Chapter 4

The role of public research institutions in the Finnish innovation system

This chapter discusses public research institutions – encompassing higher education institutions and public research institutes – highlighting the evolution of their respective roles in the Finnish innovation system. It reviews the reforms that have taken place in both types of institutions, and how these reforms and changes to public research institutions' governance and funding mechanisms shape their research and innovation activities. It also discusses how these recent changes might impact on the performance and development of Finland's research and innovation system, bearing in mind that many of them have been adopted and implemented only very recently.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Higher education institutions

Historical background and main features

Apart from the University of Helsinki, which was founded in 1640, Finnish universities are rather young. Five were founded or became universities in the first three decades of the 20th century (Åbo, Turku, Tampere, Jyväskyla and the Hanken School of Economics), while the others have been established since the 1950s. Aalto University Helsinki was established in 2010 by merging the University of Technology (established 1849), the Helsinki School of Economics (established 1904), and the University of Art and Design Helsinki (established 1871). All of these are public universities and tuition fees are only charged for students from outside the European Economic Area (EEA), starting in 2017. The first polytechnics or university colleges, now referred to as universities of applied sciences (UAS) emerged in the 1990s, with the sector expanding significantly since then. As of 2016, there were about 170 000 students in the universities and 130 000 students in the UAS sector.

The quality and reach of the Finnish higher education system are reflected in a well-educated population. In 2015, 43% of the Finnish population aged 25-64 had some form of tertiary education, putting it at the top among the EU member states, along with the United Kingdom, Ireland and Norway (OECD, 2016d). Higher education expenditure for research and development (HERD) accounted for 0.73% of GDP in 2014, which is high in international comparison, albeit lower than in Denmark (1.01%) and Sweden (0.92%) (Figure 4.1). Today, Finnish HEIs perform a significantly lower share of gross domestic expenditure on R&D (GERD) as a percentage of gross domestic product (GDP) than their counterparts in Denmark, Norway or Sweden (Figure 4.2). This is explained by the fact that Finland has a larger public research institute (PRI) sector than Denmark and Sweden and that its business sector accounts for a larger share of R&D expenditure than in Norway.

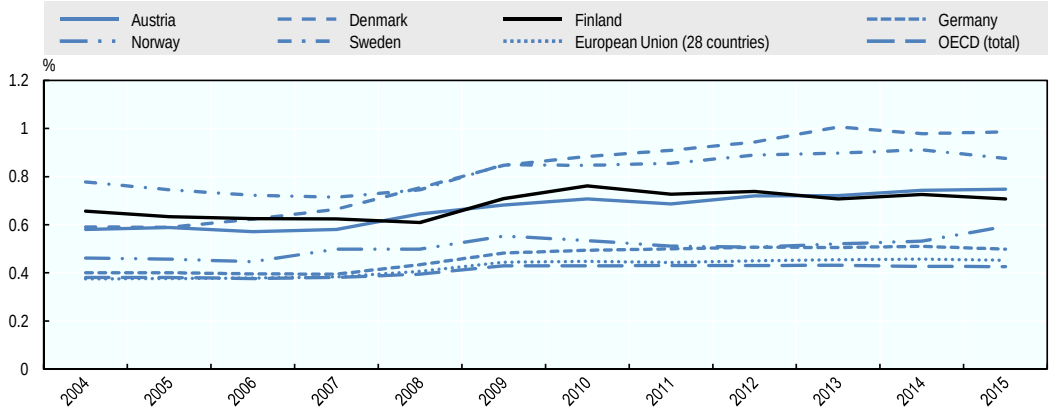
In the past decade, the Finnish higher education system has been subject to a number of substantial changes, ranging from legal and governance reforms to significant changes in funding streams and levels partially as a result of the recent global economic crisis. After a long period of continuously increasing public funding (in real terms), Finnish university funding has entered a period of stagnation and even cuts in real terms (starting in 2016). This situation, in addition to the growing necessity to enhance the contribution of HEIs to socio-economic development, reinforces the challenges for HEIs to continue adapting to a changing world while dealing with tighter resource constraints.

A dual system and different forms of innovation contribution

Since the early 1990s, Finland has had a dual higher education system, with universities and UAS, which traditionally have a strong focus on education and on meeting the needs of regional (and local) labour markets. According to Melin et al. (2015), the UAS have an explicit, legally based regional role to deliver education which is aligned with the needs of the surrounding society and industry; they undertake applied R&D and entrepreneurial activities, and help facilitate cluster development.[1] In contrast, universities have a more general obligation towards societal and economic engagement. Both universities and UAS have a legal obligation to include external stakeholders in their governance structures to ensure the relevance of education and R&D.

The dual structure of the Finnish HEI system is illustrated by the different (performance-based) funding models for its two components. Universities' orientation is reflected in a stronger emphasis on research than that of UAS, although the latter are also engaged in applied research activities and different forms of technology transfer. In 2015, 34% of universities' core funding from government was allocated on the basis of research performance; the corresponding figure for UAS was only 15%. In contrast, 85% of UAS' core funding was allocated on the basis of education performance, compared to 41% for universities. In 2014, 56.9% of total public funding for R&D went to universities, as opposed to a mere 5.5% to UAS (Statistics Finland, 2016a).

