary findings and recommendations with the Slovenian government and major stakeholders. Through this process, the panel was able to identify the positive aspects and achievements of the Slovenian R&I system while also distilling the core challenges Slovenia is facing which must be overcome to improve the current situation.

On the one hand, it must be stressed that Slovenia’s economy has benefited from a general upgrading over the last decades reflected in the comparatively high GDP per capita which was reached. The Slovenian economy is an already R&D-intensive and advanced modern economy with a prominent industrial base, including significant medium- and high-tech segments (e.g. automotive sector, machinery) and a strong export orientation. Such significant development would not have been possible without competitive firms and a highly skilled workforce. Besides this generally positive picture of the economy, there are many signs of a modern, excellent scientific system, as documented in its good publication output and a very active and successful involvement in the European Union’s (EU) Horizon 2020 programme. The present situation regarding Slovenia’s R&I system shows a considerably high degree of sophistication characterised by an academic

¹ Additional empirical evidence is also provided in the background report by Bučar (2017).

system striving for international excellence and an innovative business sector, which is orientated towards international (especially European) markets.

On the other hand, there is still a considerable gap in relation to European innovation leaders, notably in the areas of internationalisation and links between academia and the business sector. Based on empirical analyses and the information gathered during our country visits, four key challenges were identified:

- First, the Slovenian R&I system is facing **governance problems** as a result of previous instability and discontinuity combined with policy fragmentation. Governing institutions, such as responsible ministries and agencies, have been reorganised several times leading to a complex and instable policy framework, while the public budget for R&D has been severely reduced since 2011.
- Second, Slovenia's role within the **process of internationalisation is being hindered** by difficulties in attracting talented researchers from abroad.
- Third, to some degree there is a **mismatch between the activities of the academic sector and the business sector**. Slovenia boasts a modern, fully-fledged academic system covering a wide range of disciplines and thematic fields. Given the limited size of its economy, there is no demand for scientific services for all of these thematic fields. To make things worse, major parts of the business sector are characterised by a limited absorptive capacity (e.g. financial and personnel resources, know-how, etc.) to engage intensively in cooperative research. This is particularly true for long-term strategic research cooperation.
- Fourth, the Slovenian **start-up ecosystem is still in its infancy**. Start-ups constitute one avenue increasingly being used to commercialise new ideas (often originally created or supported by new academic knowledge and technologies). Thus, universities and Public Research Organisations (PROs) often function as incubating sources for innovative start-ups. However, in Slovenia the start-up ecosystem is not yet fulfilling this role properly. Thus, jump-starting and supporting the start-up system requires a sustained and systemic approach with various measures and instruments.

To tackle these challenges, Slovenia needs adequate reforms in the structure, governance and functioning of the R&I system. Based on its analysis of these main challenges, the PSF panel developed 10 distinct policy recommendations. In the box below, these recommendations are grouped along four overarching themes, which define the areas of major policy intervention:

- **Improving governance:** Although questions of governance were initially not at the heart of its mandate, the panel identified certain governance problems as key obstacles to be overcome to improve the situation in the two focus areas. In particular, issues like instabilities and discontinuities within the R&I governance system (e.g. new ministerial divisions of competences, changing the structure of agencies) and within policy instruments and funding schemes have led to inefficiencies within the system and created uncertainty for relevant stakeholders (e.g. regarding their strategic planning horizons). In

addition, improving the overall quality of the governance of the R&I system will involve strengthening the administrative structures and equipping them with sufficient personnel resources. It will also be important to incentivise universities and PROs to adapt their statutes and by-laws and improve the effectiveness and flexibility of their internal regulations.

- **Attracting talent and opening the science system:** Universities should become full legal entities and gain more autonomy and room for their strategic decisions. Specific performance agreements between the MESS (Ministry of Education, Science and Sport) with universities and PROs should include a new system of key performance indicators (KPIs), ensuring accountability as a counterpart of autonomy. These indicators should notably 'nudge' universities and PROs towards internationalisation and increasing their involvement in entrepreneurial activities (i.e. cooperative research with the business sector, fostering academic spin-offs, etc.). To attract excellent talent internationally, it is quintessential to reduce any language barriers still existing in teaching and research. Therefore, we advise that English be used as the teaching language on a more regular basis. In addition, the traditional habilitation system should be progressively replaced by a modern tenure track system. To foster the mobility of talent between academia, PROs and the business sector, the young researchers' science-business mobility programme should be restarted.
- **Fostering links between academia and business:** By reinforcing the innovation cluster policy, long-term sustainable research cooperation between science and industry should be stimulated using the Strategic Research and Innovation Partnerships (SRIPs) approach. SMEs' access to research facilities available in universities and PROs should be facilitated by specific support to help them use these services and facilities. The reintroduction of innovation vouchers for SMEs is strongly advised. Long-term, strategic cooperative research between business firms and academic institutions should be stimulated by establishing a new programme which supports cooperative research labs with dedicated research themes with a long-term time horizon (up to seven years) using a bottom-up approach.
- **Establishing an integrated entrepreneurial ecosystem:** Academic spin-offs and innovative start-ups are not only an important avenue for commercialising new ideas but they also constitute increasingly important cooperation partners for universities. They usually have extensive links with universities (often their incubating institution) and demand specialised academic services (e.g. research, testing and prototyping, etc.). Hence, a dynamic entrepreneurial ecosystem in which universities and PROs act as incubators and hubs may work as a driver for science-industry links. To facilitate and foster the development of a well-interconnected entrepreneurial ecosystem, a range of financial as well as network-oriented measures should be organised. These activities should be guided by a coherent and strategic action plan to jump-start and develop a modern entrepreneurial ecosystem based on a dense network encompassing all relevant actors: entrepreneurs/start-ups; venture capital financiers and business angels; universities and other incubating institutions; intermediaries;

local/regional/national governments and administrations and supportive services.

For each policy recommendation, this report describes its rationale (i.e. why it would help the Slovenian situation within the specific setting/challenge) and advises on implementation as well as selected international (European) good practice examples. In addition, first estimates are provided for the time line associated with implementation.

The nature of these policy recommendations is diverse. Some cover specific measures (funding programmes, for example) which can be designed and set up within the existing policy framework without a major effort, once the financing has been secured. Other recommendations go beyond this level of measures and cover systemic changes to a particular part of the Slovenian R&I policy framework. Such changes are much more difficult to implement since they need political coalitions and the will to make (sometimes deep) reforms. Those measures relate, for instance, to the (increased) autonomy of universities, to changes in the academic career system and in the system of incentives at the level of academic research institutions. It must be stressed that Slovenia is not the only country, which has faced some of these challenges leading to structural policy reforms. Indeed, a recent overhaul of the university system has been carried out in several European countries and their experience could act as a platform for good practices and provide ample ground for policy learning.

THE PSF SPECIFIC SUPPORT TO SLOVENIA

The Horizon 2020 Policy Support Facility (PSF) is an instrument aimed at supporting Member States and countries associated to Horizon 2020 to improve the design, implementation and evaluation of their national R&I policies and systems. The PSF has been set up by the European Commission, DG Research and Innovation, under Horizon 2020.

Specific support services provide tailored advice, expertise and good practice to help Member States and Associated Countries in the design or implementation of a specific reform or topic concerning R&I strategies, programmes or institutions. This is provided by an international and independent expert panel, which formulates concrete and operational recommendations to the national authorities on the reforms which are necessary to address the specific objectives.

Following a request from the Slovenian authorities for a PSF Specific Support, an international panel of experts was appointed by the Commission (Directorate-General for Research and Innovation). It started work on 2 December 2016. The panel includes four independent experts from Spain, Austria, Finland and Belgium acting in their personal capacity.

AIM AND FOCUS AREAS OF THE PSF SPECIFIC SUPPORT TO SLOVENIA

The purpose of this Specific Support is to answer the following questions put to the PSF panel by the Slovenian government:

- How should the internationalisation of the Slovenian science base be improved?
- How can cooperation between the science base and businesses be improved?

This report presents the main challenges related to these two focus areas, as identified by the panel, together with specific policy recommendations to address them. In chapter 1, we first discuss the strengths and weaknesses of the Slovenian R&I system, notably in regard to the internationalisation of its science base and the cooperation between the science base and businesses. The key barriers and challenges faced by Slovenia in the process of catching up with Europe's leading innovation countries are then identified. The main part of this report is presented in chapter 2 where we discuss our policy recommendations for addressing these challenges.

METHODOLOGY

The PSF Specific Support takes a two-step approach:

First, a preparation phase which involved the collection of relevant evidence in the form of studies, legislation, policy documents and statistics and, based on that, an initial analysis of the current situation. This analysis included an assessment of the strengths and weaknesses of the Slovenian R&I system and a review of the current policy framework. It was presented in a Background Report.

Second, a diagnosing and reporting phase which involved:

- Two country visits, 13-15 February and 18-19 May 2017, during the main actors and stakeholders – including public authorities, universities, research organisations, industry, company support structures – were interviewed and additional information was collected;
- Synthesis of the findings and review of European good practices that could inspire the recommendations;
- Preparation of a report presenting the results of the analysis and proposing concrete recommendations for policy reforms and the design of relevant measures.

1 SLOVENIA'S SCIENCE AND INNOVATION SYSTEM

1.1 Strengths and weaknesses of the Slovenian science and innovation system

According to the European Innovation Scoreboard,² Slovenia belongs to the group of "Strong Innovators" which is the second group "following" the group of "Innovation Leaders". However, aggregate innovation performance (measured by the Summary Innovation Index, SSI) has been declining since 2010. Slovenia's performance relative to the EU average was 96 % in 2016 and 92 % in 2017. Thus, its performance is still relatively close to the EU average with three dimensions being above and seven dimensions being below average. Particular relative strengths are new doctorate graduates and the population with tertiary education. Significant relative weaknesses are observed for venture capital investments, knowledge-intensive service exports, and foreign doctorate students.

Key features of the Slovenian R&I system, indicating some strengths as well as some particular weaknesses, can be summarised as follows:³

- A relatively high GDP per capita of about 83 % of the EU-28 average indicates the comparatively strong progress of Slovenia's economy. This is supported by a strong export orientation with close (inter)connections to rich, advanced economies (e.g. Italy, Austria as direct neighbours and Germany as the EU's largest economy). It must be underlined that Slovenia's industrial base (i.e. manufacturing sector) is still comparatively strong with a share of about 23 % of its employment. About 37 % of this employment is provided by medium- and high-tech industries (EU average: 36.4 %).
- The Slovenian workforce is highly skilled and there is a relatively high share of participation in tertiary education, with an attainment rate of 44.2 % within the 30-34 age group (EU-28: 39.1 %). Indeed, human resources are one of the areas in which Slovenia shows significant strength in the European Innovation Scoreboard compared to the EU average.
- Although R&D intensity is relatively high, especially compared to other Central and Eastern European Countries, it has faced a sharp decline since 2013. With R&D expenditure amounting to 2 % of GDP (2016), Slovenia is now slightly below the EU-28 average of 2.03 %. In the aftermath of the financial crisis, the total volume of R&D expenditure (GERD) stalled in 2013 and fell in 2014 (EUR 890m or 2.39 % of GDP) and 2015 (EUR 853m or 2.21 % of GDP).
- The still relatively high R&D intensity of Slovenia is driven by business enterprise R&D (BERD): business R&D intensity ranks seventh among EU

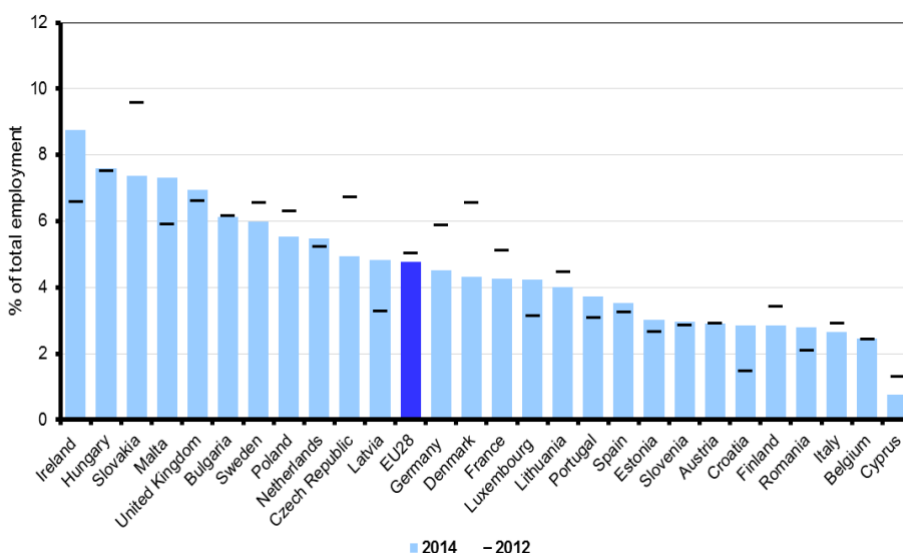
² <https://ec.europa.eu/docsroom/documents/30700>

³ See the background report (Bučar 2017) for a detailed discussion backed up with many more empirical facts. Additional evidence is also found in the RIO Country Report 2016: Slovenia, by Bučar and González Verdesoto (2017).

Member States. Businesses fund almost 70 % of the overall gross domestic expenditure on R&D (GERD), the highest share among all EU Member States. Indeed, Slovenia exhibits a comparatively advanced industrial structure with a prominent industrial base, including significant 'medium- and high-tech' segments (e.g. automotive sector, machinery). Firms from within these industrial sectors constitute the main target group for engaging intensively in science-industry links, providing a sophisticated home market demanding knowledge and/or research-driven services from academia.

- Due to severe budgetary constraints, the government budget for R&D (GBOARD) decreased rapidly during the period from 2011 to 2014. This resulted in a stark decline in the government's share of R&D funding, which recently has amounted to only about 20 % (down from almost 36 % in 2009 and 2010). With a fall in the public R&D intensity from 0.63 % in 2011 to 0.49 % in 2016 (ranking only 17th in the EU, the EU average being 0.69 %), the financial constraint for the public research sector (i.e. universities and PROs) has become severe in recent years. Business R&D intensity has also been in decline since 2013, falling from 1.97 % in 2013 to 1.68 % in 2015 and 1.51 % in 2016. A major part of this decrease is explained by the sharp reduction in direct public support to business R&D: from 0.29 % of GDP in 2013 to 0.11 % in 2015.
- Despite the comparatively modern structure of the Slovenian business sector, the employment in fast-growing firms within innovative sectors is well below the EU average. In Slovenia (2014), only 3 % of the total employment was employed in fast-growing firms in innovative sectors, whereas the EU average was 5 % (see Figure 1). This indicates a lack of dynamism, which is especially pronounced in innovative parts of the economy.

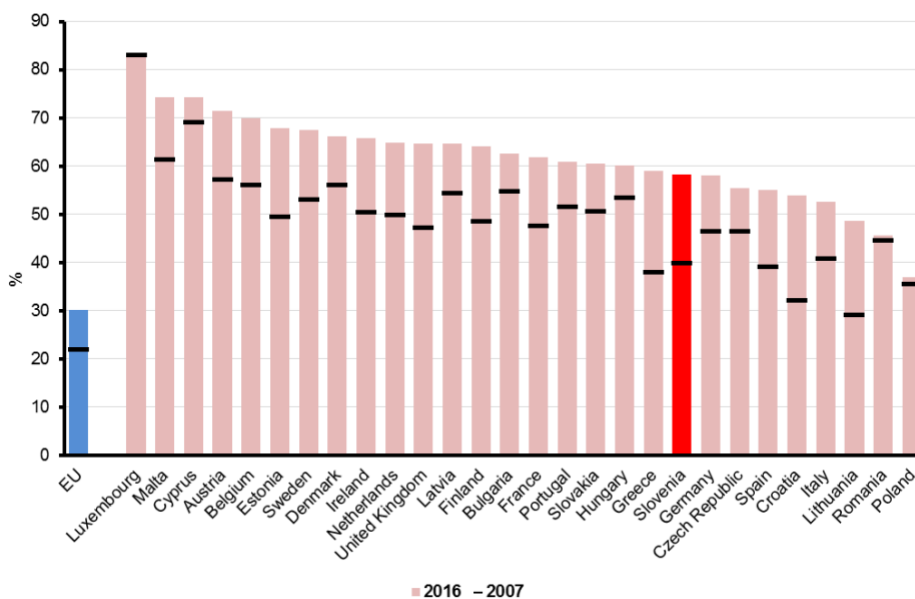
Figure 1: Employment in fast-growing firms in innovative sectors, 2012 and 2014



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies, based on EIS data

- Indicators concerning the connections between the business sector and academic or other public research institutions give a mixed picture in term of benchmarking, but show a clear declining trend in recent years. In Slovenia, the volume of contract research (R&D performed in the public R&D sector funded by the private sector) represented 0.05 % of GDP in 2015, which still equalled the EU average, but has been on a continuously decreasing trend since 2011. Concerning the volume of public-private co-publications, while Slovenia has traditionally performed very well on this indicator, its performance has declined considerably since 2011. While the large volume of business R&D activities in the country should in principle offer many opportunities for public-private cooperation, the capacity of the public research system to play its role in the innovation ecosystem seems to be on a downward path.
- Slovenia is well integrated into international partnerships and networking mechanisms. The annual report of the Slovenian Research Agency ARRS lists international activities such as the co-funding of international bilateral projects (EUR 0.6m), promoting research organisations in Horizon 2020 (EUR 0.7m), support to international associations (EUR 0.3m) and the co-financing of projects within the European Research Council (ERC) complementary scheme (EUR 0.8m) and the lead agency scheme (EUR 0.7m). Together, these consume 2.4 % of the funding agency's budget. The relatively high degree of international collaboration and networking is shown by Slovenia's intensive participation in EU R&D programmes. During the period 2007-2014, Slovenia participated in more than 800 projects. According to data from May 2017, Slovenia is already participating in 370 projects in Horizon 2020, with an EU financial contribution of EUR 143m. Slovenia can be seen as an active partner and contributor to the European R&I landscape compared to other similar-sized European countries (Estonia, Latvia, Lithuania). Slovenians are able to cooperate with large European countries as well as neighbouring countries. However, outside Europe there is little cooperation (with Turkey, Israel, South Africa, Ukraine, China and United States being the most active partnerships outside the EU).
- The country's share of international co-publications among its total volume of scientific publications is below the respective values of other smaller advanced Member States such as Austria, Belgium, Sweden, Denmark, Ireland, Netherlands, Finland, Slovakia or Hungary (see Figure 2). This clearly indicates room for further strengthening the international openness of the Slovenian public science base.