Figure 4.1. **Higher education expenditure for research and development (HERD) as a percentage of GDP**

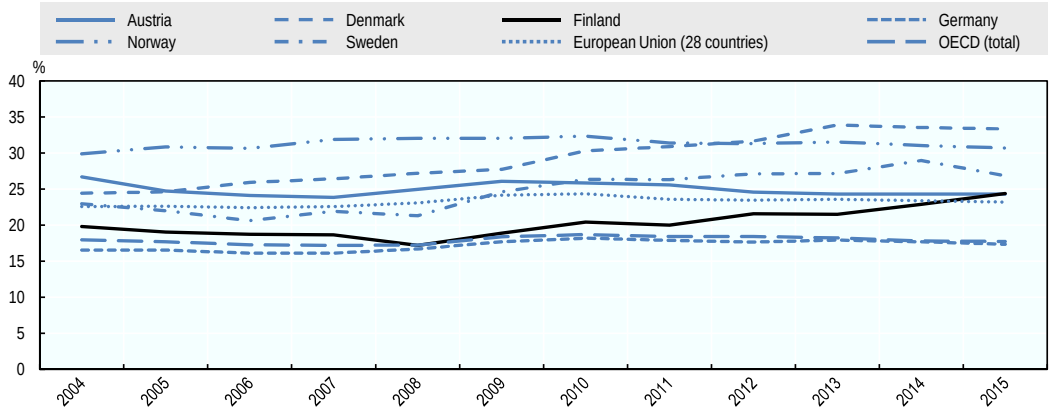


Source: OECD (2016), "Main Science and Technology Indicators (Edition 2016/1)", *OECD Science, Technology and R&D Statistics* (database), http://dx.doi.org/10.1787/db23df7c-en.

One significant change affecting Finland's system of higher education has been a wave of mergers which began in 2009. These included, in 2010, the merger of Helsinki University of Technology, Helsinki School of Economics and Business Administration, and the University of Industrial Arts Helsinki into Aalto University; the foundation of the University of Eastern Finland; the fusion of the University of Turku and Turku School of Economics and Business Administration; and the fusion of three academies of fine arts, theatre and music into the University of the Arts Helsinki in 2013 (for a more detailed account see Aarrevaara and Dobson [2016]).

Consequently, the number of HEIs (defined as universities and UAS) declined from 48 in 2009 to 38 in 2014 and will drop further to 35 by 2018, as a result of the mergers of Kymenlaakso and Mikkeli Universities of Applied Sciences into the South-Eastern Finland University of Applied Sciences in 2017 and the merger of Tampere University of Technology, the University of Tampere and Tampere University of Applied Sciences in 2018. The latter, referred to as Tampere3 will be the first merger between a university of applied science and a university.

Figure 4.2. **Percentage of gross domestic expenditure on R&D performed by the higher education sector**



Source: OECD (2016c), "Main Science and Technology Indicators (Edition 2016/1)", *OECD Science, Technology and R&D Statistics* (database), http://dx.doi.org/10.1787/db23df7c-en.

In spite of this restructuring, Finland still has a relatively large number of HEIs in relation to its size compared to other Nordic countries. Currently, there are 14 universities and 25 UAS, down from 21 universities and 27 polytechnics in 2009 (Aarrevaara and Dobson, 2016). In relation to population size, Finland has more than twice as many HEIs per million inhabitants. In relation to student enrolment, Finland has 2.18 HEIs per 10 000 full-time students and 1.24 HEIs per 10 000 total students (i.e. both full-time and part-time), considerably more than the other Nordic countries. The respective figures are 0.59 and 0.53 for Denmark, 1.14 and 0.72 for Norway, and 1.43 and 0.77 for Sweden. Table 4.1 lists HEIs and respective student enrolment for the Nordic countries. Even after the mergers of the three HEIs in Tampere and the merger of the Kymenlaakso and Mikkeli Universities of Applied Sciences, Finland will still have more HEIs than the other Nordic countries, both in relation to population size and number of students.

Table 4.1. **Higher education institutions in the Nordic countries**

	Number of universities and university colleges	Student enrolment (full time), 2014	Student enrolment (full and part time)	Population, 2015	Universities per million inhabitants	Universities per 10 000 full-time students	Universities per 10 000 students
Denmark	16	269 493	301 399	5.1	3.14	0.59	0.53
Finland	38	174 037	306 080	5.5	6.91	2.18	1.24
Norway	19	166 322	264 207	5.7	3.33	1.14	0.72
Sweden	33	230 549	429 444	9.9	3.33	1.43	0.77

Note: For comparability purposes artistic higher education institutions and business academies (of which there are several in Denmark) have been excluded. Also the Police University College has not been included.

Sources: OECD (2016d), *OECD Education Database*, http://dx.doi.org/10.1787/edu-db-data-en (accessed 9 October 2016) and national homepages (for number of higher education institutions).