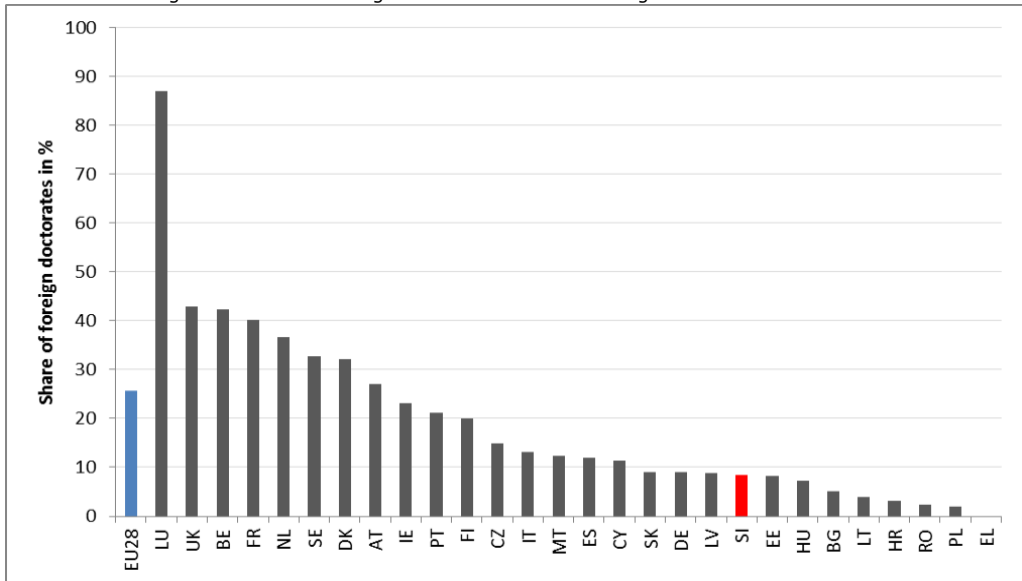
Figure 2: Total international scientific co-publications per country as % of total scientific publications per country, 2007 and 2016



Source: DG Research and Innovation, based on Web of Science database

- Slovenia is represented in a good number of European Strategy Forum on Research Infrastructures (ESFRI) projects. Nevertheless, it is currently not participating in other large and well-established pre-existing research facilities in Europe like ESRF (European Synchrotron Radiation Facility), ESO (European Southern Observatory), ILL (Institut Laue Langevin) and EMBL (European Molecular Biology Laboratory). Slovenia became an associated member of the European Space Agency (ESA) in 2016, which is an important step before gaining fully-fledged membership. These participations represent strong instruments for increasing international cooperation in the future and give Slovenian firms the opportunity to participate in international tenders for advanced products and services.
- A pronounced weakness of the Slovenian R&I system can be identified in the area of "internationalisation at home", i.e. internationalisation through the influx into Slovenia of human resources from abroad. This is notably indicated by the low influx of foreign graduate students. The share of foreign doctorate students (8.5 %) among all doctorate students is considerably lower in Slovenia than the EU average (25.6 %) (see Figure 3), which indicates that the Slovenian academic system is not very successful in attracting young, upcoming scientists.

Figure 3: Share of foreign doctorate students among all doctorate students



Source: DG Research and Innovation (EIS 2017)

1.2 Barriers and challenges for the further advancement of the Slovenian science and innovation system

Taking as the starting point the analysis of the current situation and of the important recent developments within the Slovenian R&I system published as a background report (Bučar 2017), the PSF panel developed its own assessment via a workshop with Slovenian experts and policymakers in Brussels (in December 2016) and an extensive three-day visit in February 2017. This enabled the panel to identify which key barriers and challenges need to be prioritised and tackled in order for the country's science and innovation to further progress in the two focus areas selected by the Slovenian authorities. Although questions of governance were initially not at the heart of its mandate, the panel identified certain generic governance problems as key obstacles to be overcome to improve the situation in these two main areas. The key challenges identified by the panel are presented below in three groups:

- generic issues and governance;
- Slovenia's role within the process of internationalisation; and
- the links between academia/science on the one hand and business on the other.

1.2.1 *Generic issues and governance*

Studying the framework conditions of the Slovenian R&I system, and based on discussions during the Brussels workshop and the first country visit, the panel detected some generic issues in the system which affect the two focus areas under consideration (i.e. internationalisation and science-business links) and which might create barriers for potentially fruitful interactions. These general 'barriers' are:

Instability/discontinuity/unsustainability of measures

Particularly in times of turbulent market developments, a stable policy and regulatory framework is crucial to reduce the level of uncertainty for all those involved. A stable policy framework makes it easier to cope with this, while with instability, R&I actors need more resources to learn how to 'navigate' in the policy environment. Despite the importance of stability and continuity, Slovenia's R&I policy system is continuously changing at many levels leading to fragmentation and discontinuity:

- At the governance level, the responsibilities of ministries and agencies (as well as their composition) have changed drastically in recent years. Today, responsibility for research, technology and innovation is divided between two ministries: the Ministry of Education, Science and Sport (MESS) and the Ministry for Economic Development and Technology (MEDT). MESS is responsible for preparing the main policy documents, support measures and all the activities in the area of science. MEDT is responsible for technological development and innovation support, with the primary attention on the business sector. While such a division of responsibilities is not unusual in European countries, the problem for the Slovenian R&I system is caused by instability due to frequent government changes in recent years. Until 2011, Slovenia had a comprehensive ministry integrating higher education, science and technology. In an attempt to reduce the number of ministries, this was merged with the Ministry of Education and Sports and the Ministry of Culture. The technology section was moved to the MEDT. (Eventually, in one more change, culture was given its own ministry, but science remained with MESS). Today, the practical implications of this organisational scheme are that R&D policy (the responsibility of MESS) and technology and innovation policy (MEDT) are disconnected with insufficient strategic and day-to-day cooperation and coordination.
- At the policy measure level, the changes are both plentiful and far-reaching, creating gaps in the system. Many instruments have suffered from a 'stop and go' policy, due to discontinuity in the financial flows from the Structural Funds or to budgetary restraints. Some measures have been abandoned completely, even though they may have proven successful or have been assessed very positively by the relevant target groups (e.g. young researchers in industry, and the innovation voucher programme), while other measures have limited time horizons (e.g. competence centres) with no meaningful phasing-out periods, etc. In the panel's view, a constantly changing support landscape is detrimental to the successful development of the R&I system. It appears that

a detailed analysis of the effectiveness of policy measures before changing them is often lacking due to an underdeveloped evaluation culture.

Lack of incentives/reward to modify behaviour at the institutional and individual level

There is still a lack of incentives and 'strategic space' for the relevant institutions within the Slovenian S&I system (i.e. universities and PROs) to modify their behaviour towards fulfilling their "third mission" (cooperation with business and society beyond teaching and the generation of new knowledge) as well as towards proactive internationalisation. Limited institutional funding and a lack of real autonomy for the universities (especially concerning financial and human resources) lead to barriers hindering the relevant institutions in formulating their respective strategies and consequently 'filling' these strategies with real measures.

At the individual level, the incentive structure for researchers in academia remains geared towards teaching and doing (excellent) research. The career system for university researchers (and to some extent even for the researchers employed at PROs) is still based on "being public servants", and the habilitation system prevents flexible cross-sectoral mobility as well as mobility between the institutions. Habilitation is a lengthy and cumbersome procedure, which may act as an additional barrier to the mobility of young postdoc researchers. It is also an added disincentive for attracting foreign talent (or for the possible return of Slovenian scientists who went abroad and want to return to Slovenian academic institutions). Today, the traditional arguments for the habilitation system (i.e. ensuring high research quality and the ability to teach) are mainly guaranteed by the PhD process itself, the 'publish or perish' principle as well as by quality standards for teaching (e.g. teaching evaluation, etc.). Engaging in applied research in close cooperation with the business sectors (and/or members of civil society) has no similar reward structures (compared to earning a reputation within the scientific community, etc.). To some extent, this also holds true for the internationalisation process in Slovenia's academic institutions. 'Internationalisation at Home' (i.e. via foreign researchers and students in Slovenian institutions) remains very underdeveloped and, once again, lacks a sufficient reward structure via meaningful incentives.