Recognising that the current performance-based funding model for universities "in itself … does not provide very strong incentive to making strategic profiling choices" (Academy of Finland, 2017), the government earmarked EUR 50 million between 2015 and 2019 for a programme to be administered through the Academy of Finland to encourage HEIs to strengthen their strategic orientation by developing clearer "research profiles". In its second call, in March 2015, all of the 14 universities applied, and 12 out

of them received between EUR 600 000 and EUR 12 million for the four-year period. The need to reduce the number of HEIs and increase profiling was recognised and endorsed in a recent strategy for Finland's higher education system presented by the Rectors' Conference of Finnish Universities of Applied Sciences Arene Ry in 2016.

In addition to reducing the number of institutions, there also appears to be a need to reduce the number of small branches (around 120) of these institutions and the high number of comparatively small departments (in the same or related field of education/research) scattered across the country. The discipline units of Finnish universities are typically small. More than one-third of the university disciplines employ three professors or less, calculated in terms of full-time equivalents (FTE). Almost all universities have a maximum of nine disciplines that have at least one-fifth of the FTE of the professors of the discipline (Academy of Finland, 2016).

University reforms: The need for system consolidation and specialisation

The Finnish higher education system has undergone a number of significant changes and reforms since 2007. The purpose of the reform, according to the homepage of the Ministry of Education and Culture, was to better equip universities to secure more external funding, increase international co-operation, enable greater prioritisation and strategic focus of research, promote the quality and effectiveness of research and teaching, and "strengthen their role within the system of innovation" (Ministry of Education and Culture, 2016a). Overall, an important goal has been to strengthen the attractiveness and quality of Finnish universities by reducing what was perceived as a problematic fragmentation and duplication of research and teaching in higher education in Finland.[2]

First, as a result of the Universities Bill of 2009, Finnish universities became independent legal entities separate from the state.[3] The reform also gave universities more control over, and responsibility for, their human resources and finances.[4] The bill is in line with a recent trend in Nordic and European countries to increase the autonomy of public universities. The reform mandated that at least 40% of board members at public universities should be from outside the university. Aalto stands out in this regard, having only external board members with a very strong international orientation. Aside from Aalto, the universities of Lappeenranta, Lapland, Tampere and Vasa have a higher share of external board members than the 40% required. Overall, aside from Aalto, there seems to be potential for strengthening the international perspective and profile of the university boards.

The reform of the universities was followed by a corresponding reform of the polytechnics (UAS) in 2011 and 2015, which required them to focus primarily on teaching activities – although many of them are strongly engaged in entrepreneurial and applied research activities as well. Since 2015, UAS are limited companies with municipalities, regions and the private sector usually as joint owners (Elken, Frølich and Reymert, 2016). The vast majority of their funding, 88% according to Elken, Frølich and Reymert (2016), is in the form of direct government funding.

One of the key elements of the recent reforms has been the move to a more performance-based system for allocating government funding. Each university and UAS negotiates individual performance agreements with the Ministry of Education and Culture every four years. It is the universities' and UAS' responsibility to provide statistics to support the monitoring of their performance (Elken, Frølich and Reymert, 2016). Each performance agreement contains institution-specific targets. Feedback on performance is

provided annually and made publicly available. The evaluation process also involves on-site visits. The model has been modified twice since it was first introduced in 2013. As a result of the reform, Finland now has one of the most performance-based funding systems in Europe in terms of the share of funding allocated on the basis of performance.

The state of progress

Overall, the process of optimisation through institutional merging and department consolidation – internally within universities – has been rather slow. Yet an evaluation of the university reforms delivered in mid-2016 found that they had "triggered a significant structural and cultural change in the way universities are led" (Owal Group, 2016). Among other things, university boards have gained greater influence in universities' strategic decisions, and the rector's position has been strengthened. The changes have been heavily criticised by many university employees as severely undermining the collegiate's role and influence in decision making. As a result, the reforms, combined with significant budget cuts particularly since 2016, have, according to the evaluation, led to a sense of alienation and dissatisfaction among a significant proportion of university staff (Owal Group, 2016).

Overall, the evaluation found that universities have started to think more strategically about where they should be headed and what they should be doing. At the same time, it is still too early to discern how this increased strategic thinking has been transformed into action, decision making and prioritisation or "re-prioritisation" in terms of recruitment and the allocation of basic funding. Thus, the evaluators found that "while the increased autonomy has improved the universities' preconditions for profiling, structural reforms have progressed rather slowly" (Owal Group, 2016). A challenge with evaluating the effects of the university reforms is that many other changes have occurred at the same time, all of which affect universities, such as funding cuts, university mergers, the drastic reduction of Nokia's R&D activities, and the economic crisis.

Findings by the recent evaluation echo an earlier analysis which examined the impact of the reforms on research (Luukkonen, 2014a). Accordingly, there has not been much impact from the recent policy changes on intellectual innovation in research in Finland. University governance influences research content very indirectly and is mediated by multiple other factors, which implies that policy changes are not, at least in the short run, translated into changed research content. The report is critical of what it sees as exaggerated and misguided faith in performance measurement and performance-based funding and points to some risks, in particular narrowing research options and variety of research.[5]

Lack of flexibility and alignment with labour demand

The Finnish higher education system has been criticised for forcing students to specialise early in narrow programmes – many of which have limited attractiveness on the labour market – rather than offering more "broad-based bachelor's degree programmes, relevant to the labour market and quality- or problem-based Master's degrees" (Melin et al., 2015). The University of Aalto has tried to address this problem by reducing the number of Bachelor of Arts programmes it offers to eight and in turn making them broader. In addition, degree programmes are highly specialised and university rules make it very difficult to move from one programme to another. It is almost impossible to move course credits from one system to the other, impeding institutional and social mobility.

A considerable number of students are formally listed in the programme they were originally admitted to while waiting to get into the programme they want to be in. In 2015 and 2016, less than one-third of all applicants to HEIs were granted a place. For some programmes, for example in behavioural sciences, political science or veterinary medicine at the University of Helsinki, the acceptance rate is below 10%.[6] Many students apply multiple times. Further, it is particularly difficult for students to transfer from universities to polytechnics or vice versa, effectively creating two silos in higher education (Melin et al., 2015).

This situation has led to repeated calls for the shortening of study completion times, easier transition between different levels and programmes of education as well as a reduction of overlaps in the educational offering (Haila, 2014). Overall, the picture that emerges is one of many people wanting to study but many being "parked" in programmes they do not want to be in and too few (for this and other reasons) completing their education in time or at all.

It should also be pointed out that Finland has a very high share of part-time students. In 2014, one-third of bachelor students were part-time students, compared to an OECD average of 18%, though Sweden and Norway had even higher shares. At master's level, 60% of all students were part-time students, compared to the OECD average of 24% and much higher than in Sweden, Norway and Denmark (OECD, 2016a). As a result, many students take relatively long to finish their education and many do not finish at all.

A long-standing challenge in Finnish higher education has been that "young people graduate later than their counterparts in other countries and enter the labour market at an older age" (Ministry of Education and Culture, 2014; see also Melin et al. [2015]). In recent years, the share of students completing their degree within three years of the theoretical duration seems to have improved slightly, although at 67.7% (of the true cohort) it is still below the OECD average of 69.2% and significantly lower than in Denmark and Norway – 80.6% and 76.1% respectively – but higher than in Sweden (53.2%) (OECD, 2016a).

The government has introduced a number of initiatives to lower the age at which people enter higher education, reduce the time it takes students to get a degree, and accelerate and improve students' entry into the labour market.[7] In an effort to make it easier for first-time applicants to get admitted to HEIs, since 2016, universities are required to allocate a certain share of places, usually between 50% and 85%, to first-time applicants.[8]

In terms of tertiary graduates in natural sciences and engineering, Finland ranks above the OECD average, just behind Sweden and Germany (OECD, 2015a). In 2012, 28% of tertiary graduates belonged to these fields, whereas the OECD the average was 22%. The percentage of tertiary female graduates in these domains is, however, lower than the OECD standards (28% vs. 34%) and much lower than Denmark (36%) or Sweden (34%) (OECD, 2015a).

However, it has become increasingly difficult for people with a tertiary education in general, but young people in particular, to get jobs. Unemployment among people with a tertiary education is high, particularly among young people, compared with other OECD countries. In 2015, the unemployment rate for 25-34 year-olds with a tertiary education was 8.1%. Among OECD countries, only Greece, Italy, Portugal, Slovenia, Spain and Turkey had higher rates. Furthermore, since 2005, Finland has suffered a comparatively large increase in unemployment rates for people with a tertiary education in general and

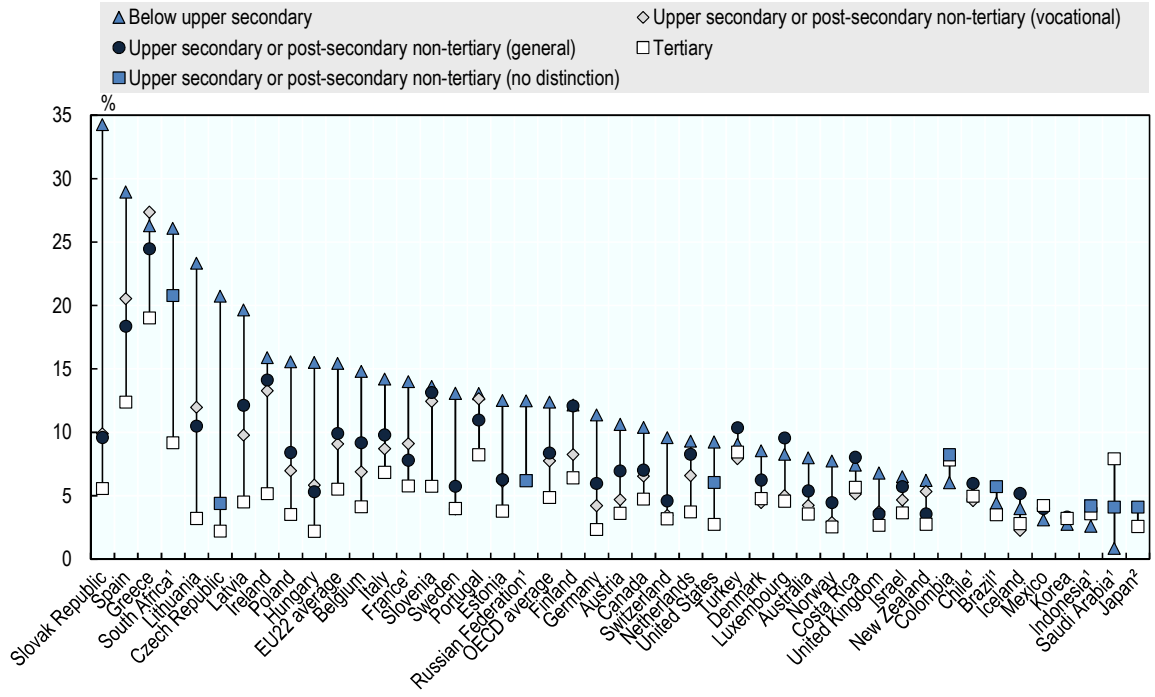
for young people with a tertiary education in particular (OECD, 2016a). Finally, the difference in unemployment between more and less educated people is low compared with many other OECD countries (Figure 4.3).