1.2.2 Internationalisation

Systemic barriers for Internationalisation at Home (IaH)

As previously stated, Slovenia has certain weaknesses with regard to IaH, linked to systemic barriers to the influx of human capital from abroad. These result from influences which can be grouped into the following two categories: first, the language barrier (which leads to a low share of foreign students, especially graduate students, at Slovenian universities); and second, to the public-sector employer system and the old-fashioned habilitation system in universities (which lead to a low influx of foreign researchers/academics). A strong barrier to inward mobility in Slovenian higher education is legally binding to provide teaching and teaching material in Slovenian: "*Gradual introduction of joint PhD programmes at different universities with universities in other EU countries allows for greater*

flexibility in use of language and opens doors to students from abroad. Yet the proposal of the MESS to introduce the possibility of teaching in English language at the tertiary level has triggered a very emotional and nationalistic public debate on necessity to protect Slovenian language and culture. Eventually, MESS dropped the amendment to the Law on Higher Education.”⁴

Smallness of Slovenian market and pressure towards early internationalisation

Slovenia is a rather small country with a population of only 2.06 million inhabitants and a GDP of about EUR 39.8 billion. There are distinct disadvantages attached to its smallness, which are detrimental to some areas, especially science-business links and cooperation. Smallness implies a limited demand for specialised R&D services provided by public research institutions. This limited demand means that cooperation projects may be rare and/or on a smaller scale. However, in many fields (especially technical or the natural sciences) there are minimal optimal lab sizes implying that some Slovenian research labs might be ‘too large’ for the small national market as regards science-industry links. Thus, the limited demand for their services forces these labs to look for cooperation partners beyond the national borders if they want to engage in commercialisation projects with the business sector.

The smallness of the Slovenian internal market is a particular handicap for innovative start-ups and/or academic spin-offs. Scaling up the business plan is a necessary condition/phase for start-ups. However, given its smallness, the Slovenian market alone does not usually provide enough room for such scaling up. This forces start-ups to go international very early without the benefit of having a test market for their early innovations/products/processes on their own ‘home turf’. Going international at a very early stage implies high risks given the high costs (in both financial and human resources) associated with this approach which might not be sustainable for many or even most start-ups.

Furthermore, the smallness of the internal market implies a significant disadvantage for the development of an own dynamic market for risk capital (venture capital). Due to its size, there will only be a limited deal flow of potentially interesting start-ups resulting in limited possibility to build up a diversified portfolio of investments to mitigate the high risks associated with early-stage investment. Thus, even endogenous Slovenian venture capital firms could be forced to go international, which gives them a competitive disadvantage to venture capital firms which are able to ‘learn’ and gain experience within their own home markets before they go international. On the other hand, the Slovenian start-up landscape might be assessed as too small (and too ‘exotic’) for large, international (e.g. British or Dutch, or the European subsidiaries of large US) venture capital firms that often tend to look more at the large, well-known ‘hot spots’ (e.g. London, Berlin, Munich, etc.) on the European start-up landscape.

⁴ See the background report (Bučar 2017, p. 65).

Of course, the size of Slovenia and its population is a given fact, which cannot be changed by policy. However, policy measures can mitigate some of these limitations to a certain extent.

Human resources: low attractiveness for foreign talent

As previously noted, rapid changes in the global economy and talent hot spots create pressure on national higher education and science policies as well as economics, social affairs and all other political sectors. The tendency that “the global population of higher education research centres/institutes and programmes are highly concentrated in just a small number of countries”⁵ makes it especially difficult for small nations like Slovenia to attract human capital in the context of “brain competition” and to develop academic institutions with a truly global presence. In the case of Slovenia, this inherent difficulty is multiplied by the still below-average (in comparison to most EU-15 countries) remuneration and wage levels. Naturally, having a comparatively ‘small language’ (spoken by only about 2.2 million people as their mother tongue) does not help either to attract foreign talent. Nevertheless, there are some positive factors, such as safe and secure environments or easy access to other Central European countries, which can be used as levers for further improvement.

⁵ The Skewed Global Landscape of Higher Education, Training and Research, Laura E. Rumbley. *International Higher Education*, No. 79; winter 2015.

1.2.3 Science-business links

Lack of stable cooperation at the institutional level

In Slovenia, cooperation between universities, public research organisations and business appears to depend strongly on the ad hoc availability of public resources for applied R&D projects. Stable, long-term relationships seem to be limited to certain leading Slovenian companies and to some top public laboratories. Different successful initiatives have been taken in the past to improve this situation but none of these instruments have been maintained.

Mismatch between science and business and limited absorptive capacities within the business sector

In the context of science-business links, we use '*absorptive capacity of the business sector*' to mean the capacity to absorb, internalise and utilise the (new) knowledge potentially made available by the science sector (universities and public research organisations). Thus, the absorptive capacity of the business sector defines the potential level of possible fruitful interactions between academic institutions and firms. If the absorptive capacity is low, the presence of excellent academic institutions with a high propensity to engage in knowledge-transfer activities will be not enough to stimulate science-business links. In short, the quality of academic institutions and their openness to engage/interact with business sector institutions is a necessary but not sufficient prerequisite.

Usually, there is *ceteris paribus* a strong correlation between company size and the propensity to interact with academia. Large firms tend to have their own in-house R&D facilities, which are better able to communicate and interact with academia than the more 'ad-hoc' research personnel in smaller firms. To make things worse, the few large – by Slovenian standards – firms are still rather small (or even tiny) in an international or global comparison. Thus, the size structure of the Slovenian economy is detrimental to strong cooperative connections between the business sector and academia. In addition to the general smallness of the Slovenian economy, this leads to a situation whereby in any given thematic area there will only be a small number of firms (most of them relatively small) which might demand state-of-the art know-how from academia in this particular area. Thus, academic institutions might only find a limited demand for their research services within Slovenian borders.

Weak entrepreneurial system

The importance of a dynamic entrepreneurial system for fostering science-industry links is increasingly recognised. Academic spin-offs and innovative start-ups constitute important cooperation partners for universities. Usually, they have extensive links to universities (often their incubating institution) and demand specialised academic services (e.g. research, testing and prototyping, etc.). Hence, improving the entrepreneurial ecosystem is recognised more and more as an important driver for science-business links. According to some relevant business indicators (e.g. number of new firms created, ease of starting a business, availability of venture capital) Slovenia experiences some weaknesses (with varying degrees) compared to the EU average. In combination with on-site

visits to relevant intermediary institutions (e.g. technology and incubation parks), talks with business leaders and start-up founders and with relevant experts, we conclude that Slovenia's entrepreneurial ecosystem remains under-developed.

This weak entrepreneurial ecosystem is also measured in terms of new technology-based companies created from the public system, their acceleration and scaling-up rate to become international, the consolidation of support entities like business incubators, as well as the structure of the risk capital sector, especially business angels.

In addition, during the country visits and discussions with main stakeholders, the panel did not identify a clear attitude towards entrepreneurship as a key institutional objective in universities and PROs. This 'entrepreneurial' mission by universities and PROs within their respective economic system is still not integrated to a significant degree within Slovenia's universities. Rather, it is regarded more as an 'add-on' or 'nice to have' than as an integrated part of the university system.

2 POLICY RECOMMENDATIONS FOR ADDRESSING THE KEY CHALLENGES

2.1 Preamble: Generic issues and governance

The key action lines to improve the framework conditions are identified in the following four main categories:

1. **Flexibility:** The country's entire innovation system and specifically its public actors should operate with greater flexibility in internal regulations to become competitive at the international level. Today, in many cases, the operation of universities and PROs is constrained by a high degree of regulation, which might have had some justification in the past but is no longer needed and has become a heavy handicap in the competition with other equivalent partners located abroad. Examples of this situation include the rules for the recruitment of researchers from abroad, or mechanisms for the promotion of faculty members. In our opinion, more flexibility is needed to facilitate and push the development of specific institutional strategies for R&D structures (e.g. public-private), human resources and the exploitation of results (e.g. via the participation in spin-offs as shareholders).
2. **Stability:** Slovenian stakeholders (in universities, research centres and in enterprises) were requesting more stable funding instruments. They felt that some (apparently good) funding instruments were being substituted by others (or even abandoned completely) without any clear rationale. On several occasions, some funding instruments were stopped or replaced after just a few years (the moment they started to play a prominent role in the institution) and before stakeholders had extracted all their potential benefits. This destabilised institutional policies. However, the stability of funding instruments does not guarantee long-term funding: decisions about sustained funding should be based on thorough evaluations.
3. **Integration:** Today, the so-called "knowledge policies" cannot be conceived, designed and implemented in an isolated way in any innovation system. They should be fully integrated to facilitate long-term cooperation, the launching of public-private mobility schemes, and the integration of some previously isolated instruments (e.g. research infrastructures with human resources to operate them) into a single but more comprehensive one. Currently, an excessive level of fragmentation hinders the optimal use of the available resources and makes it more difficult to support complex actions in which several types of actors should participate.
4. **Openness:** A crucial element for ensuring the competitiveness of individual actors as well as the entire innovation system is to allocate the funding to 'open' initiatives in which a number of actors should be able to participate. In many cases, the adoption of an open innovation approach is the consequence of the lack of knowledge or resources to complete a complex task within one isolated entity. In other cases, it is even forced by the applicable regulation to get funds from public administrations (as happens in some of the open calls issued by Horizon 2020 whereby a consortium of European entities is required to present a proposal). To insert this open mentality into the

institutional strategy of Slovenia's universities, PROs and enterprises, and to support this process by adequate regulation is a precondition to ensure competitiveness at the international level. Today, the use of consortium-based R&D projects issued by the Slovenian government is very low compared to the total volume of funds allocated. Nevertheless, many Slovenian entities are used to participating in Horizon 2020 consortia.