The ways universities impact economic and social development through human capital provision (tertiary and also advanced post-graduates) and their placement in industry could be improved. In regards to doctoral degrees, there is wide room for better impacting business innovation through industry placement. Strikingly, in 2015, Finland had the highest unemployment rate for people with doctoral degrees among all OECD countries for which this information is available (OECD, 2016d). This can probably be explained by a combination of the economic crisis and stagnation of funding increases to universities, both of which have squeezed the labour market for people with PhDs.

The high unemployment among people with doctoral degrees could also be explained by a mismatch between the supply of doctoral expertise and the knowledge demands by industry for advanced researchers. As recognised in the recent report on the state of scientific research (Academy of Finland, 2016), Finland should enhance the placement of doctoral researchers in industry to maximise the knowledge impact of science and innovation opportunities in the business sector. In doing so, Finnish universities and business could collaborate more actively in developing content of researcher training so that scientists can be better equipped to assume demanding positions and tasks in business and industry.

Figure 4.3. **Unemployment rates by education attainment, 2015**

25-64 year-olds



Notes: 1. Year of reference differs from 2015 and refers to last year available. 2. Data for tertiary education include upper secondary and post-secondary non-tertiary programmes (less than 5% of the adults are under this group). Countries are ranked in descending order of the unemployment rate of adults with less than an upper secondary education.

Source: OECD (2016a), *Education at a Glance 2016: OECD Indicators*, OECD Publishing, Paris, http://dx.doi.org/10.1787/eag-2016-en.

It is also important to expand career options and opportunities for young researchers in order to harness and retain this talent; the risk of migration abroad is high. With tighter budgets it is more difficult for young doctorates to find employment or temporary positions. Some universities have introduced tenure, but there are very few such opportunities and it is not solving the big issue of how such young researchers can develop their careers at universities.

An evolving funding model

The university reforms included changes to the funding model, which have made external as well as institutional funding for research performance-based and dependent upon results.[9] However, major changes have been made since the reform was introduced. The current university funding models emphasise scientific merits and publishing, and can be seen as implicitly discouraging knowledge utilisation, relevance or interaction with surrounding society. This applies to both research and education.

A new funding model was introduced at the beginning of 2017. In the new model, 39% of funding is allocated by the education metrics, 33% is based on research performance and 28% is based on a mix of the university's strategic development intentions, its activities in specific fields and its performance of various national duties, such as professional education needed by the state. The number of PhDs awarded to foreign nationals as a separate indicator has been excluded from the current model (although it is included in the indicator measuring the overall number of PhDs).

Aside from educational goals (such as the number of graduates), which account for 39% of the total basic funding allocation, the funding model for universities places a strong emphasis on research excellence in terms of peer-reviewed publications in well-known journals, on strategic development, on the ability to attract external funding and on internationalisation. The emphasis on strategic development is echoed in the targets for the government's research policy listed on the homepage of the Ministry of Education and Culture, one of which is to support the "profiling" of universities (Ministry of Education and Culture, 2017). In contrast, impact or utilisation of research, societal relevance, and co-operation or interaction with society seems to have quite low priority.

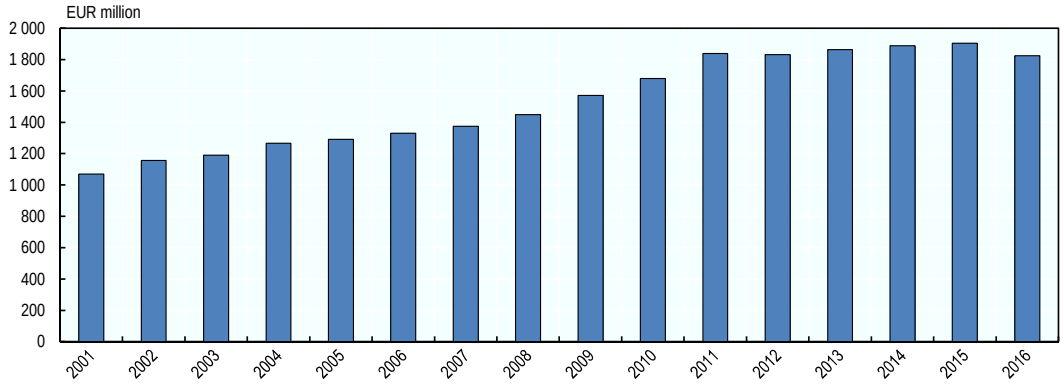
Comparing the initial 2013 model with the changes made in 2015 and 2017, there is a gradual increase in the weight assigned to peer-reviewed publications in well-known journals and in the importance assigned to strategic development. The latter also applies to UAS. In both funding models, the emphasis has been slightly reoriented towards the employability of graduates (from 1% to 2% for universities and from 3% to 4% for UAS), although the number is still low, and too low to guide universities in educating people in areas and ways useful to society. The funding model also seeks to shorten the average study duration by awarding 10% of funding to universities based on the number of students who have gained at least 55 study credits. The funding model for UAS clearly emphasises education, although its weight has declined from 85% to 79% between 2013 and 2017. The decline is explained by refocusing part of the base funding model towards strategic development.