The panel is well aware that the four elements referred to above are generic in nature, apply to every innovation system, and are beyond its initial mandate. However, the panel is of the opinion that these elements do influence the two focus areas (i.e. internationalisation and science-industry links) to a considerable degree and that the following specific recommendations must be seen in light of these generic framework conditions.

2.2 Linking recommendations to the challenges identified

Based on its assessment of the situation concerning the country's R&I system and its challenges, the panel derived 10 distinct recommendations. These are linked to one or several of the challenges discussed in chapter 1. Figure 4 depicts the links between the challenges and the accompanying policy recommendations. Some of the recommendations address several challenges while a few are linked to just one specific challenge. In the following chapters, we discuss our policy recommendations and their rationale in detail, giving hints for their implementation and examples for good practice models.

Figure 4: Linking policy recommendations to the challenges facing the Slovenian R&I system

Recommendations	Governance challenges	Internationalisation Challenges			Science-Business-Links challenges		
	Lack of incentives and rewards for behavioural change	Systemic barriers for Internationalisation at Home	Smallness of Slovenian market and force to early internationalisation	Human resources (Low attractiveness for foreign talents)	Lack of stable cooperation at the institutional level	Mismatch between science and business and limited absorptive capacities of the business sector	Weak entrepreneurial system
R1 Making universities and PROs autonomous legal entities for ensuring the best recruiting, partnerships and funding	●			●			
R2 Block funding of universities and PROs should be linked to specific financial incentives if they achieve agreed key performance indicators (KPIs) related to internationalisation (and additional to science-industry links).	●	●			●	●	
R3 Diminish language barriers – Foster the use of English in education, research and innovation activities, if not in all nationally funded programmes		●		●			
R4 Shutdown of the habilitation system				●			
R5 Reinforce the innovation cluster policy					●	●	●
R6 Re-establish the young researchers science-business mobility programme				●	●	●	●
R7 Facilitate the access of SMEs to research facilities available in universities and PROs			●		●	●	
R8 Establish a programme to stimulate long-term, sustainable research cooperation between science and industry			●		●		
R9 (Re-)Introduce Innovation Vouchers for SME						●	
R10 Facilitate the creation of a well-interconnected entrepreneurial ecosystem							●

Source: Own draft

2.3 Governance challenges

Recommendation 1: Making universities and PROs autonomous legal entities to ensure the best recruiting, partnerships and funding

Rationale

During the last couple of years, it has become increasingly recognised that research institutions (whether universities or other public research organisations) operate more efficiently if they have a high degree of autonomy associated with the corresponding level of responsibility. Formally, autonomy means that universities become their own legal entities. Autonomy in this context also means that universities are able to take more decisions on the key issues affecting them, such as their management, finances, academic profile, human resources and accompanying incentives and reward structures. They also enjoy some manoeuvrability with regard to their strategy formulation (usually in negotiation with their principal, i.e. the respective ministry of science). Autonomous universities may then use their resources as they see fit, with less governmental involvement. With respect to internationalisation, this means a broad range of activities, such as recruiting (international) staff, advertising their courses to foreign students, choosing foreign languages for teaching, cooperating with foreign universities (e.g. joint programmes, exchange mechanism, etc.) without much interference and/or regulation from the ministry. Today, according to the European University Association (EUA), Slovenian universities enjoy only low to medium autonomy, depending on the type of autonomy.⁶ Whilst the level of organisational autonomy is assessed as medium to high (Slovenia ranking 16th out of 29 countries), the level of autonomy is estimated as particularly low in the areas of finance (18th), staffing (24th) and academia (25th). In particular, the rigid tradition of habilitation, the language barriers and also the tightly regulated staffing system (including the salary system) are significant barriers to international recruitment as well as for national cross-sectoral mobility.

Implementation hints

Changes initially in national legislation and then in internal regulations of universities and PROs.

Good practice

Examples of good practice (and respective reforms during recent years) can be found in several European countries. Finland might serve somewhat as a role model: university law was changed in 2009,⁷ which gave the universities economic and administrative autonomy, with the status of legal entities. Each university now has its own capital; as a legal entity, it fulfils its obligations with its own resources: the state is no longer responsible for the university's commitments. Each university also decides on its own operational structure,

⁶ See <http://www.university-autonomy.eu/countries/slovenia/>

⁷ <http://www.finlex.fi/fi/laki/kaannokset/2009/en20090558.pdf> translated into English.

units, and positioning within the legal framework. As regards human resources, each university autonomously decides on the basis of its personnel management, while national collective agreements determine the framework for these decisions.

In 2015, the Ministry of Education and Culture launched an evaluation to gauge the impacts of university reform. The evaluation indicated that the legislative reform had triggered a significant structural and cultural change in the way universities are being led. It also resulted in several mergers of institutions. The financial responsibility brought about by the reform has meant a major change in leadership structures and the requirements set for leadership and leaders at universities.

Recommendation 2: Institutional funding of universities and PROs should include specific financial incentives linked to agreed key performance indicators (KPIs)

Rationale

By introducing a system of Key Performance Indicators (KPIs), universities could be provided with a certain incentive structure in line with the overall aims of a national R&I strategy, notably in relation to internationalisation and science-business cooperation. As a precondition, universities should get significant funding for R&D at the institutional level, so that the management in each university can develop its own R&D strategy. The introduction of a limited number of relevant KPIs, with a percentage of the instructional funding linked to the satisfaction of the institutional objectives related to them, will allow the reform process to be steered at the institutional level: if a part of the annual (or multi-annual) funding depends on the evolution of these KPIs, universities and PROs will be 'nudged' towards the aims operationalised by the KPIs (e.g. internationalisation and science-industry links). Over time, they will devote more and more attention and resources to these aims.

Implementation hints

A period of time is necessary to adapt the present mentality and strategy. The set of KPIs could be divided into a mandatory subset and a voluntary subset. Values for the indicators should be agreed jointly between the institutions and the relevant ministerial department on the basis of the initial situation and available measurement and documentation tools. The system should be kept simple and the indicators should be easy to measure. The KPI system should notably account for the density of links between science and the private business sectors, incentivising cooperation and contract research between universities and PROs and the private sector. A KPI system could evolve, for example, around the following specific indicators:

- KPIs for internationalisation in specific institutions could be:
 - % of foreign students (weighted by undergraduate/graduate students);
 - % of foreign faculty members;

- % of budgetary resources secured from abroad/internationally competed research funding (e.g. from Horizon 2020);
- Joint international co-publications (weighted by citations).
- KPIs for ‘third mission’ and ‘entrepreneurial university’
 - Amount of funding (i.e. its share of total funding) received from the private business sector for cooperative research projects, contract research, etc.;
 - Formulation and establishment of a proactive policy and support infrastructure for academic spin-offs at the university level implemented under a coherent and integral strategy (‘entrepreneurial mission’);
 - Number of spin-offs created every year by faculty members or researchers and graduate students.

Good practice

An interesting example of reforms within higher education funding (and incentives) which is now linked (to a certain extent) to a set of KPIs can be found in Finland, which is currently implementing changes in the course of the ‘Vision 2030 process’. In Finland, the Ministry of Education and Culture currently disburses the disposable core funding using the financing models for the two types of higher education institutions (HEIs): universities and universities of applied sciences (UAS). Besides the core funding, HEIs receive financing from other sources (external funding), such as the Academy of Finland, The Finnish Funding Agency for Innovation (Tekes), foundations, enterprises, the EU and other international sources (see Figure 5).

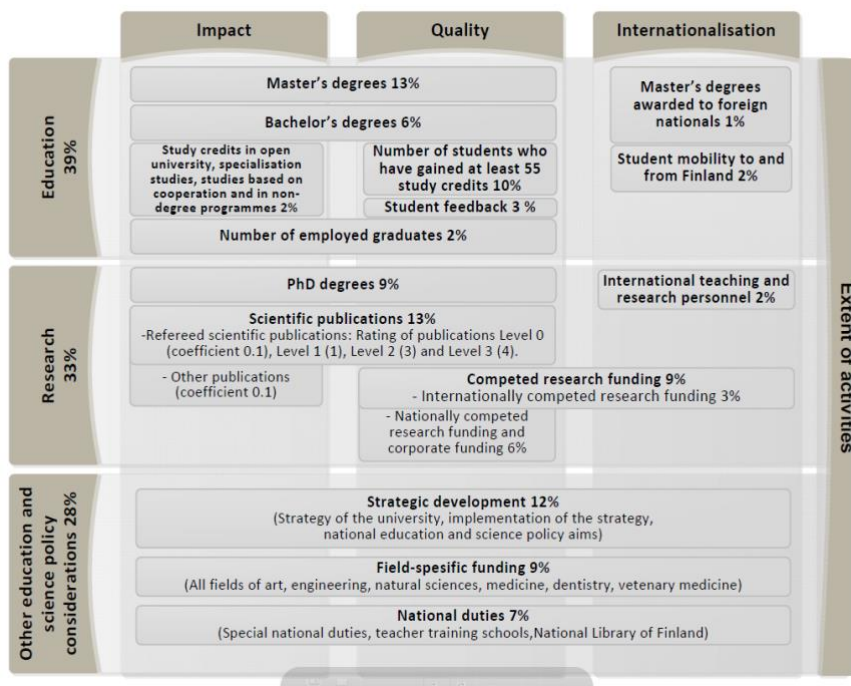
The appropriations for core funding have been allocated to universities mainly in an imputed way on the basis of their teaching and research performance, and to universities of applied sciences on the basis of their performance in education as well as R&D. Part of the financing for both higher education sectors has been allocated on the basis of their strategies, which are formulated together between the ministry and each institution. In addition, the universities’ national tasks and duties are taken into consideration in their central government funding. The purpose of the financing models has been to improve the quality, impact and productivity of the HEIs. The model has allowed the core funding divided among the HEIs to be allocated as a single entity. The HEIs then decide on the internal allocation of funding independently, on the basis of their strategic choices.⁸