Funding trends

In parallel to the changes in the funding model, there has also been a change in the overall trend of public funding to universities. Whereas public funding to universities increased continuously from 2001 to 2011 at an average annual rate of 6.2% in nominal terms, since 2011 total public funding to universities has stagnated, and even fell by 4.2%

in 2016 compared to the previous year (Figure 4.4). Public research funding to universities increased continuously between 2001 and 2012, at an average annual growth rate of 4.8% in nominal terms, but in 2012–2017 the funding volume has remained more or less the same, at around 585 million EUR.[10] As a result of this development, some universities have had, or will have, to reduce their staff or even lay people off; something that has been unheard of in the history of Finnish HEIs (University of Helsinki, 2015). It can be argued that the university reform has made it easier to lay people off since university staff is no longer employed by the state.

Figure 4.4. **Public funding for universities, nominal value**

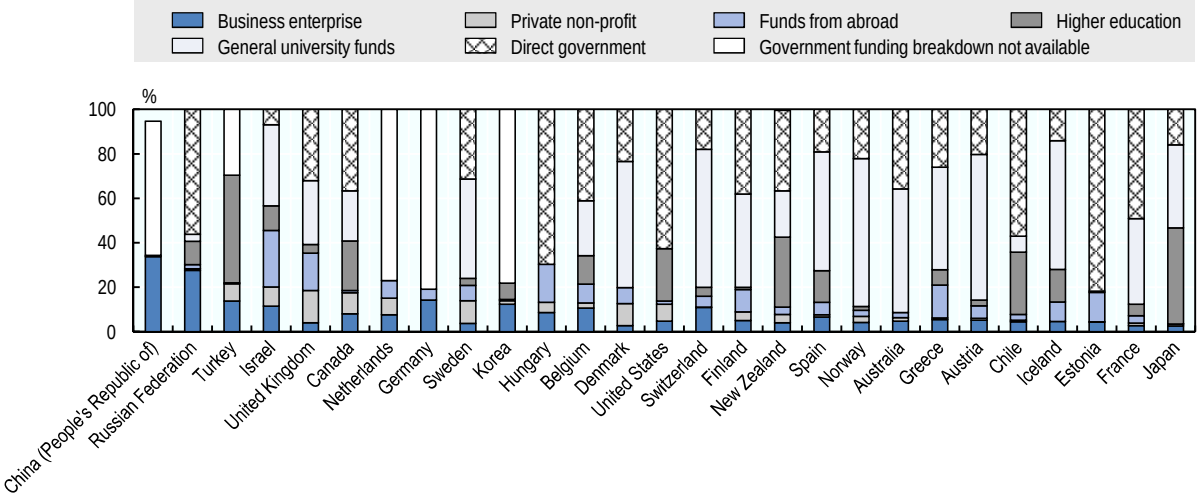


Source: Ministry of Education and Culture (2016b), Database, https://vipunen.fi/en-gb/higher-education-and-r-d-activity (accessed 5 March 2017).

Funding of R&D in higher education in Finland was predominantly from general university funds (42%), followed by direct funding from the government (38%), funds from abroad (10%) and business enterprise funding (5%) (Figure 4.5), which is broadly comparable with other Nordic countries and commensurate with OECD countries in general.

Figure 4.5. **Funding of R&D in higher education by source, 2013**

As a percentage of HERD



Notes: Data for Austria and Belgium are for 2011. Data for Australia, France, Israel and Switzerland correspond to 2012.

Source: OECD (2015), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_scoreboard-2015-en.