HEI funding has to be renewed according to the changing society, global demands and higher education, research and innovation landscape. This is why Finnish HEIs and the Ministry of Education and Culture are processing new ways of

⁸ <http://minedu.fi/en/steering-financing-and-agreements> 17.11.2017

enabling the management, funding and structures of the HEIs in the Vision 2030 process.⁹

Figure 5: Finnish universities' funding model, as of 2017



Source: Ministry of Education and Culture¹⁰

2.4 Internationalisation challenges

Recommendation 3: Reduce language barriers – foster the use of English in education, R&I activities, if possible in all nationally funded programmes

Rationale

Today, English is indisputably the lingua franca of research and teaching at the tertiary level. However, in Slovenia, teaching in the Slovenian language is still mandatory even at the tertiary level. Although universities can circumvent this (albeit with significant monetary costs) by organising parallel courses, the sustained use of Slovenian as the teaching language hinders the

⁹ <http://minedu.fi/en/vision-for-higher-education-and-research-in-2030>

¹⁰ http://minedu.fi/documents/1410845/4392480/Universities_funding_2017.pdf/abc0974d-b8d5-4486-a12a-aa141d54b66f/Universities_funding_2017.pdf.pdf

internationalisation of the Slovenian R&I system in two ways. First, the incentive for foreign students to study in Slovenia is significantly reduced since usually English is the preferred language for these students. Secondly, Slovenian students and graduates are missing the opportunities, which would be created by the widespread use of English as the teaching language in Slovenia as a proficient knowledge of English would help them to engage in international activities (e.g. outward mobility, cooperation in international research projects, etc.).

Thus, the panel's recommendation is to allow the widespread introduction of English as a teaching language at the tertiary level, at least at the MA level if not at the BA level.

Implementation hints

Careful studies of the approaches within other countries with a relatively small language base (e.g. Nordic and Baltic countries and some selected Slavic countries like the Czech Republic) could provide insights and role models on how to internationalise tertiary education by introducing English as the teaching language while, at the same time, preserving the cultural and linguistic specialities.

Good practice

Today, many European universities provide higher education degrees (i.e. PhDs or even Master's) only in English while the domestic language is still used at the Bachelor's level. A study of some of these universities (and how the domestic students and teaching staff cope with the language issue) could provide interesting role models (e.g. about problems during the implementation process, etc.) for Slovenia's universities.

Recommendation 4: Shut down the habilitation system to open the career system for researchers in academia

Rationale

Habilitation is a special selection process, which enables candidates to gain one of the higher education teaching qualifications. In Slovenia, it is possible to get a habilitation, which, in effect, only exists in one university. Therefore, when applying, for example, for a professorship in another university in the country the candidate must begin the habilitation process from the start. Thus, the panel sees the habilitation system as a major obstacle to renewal of the STI landscape. A small country needs a dynamic and regenerating faculty. This tedious and traditional German and Central European peculiarity no longer fits into a modern research system. Already the Resolution of Higher Education¹¹ from 2011 noted that the current habilitation ("habilitacija") system does not *"always enable the selection and academic development of the best academic staff because it is a*

¹¹http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/ANG/Resolution_on_the_National_Higher_Education_Programme_2011_2020.pdf

too closed system". The Resolution explained that the HEIs should eliminate the excessive number of *habilitacija* fields, which, due to significant fragmentation, make it impossible to exploit the full potential of a university. A complete overhaul of the habilitation system should be envisaged in view of its replacement by a tenure-track-based system, as applied in many other countries.

Implementation hint

The agreement on a transition period is relevant to accommodate the structure of payrolls. In any case, current civil servants should keep their rights.

2.5 Science–business links

Recommendation 5: Reinforce the innovation cluster policy

Rationale

To address the challenges of mismatch between academia and the business sectors and the lack of stable, long-term interactions between these two sectors, a cluster approach is a promising measure. The cluster mechanism is an important tool to establish long-term interactions between science and business. Cluster initiatives are very useful and powerful mechanisms to bring science and business together with the goal of strengthening a certain sector, domain or value chain and to align various stakeholders from different domains (i.e. private business firms from different industrial sectors, academic institutions, public institutions, etc.). Different goals can be fulfilled under the umbrella of clusters. They can offer platforms for providing collective services and infrastructures, developing innovation agendas, performing collaborative research, and organising networking events, etc.

For Slovenia, clusters focusing on new emerging and strategically important sectors could play a crucial role in strengthening the fragmented landscape and enhancing the coherence of the innovation system. It already has experience with clusters and cluster-like initiatives. The Slovenian cluster programme was put in place until the end of 2014 when a new government abandoned it despite a positive evaluation. This programme, which had a total budget of about EUR 1.5 million, comprised 29 different projects including 3 pilot clusters, 13 early-stage clusters and 13 additional cluster initiatives. These projects and initiatives brought together about 350 companies and 40 education/research institutions. The Strategic Research and Innovation Platforms (SRIPs) that have been identified to implement the Smart Specialisation Strategy could become the core of a new strengthened cluster policy approach.

Implementation hints

Lessons should be learned from Slovenia's previous cluster experiences. The weak points have to be avoided and good practices can be restarted:

- The cluster policy (involving public and private entities) should also take into account pre-existing structures and networks in the region.

- However, a cluster system must also be dynamic: new clusters need to be able to enter the system in the future and non-performing ones should lose their support. This also implies that an evaluation system must be established. Initially, the clusters should get a management contract with clear goals, expected results and performance indicators. Periodically, an in-depth evaluation of the outcome of the individual clusters and the system as a whole must be performed.
- The long-term goals of the policy and the availability of funding or funding schemes (for support organisations and/or for collaborative projects and infrastructure) need to be clear, and beyond the period of the Structural Funds current operational plan, too. Specific funding can be limited to networking and coordinating activities. Clusters should be able to apply for collaborative projects in the regular support programmes.
- The business sector must co-finance in a substantial manner. Joint Technology Initiatives (JTIs) could work as role models in this respect.
- SRIPs have the potential to encourage and foster strategic cooperation, but there are a number of pitfalls and care must be taken to avoid repeating past problems.

Good practice

Different systems of cluster-like initiatives have been taken up in the past 20 (or more) years in a number of countries. A good example for an evolving and versatile 'cluster system' can be found in Flanders in Belgium. Learning from experiences with different cluster approaches over 15 years or so, in 2016, the government of Flanders set up an improved system with a dual approach. On the one hand, 'flagship' clusters were created in strategic 'smart specialisation' sectors. In addition, a call for 'innovative enterprise networks' was launched. These are smaller-scale initiatives, which have the aim of increasing dynamism in the ecosystem and developing newly emerging niches. The 'flagship clusters' nominated are active in sustainable chemistry, materials, energy, logistics and the food industry. There are innovative enterprise networks in sectors such as air cargo, drones, construction, digitisation of industry, and fintech, etc.

Cluster support focuses on ambitious companies with innovation awareness and an international and open attitude towards collaborating with other companies and research institutes. The clusters' targets include both individual company goals and common goals of a group of companies to help them increase their competitiveness. Cluster organisations receive a 50 % subsidy for their facilitating role. Cluster membership and activities have to be open to all interested companies and organisations.

Schematically, the differences between flagship clusters and innovative enterprise networks are as presented in Table 1

Table 1: Differences between flagship clusters and innovative enterprise networks

Flagship clusters	Innovative enterprise networks
Support for small number of clusters (+/- 5)	Support for large number of networks (+/- 15)
Topics in strategic sectors	Bottom-up approach
Focus on long-term vision Max. 10 years duration EUR 500000 per year funding +50% private investment Earmarked funding for projects	Focus on short-term results Max. 3 years duration EUR 150000 per year funding +50% private investment Make use of regular subsidy schemes
Participation of companies, research institutes and public organisations Creation of international partnerships	Focus on companies

Source: <https://www.vlaio.be/nl/clusterorganisaties/het-clusterbeleid/het-vlaamse-clusterbeleid>

The total 2017 budget for clusters and innovative networks is EUR 58 million. This includes both the subsidy for the facilitating cluster/network organisation and the earmarked budget for flagship cluster projects. The activities and projects can vary from dissemination activities to joint R&D projects across the whole innovation spectrum. The innovative networks make use of the regular subsidy schemes to support their projects.

A call for inter-cluster projects was launched to stimulate intersectoral collaboration between clusters and innovative networks.

Time line

This recommendation refers to the instrumental level and could be implemented on a short-term basis if additional funds were found.