R&D trends and scientific performance

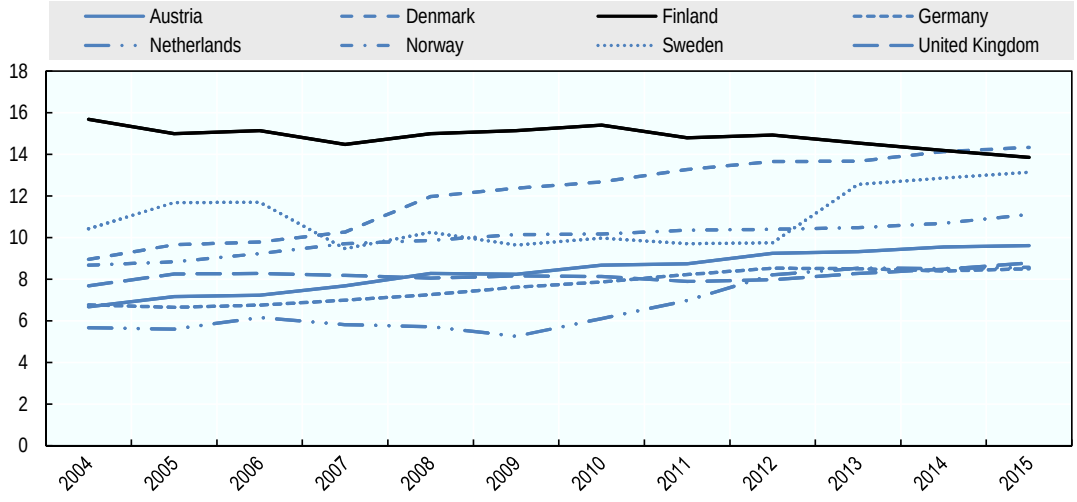
Between 2011 and 2015 universities' total research funding increased by 5.7%, largely due to a 23% increase in basic funding from the Ministry of Education and Culture. At the same time, R&D funding by Finnish companies fell by 24% between 2011 and 2015 (Statistics Finland, 2016c). In the long run, the percentage of universities' R&D expenditure funded by the business sector has fallen from 8.0% in 2008 to 4.4% in 2015. Concurrently with the changes in public funding to universities, a number of other shifts in public funding to other actors have had impacts both on HEIs' funding streams and the innovation ecosystem in which the universities and UAS operate.[11]

The number of research staff remained roughly the same between 2011 and 2015 although its composition changed. The number of administrative staff declined by close to 20% while the number of PhD students increased by 37% between 2011 and 2015 (Ministry of Education and Culture, 2016).

At UAS, total research income fell by 17.3% (in nominal terms) between 2011 and 2015. This is largely explained by a 37% drop in external research funding during that period, primarily driven by the steep cuts in funding from ministries (29% since 2012) but also business enterprises (a 41% drop since 2012) and municipalities (by 54% since 2011). As a result, the number of researchers (full-time equivalents) fell by nearly 25% during that time and the number of other R&D staff fell by even more (the exact number was not available at time of print).

Finland has long had one of the highest numbers of researchers (per thousand labour force) among OECD countries (see OECD [2015a] and Figure 4.6). In response to the budgetary stagnation and cuts, this figure gradually declined from about 15.7 in 2004 to 13.9 in 2015.

Figure 4.6. **Total researchers per thousand labour force, selected countries**



Source: OECD (2016b), *Main Science and Technology Indicators*, *Volume 2015, Issue 2*, OECD Publishing, Paris; http://dx.doi.org/10.1787/msti-v2015-2-en.

UAS and universities differ very clearly in terms of the amount and sources of external R&D funding (Raunio, Räsänen and Kautonen, 2016). Further, profiles of individual institutions vary greatly within both categories. Importantly, co-operation with business is strongly biased to only a few universities in terms of corporate funding. For example, a recent study on open innovation platforms as policy tools for fostering co-

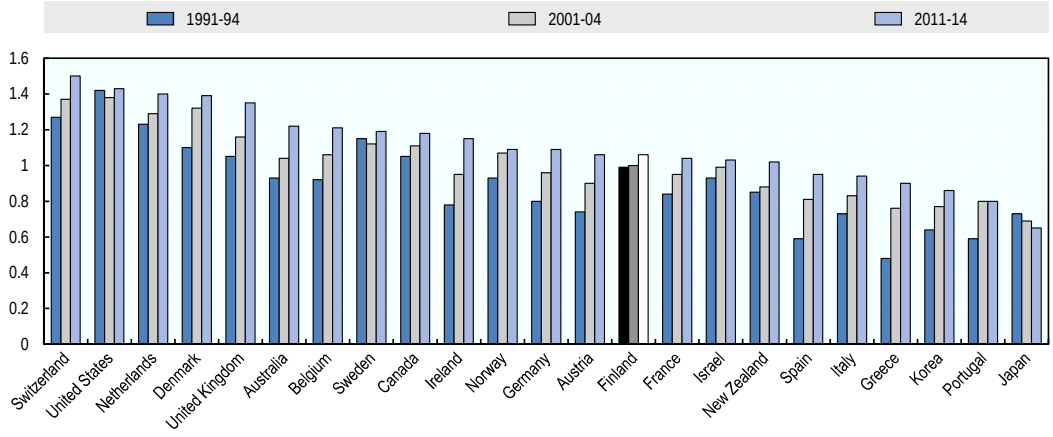
operation and value creation in a knowledge triangle (Raunio, Räsänen and Kautonen, 2016) found that:

- in 2014, the University of Tampere alone gathered 57% of the total funding from foreign companies in Finland, mainly due to its vaccination-related research
- Aalto University (technology-oriented) and Tampere University of Technology together gathered about 45% of total funding from domestic companies (about EUR 10 million each).

An important concern remains the quality of scientific research, which has slightly improved over recent years (Figure 4.7). As reported in several reports (e.g. Academy of Finland [2016] and OECD [2015a]), in an international comparison of scientific impact, Finland ranks just above mid-table and seems to be stagnating or slightly improving according to certain indicators (e.g. share in top 10% of most-cited publications). Looking at scientific impact, measured in terms of the relative proportion of a country's publications that are among the top 10% most cited in the world compared to a world average of 1, Finland is slightly above the world average at 1.06 for 2011-14. However, although there has been a gradual improvement since 1991, many other countries' top 10 index has increased significantly faster than Finland's and a number of countries that were below Finland in 1991 have now caught up with or overtaken Finland, such as Australia, Austria, Belgium, Germany, Ireland and Norway.