Recommendation 6: Re-establish the young researchers science-business mobility programme

Rationale

Possibly the most important channel for knowledge and technology transfer is the continuous flow of human capital from academia to business, i.e. the recruitment of university graduates and/or young researchers by business firms. Usually, these new employees bring fresh ideas, concepts, methods and thinking with them. Hence, these recruitments act as links between the creation of new

knowledge at universities and research institutions and their application and testing in the business world. Thus, it is extremely important that each generation of new graduates and/or young researchers 'diffuse' rapidly within the business sector.

Slovenia was accustomed to have a funding programme specifically geared towards fostering this mobility: the annual call for young researchers from business was implemented by the Technology Agency (TIA) and backed up with resources from the European Social Fund (ESF). Young researchers from the business sector participated in research work during their postgraduate studies, on basic research or R&D applied research projects, related to their company's needs. What was also specific to this programme was the fact that PhD candidates worked with two mentors: one from the company and one from the HEI where the studies took place. This assured the relevance of the research for the company and thus contributed to the young researcher's future employability. TIA covered the salary, social contributions, as well as material and non-material costs for research and doctoral studies. The funds for the training of young researchers were allocated for a fixed term of up to a maximum of four years and six months for a PhD programme (doctorate). Around 400 young researchers were supported during the programme's lifespan. The measure received quite positive reviews and was also evaluated as a good tool to enhance contacts between academia and the private business sectors, thereby increasing the potential for further contract research and/or other cooperative links. Indeed, the programme's role was highlighted as the most important instrument for fostering cooperation between academia and the private business sector (Bučar and Rojec, 2014).¹²

Re-establishing such a programme would help to address all the challenges identified associated with the problem of science-business links in Slovenia. It might mitigate the problem of stable connections between science and the business sector since it fosters a constant flow of graduates between academia and business, reducing the mismatch between them (due to feedback information about promising occupational areas) and may even strengthen the entrepreneurial system since it guarantees a supply of skilled human capital.

Implementation hints

- The necessary funding should be redirected to a renewed intersectoral mobility scheme for PhD researchers, managed by the research agency or a reinforced 'innovation and technology' unit within SPIRIT.
- The enterprises pay 50 % of the total cost of PhD projects.

¹² Bučar, Maja, Matija Rojec (2014): Science-industry cooperation in Slovenia: determinants of success, *Economic and business review* 16 (3): 315-336, 371. Available at: http://www.ebrjournal.net/ojs/index.php/eb/article/view/329/pdf_14

- In the future, the ESF could be used to support this measure financially: to do this, it is necessary to reintroduce the measure in the next Structural Funds reprogramming period.
- Topics for these industrial doctorates could be linked to the nine priority areas of the Smart Specialisation Strategy selected by Slovenia.
- A similar scheme at the postdoctoral level could be considered.
- The mobility schemes have to be open to researchers from abroad.

Good practice

In Flanders, the 'Baekeland mandates' are projects that are assigned to a 'consortium' involving a Flemish company and a Flemish university. They support basic research that has clear economic objectives and offers added value to the company involved. The research should be directed towards achieving a doctorate (PhD) degree and meet the criteria for doctoral research. In most cases, the PhD student performs the research at the company. Both SMEs and larger companies are involved. The enterprises appreciate the scheme as a means of access to talent and academic cooperation.

Time line

This recommendation is at the instrumental level and could be implemented on a short term (or in accordance with the reprogramming time line of the Structural Funds, if it is possible to get financial support from the ESF).

Recommendation 7: Facilitate SMEs' access to research facilities available in universities and PROs

Rationale

It is stated in chapter 1 that the sophisticated science sector is confronted with a business sector, which, to some extent, has limited absorptive capacities. The latter holds true especially for Slovenia's huge SME sector. Thus it is of paramount importance to increase the capabilities of the SME sector to assess, use and process the new knowledge, ideas and methods created by academia and to cooperate with research institutions in a productive way. One particular barrier for SMEs is the costs of accessing the research infrastructures available at universities and PROs. Their access to research facilities is an open issue, which has yet to be solved in Slovenia. Some discussions about the use of public facilities by the private sector are ongoing due to doubts about the legislative constraints and impact on the universities' autonomy.

Unfortunately, SMEs do not have enough resources to purchase their own equipment and from a global perspective the use of many facilities is not optimum, which means other uses, could be integrated. It does not mean that the use should be available completely for free; on the contrary, SMEs should pay a reasonable fee (market price) for the services (not only for 'access' but also the support from experienced technicians).

This type of interaction is also very relevant to increase science-business cooperation as other additional R&D cooperation (as joint research projects or the recruitment of researchers or technicians by SMEs) can also appear as a side effect of using the facility.

Implementation hints

- The Slovenian government should provide a common framework to facilitate the use of public-sector research infrastructures as a part of their societal role within some pre-defined conditions.
- Prioritisation of SMEs is relevant although the extension of these schemes to the rest of enterprises (from Slovenia or abroad) could be considered, too.
- Universities and PROs should define the cost of public services offered to the private sector for the use of their facilities. Here, the autonomy of the universities can provide the framework to create a public offer for external users.
- Implementation could be based on a 'voucher system'. Thus, SMEs could obtain some vouchers in specific calls (i.e. distributed by SPIRIT) which they can redeem for the use of advanced equipment in the public sector.

Recommendation 8: Establish a programme to stimulate long-term, sustainable research cooperation between science and industry based on international good practice examples

Rationale

Today, in Slovenia, research cooperation between academic institutions and the private business sector is usually undertaken on an ad-hoc basis. Typically, cooperation projects are limited in both size and duration. They are usually based on a specific problem and/or question. Strategic cooperation (e.g. on a long-term basis and with an alignment of thematic areas and research questions) is very rare, although strong and sustainable links between science and industry are an important element for improving the speed and efficiency by which new knowledge diffuses within an innovation system. Hence, strategic, long-term partnerships between innovative private firms and academia are crucial to act as the 'backbone' for interactions between the academic and business sphere and to facilitate flows within the various elements of the innovation system.

A dedicated programme in which universities (and private business firms cooperating with them) receive funding to cooperate in bottom-up defined research projects (at the edge between basic research and applied science) with an intermediate time frame (five to seven years) could bridge this gap and provide the necessary incentives to engage in more stable cooperative behaviour. The main elements of such a programme are discussed below where the 'role model', Austria's Christian Doppler lab programme, is described in more detail.

Implementation hints

- The selection of projects to be funded should be made by a competitive call based on a strict bottom-up approach.
- The responsible agency for the programme could be the Slovenian Research Agency (ARRS) or managed as a joint initiative with SPIRIT.
- Austria's Christian Doppler Lab Programme could act as 'role model' for such a programme since it has also been organised to fit into a relatively small innovation system with only a limited number of large R&D intensive firms. Of course, the amount of funding and the envisaged size of the 'typical' lab should be adapted to suit the peculiarities of the Slovenian R&I system.
- In the medium and long term, the number of joint labs could be around 10-12 involving about 30 partner firms of which about a third should be SMEs.

Good practice

Austria's Christian Doppler Research Association promotes cooperation between science and business by funding dedicated research units with fixed terms over a period of several years, in which application-orientated basic research is pursued: Christian Doppler Laboratories at universities and non-university research institutions, Josef Ressel Centres at universities of applied sciences ('polytechnics'). The research groups at the CD labs work in close contact with the commercial partners on research issues at the interface between basic and applied research. In order to establish a CD laboratory or a JR centre, two prerequisites must be met: the specific needs of a company for knowledge and know-how from the application-orientated basic research, and the eagerness of academic scientists to engage in applied research in cooperation with the business partner. Both funding models are open thematically (bottom-up approach). In 2015, there were 73 CD labs and 7 JR labs involving almost 150 partner firms from Austria and abroad. About a quarter of these firms can be characterised as an SME.

The typical size of a CD laboratory (head count of researchers without director) ranges from about four to six although there is also a significant number of large labs (19 plus researchers). The funding is shared between the public sector (managed by the CD Research Association) and the private sector; 50 % of eligible costs are covered by the public purse. If SMEs are involved this amount can increase to up to 60 % (in proportion to the SME involvement within the participating private-sector entities). The funding period is seven years including a two-year introductory phase, followed by a three-year first phase of extension and finally a two-year second phase of extension. The amount of annual funding per CD lab ranges from a minimum of EUR 110 000 up to a possible maximum of EUR 700 000.

The programme is internationally open in both ways: foreign firms are eligible to join CD labs within Austria, and foreign universities are eligible to obtain funding for establishing CD labs together with Austrian firms (currently there are three CD labs at foreign universities).

Time line

This recommendation implies the design and financing of a new funding instrument so its time line for implementation is therefore assessed as medium-term (two to three years or even longer, depending on the envisaged financial size of the programme).

Recommendation 9: (Re-)introduce innovation vouchers for SMEs

Rationale

Given Slovenia's extensive SME sector and its importance for the overall economy, the specific barriers for SMEs to engage in science-industry cooperation have led to the previously mentioned mismatch between the sophisticated academic sector and the limited absorptive capacities of the business sector. Small firms usually do not have the time and financial resources to engage in intense cooperation activities with academic institutions. This is especially true for those firms, which do not have specific R&D personnel. Often, they face additional barriers to cooperating with academic institutions, such as 'cultural' barriers (i.e. different 'languages' between the business and the academic world or lack of knowledge about the possible problem-solving capabilities within academic institutions /departments, i.e. SMEs face high search costs required to identify relevant knowledge providers). Their R&D (if any) is usually undertaken on an ad-hoc basis to solve a specific problem encountered during the innovation process. To help these small firms, on the one hand, and stimulate cooperation with academia, on the other hand, innovation vouchers have been successfully introduced and tested in a number of countries. These vouchers are small grants (e.g. EUR 5 000 to EUR 10 000) to SMEs to purchase services from specific public knowledge providers (i.e. universities and PROs) in view of introducing innovations (new products, processes or services) in their business operations and/or to solve innovation-related problems. According to the Organisation for Economic Co-operation and Development (OECD), an innovation voucher enables a small firm to 'hire' knowledge providers for their innovation-related problems and thus incentivise the use of external academic sources. Secondly, the voucher stimulates the openness of academic institutions towards the small business sector since the total group of small firms constitute a significant 'demand power' for new specialised knowledge. In Slovenia, a voucher programme was in place in the period 2007-2013. However, despite a positive evaluation of this programme, it was abandoned due to budgetary constraints.

Nevertheless, especially for a country like Slovenia with its huge (and quite innovative and export-oriented) SME sector, the innovation voucher is highly adequate. It can greatly reduce cooperation barriers and act as a 'way in' to much more intensive cooperation with the academic sector.

Implementation hints

Due to their relative simplicity, innovation vouchers can be easily implemented and might be very helpful in jump-starting the 'knowledge market', especially in Slovenia since there are a lot of small firms which belong to the medium- and high-tech industries (e.g. machinery, metal ware, automotive sector, etc.) in

which innovation is a necessary part of being competitive. Thus, the 'absorptive capacity' for such a measure is already provided in the case of Slovenia.

Features of innovation vouchers should include:

- Simplicity and 'light-touch' administration: administration and implementation should be kept as simple as possible and under the control of one agency. Simple procedures are especially important to reduce the barriers for potential 'first-time' users of academic institutions as knowledge providers.
- Simple application (i.e. web-based) and selection processes as well as documentation and monitoring.
- Clear-cut definition of potential knowledge providers (universities, PROs).
- Clear-cut definition of potential beneficiaries (i.e. definition of SMEs according to EU standards).
- The introduction of a similar voucher for larger firms (i.e. not fulfilling the EU's definition of an SME) could be envisaged. However, this 'light voucher' should be on different terms, i.e. the grant equivalent should be lower for larger firms.

Good practice

Innovation vouchers are a tested 'low barrier and ease-of-entry' approach to stimulate engagement in SMEs' collaborative innovation activities. Thus, good practice example can be found in a number of European countries. An obvious example could be the relevant innovation voucher programmes (IS and ISplus) by the Austrian FFG (Research Promotion Agency). The IS (*Innovationsscheck*) is a lump-sum subsidy of EUR 5 000 which can be used for small cooperation projects with universities and other public research institutions. ISplus funds the purchase of R&D services from universities and other public research institutions by SMEs with up to EUR 10 000 but requires a financial contribution by the SME of 20 %. Both programmes resulted in a remarkable broadening of R&D active Austrian firms, which are now cooperating with public research institutions. Annual funding amounts to about EUR 2.4 million. (2016) resulting in around 340 funded projects.

Time line

This recommendation implies the design and financing of a new funding instrument. Thus, despite the relatively low cost of an innovation voucher system, its time line for implementation is medium-term (two to three years).

Recommendation 10: Facilitate the creation of a well-interconnected entrepreneurial ecosystem by supporting networking and international links among relevant stakeholders

Rationale

The creation of a complex entrepreneurial ecosystem depends not only on the existence of different types of stakeholders with the critical mass to operate in the country but also on the interactions between the different stakeholders. The main types of stakeholders, which constitute an entrepreneurial ecosystem, are:

- individual entrepreneurs, start-ups and (academic) spin-offs;
- venture capital firms and funds, private business angels;
- incubators and other intermediaries, universities with business competition programmes, firms with intrapreneurship programmes; and
- regional and national administrations.

Today, in Slovenia, there are specific examples for each of these categories. Nevertheless, the existence of a number of stakeholders does not imply that they interact properly to facilitate the creation, acceleration and scale-up of technology-based start-ups. The lack of adequate interaction means that entrepreneurs have difficulties finding potential investors, and vice versa.

There should be a consistent effort by the Slovenian government to support the continuous interaction between stakeholders while keeping a bottom-up approach towards selecting investments. There are many possible options for stimulating networking, such as: 'hackathons', summer schools or boot camps, investment forums, soft-landing schemes, demo days, special festivals (like the now prominent 'Pioneers' festivals) and specialised seminars. Today, since all these activities are carried out by individual actors they do not imply a consistent plan and suffer from fragmentation and lack of scale. Even when the cost of individual networking activities is not very high, there should be a relatively large number of events involving interested parties to generate a sound positive effect on the innovation system and dense interconnection within the start-up community. It must be said that although none of these activities individually might suffice, their combined effects might eventually lead to a better integrated start-up community.

Implementation hints

Elements of an integrated and systematic strategy and action plan for creating a modern entrepreneurial ecosystem include:

- Promoting a change in university curricula in order to incorporate the minimum set of skills to facilitate the creation of technology-based start-ups. It is also necessary to incorporate external experts as faculty members (e.g. non-permanent faculty members, business angels, entrepreneurs, etc.).

- Support for the pre-seed and seed stages of business development via a set of awareness, information, infrastructural and financial measures to raise the general number and quality of entrepreneurial projects, such as spin-offs and start-ups. Such measures already exist in Slovenia, albeit not in an integrated and coherent way. The first step towards the alignment of different actors and stakeholders from the start-up community, the intermediary institutions and from the universities and PROs would be to agree a common strategy and a common set of measures to be envisaged.
- Kick-starting a private risk capital market as well as a community of private business angels: this is by far the most difficult (and probably the most cost-intensive) to implement as the long trials required to develop private venture capital markets in other European countries has shown (e.g. in Austria, Germany, etc.). However, a start should be made and there are signs of better regional cooperation between relevant stakeholders in neighbouring countries (e.g. the ambition to create and foster a "central European venture capital fund" under the guidance of the Austrian aw Wirtschaftsservice GmbH).
- The organisation of networking activities could be funded through matching fund schemes (e.g. using the Structural Funds) to guarantee the commitment of stakeholders:
 - They will be grouped in specific focused programmes.
 - Stronger interaction with the European Institute of Innovation and Technology (EIT) could also be relevant. This stronger interaction could provide links at the international level and increase the participation in S&T areas covered by the knowledge and innovation communities.
- The training of entrepreneurs should be organised by universities in parallel to formal degrees although university students could receive some European Credit Transfer and Accumulation System credits for their effort. Different formats could include:
 - entrepreneurial boot camps;
 - summer schools organised by universities;
 - visits or open days to business incubators;
 - network meetings with entrepreneurs in some sectors;
 - Participating in international events.

Good practice

There are currently a number of 'systemic' approaches to fostering the entrepreneurial ecosystem of a region and/or country. Most of these work with a diverse set of instruments encompassing different institutional actors (funding agencies, universities, business parks, etc.). Some examples of instruments

embedded systematically within a national approach are EXIST (Germany), AplusB (Austria) and Flanders Innovation & Entrepreneurship (Belgium).

Time line

The establishment of an integrated and systemic 'entrepreneurship policy' can be assessed as a multi-stage, long-term endeavour with the required learning periods (sometimes even by trial and error). Hence, the time line for this recommendation is long-term, even though some individual elements could be implemented on a short-term basis (and even with limited resources).

2.6 Thematic grouping of proposed recommendations

In previous sections, this report has proposed several recommendations aimed at solving some of the bottlenecks in the analysis of Slovenia's R&I system. They are linked to the two major issues addressed by the report: internationalisation and science-business links, with some related to both aspects or even to the wider aspect of governance.

The recommendations proposed are of a very different nature. Some refer to policy measures, which should be implemented by the Slovenian government and its funding agencies as an internal decision. Others relate to the internal strategies of the executing actors both public (e.g. universities and PROs) and private entities, and approved by their respective governing bodies.

Furthermore, the complexity of implementing these recommendations also differs considerably. In some cases, they should be implemented through profound legislative changes. In other cases, successful implementation would require the available funds to be allocated (reallocated or increased), which implies making sound interministerial political decisions at the governmental level, and/or modifying internal regulations (i.e. definition of new funding instruments by Slovenian agencies).

Finally, these recommendations are not in total isolation. Groups of them can contribute to the same goal from different angles and time lines; in some cases, the benefits envisaged will depend on the joint implementation of some of them in parallel or even sequentially to achieve the necessary momentum and impact.

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

Following a request from the Slovenian authorities, this specific support focused on two aspects of the Slovenian science, technology and innovation system, namely its internationalisation and its capacity to transfer knowledge between the academic and the business sector. It was carried out between January 2017 and June 2018 by an independent expert group comprised of four independent experts from Spain, Austria, Finland and Belgium.

The report outlines the rationale behind the policy messages and recommendations proposed by the PSF panel to improve the internationalisation of the Slovenian science system and to improve the cooperation between the science base and business firms.

Studies and reports