Furthermore, Canada, Denmark, Switzerland and the United Kingdom, which were already ahead of Finland in 1991, have seen stronger improvements in their index. Breaking down the top 10 index according to academic disciplines, business studies and economics, humanities and engineering have seen the biggest improvements when comparing the period 2011-14 to the period 2001-04 (Academy of Finland, 2016). In contrast, the top 10 indices for health sciences and mathematics have dropped, with the indicator for health sciences going from being clearly above to below the world average.

Figure 4.7. **Top 10 citation index in selected OECD countries**



Source: Academy of Finland (2016), *The State of Scientific Research in Finland 2016*, www.aka.fi/en/research-and-science-policy/state-of-scientific-research.

Ongoing efforts seek to address the risk of Finland falling behind its peers and major European countries. These include promoting strategic focus through research profiling as well as enhancing institutional collaboration (including across and within universities) and new initiatives for international research.

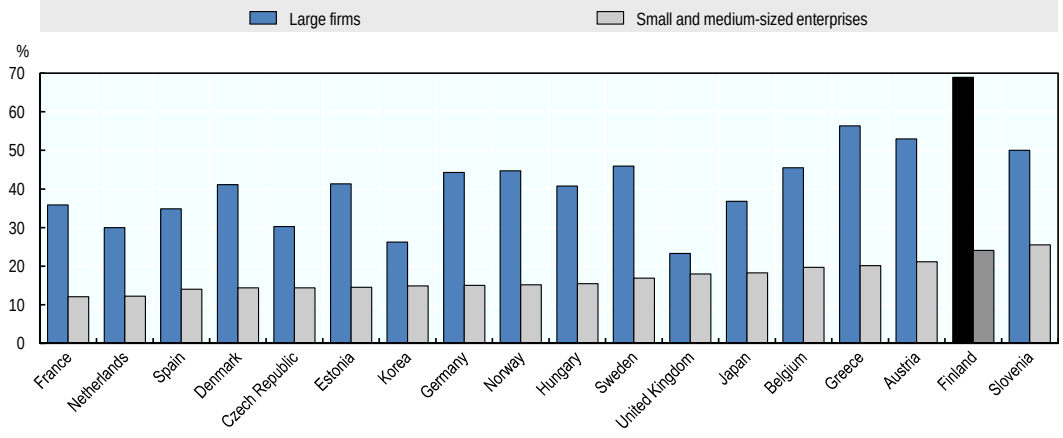
Industry-academia linkages in innovation and new forms of engagement

The volume and share of HERD financed by industry has dropped significantly since the latter part of the 2000s. Industry-financed HERD decreased from EUR 81 million in 2008 to EUR 56 million in 2015, constituting one of the biggest declines across the OECD, in relative terms (OECD, 2016b; Statistics Finland, 2016c). However, aggregate figures from national innovation surveys indicate that industry-university collaboration in research in Finland is among the highest in OECD countries. However, as in most countries, there is a wide disparity between large firms and SMEs, with the former actually being the main players in industry-science co-operation. In this case, Finland's divergence between large firms and SMEs is outstanding; larger than in most OECD countries (Figure 4.8).

There are indications that the number of co-publications involving industry and academia have been falling across the Nordic countries. At Aalto University, for example, while co-publications with their top three academic partners increased by 18% to 26% between 2011 and 2015, co-publications with their three top corporate partners fell by 37% to 98% in the same time period. Similarly, at the University of Helsinki, co-publications increased for nine out of ten of the university's top academic partners, while they fell for six out of their top ten corporate partners (Elsevier, Scival database 2016).

Figure 4.8. **Firms collaborating on innovation with higher education institutions or research institutions, by firm size, 2010-12**

As a percentage of product- and/or process-innovating firms in each size category



Note: Data for Korea are for 2011-13 and data for Japan are for 2009-12.

Sources: OECD (2015a), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_scoreboard-2015-en based on Eurostat Community Innovation Survey (CIS-2012) and national data sources, June 2015.

Another type of knowledge interaction between industry and science is technology commercialisation and licensing of intellectual property rights. The HEI Invention Law reform of 2007 provided universities with the right to own intellectual property rights of the results of publicly funded research. Prior to the reform researchers owned rights to their inventions. In the case of Finland, the establishment of universities' patent policies, technology transfer offices and the new Act on the Right to Inventions Made at Higher Education Institutions have played an instrumental role in fostering university technology transfer and commercialisation, as a variety of actors have tried to increase the relevance

of universities to economic competitiveness and encourage researchers to participate in patenting activities (Kauppinen and Kaidesoja, 2014). Yet it seems that the reform has not had any significant impact or change on the magnitude and types of knowledge transfer activities.

A survey conducted by the Ministry of Economic Affairs and Employment in 2014 on universities' and UAS' commercialisation activities between 2010 and 2013 indicates that commercialisation activities are still rather limited. The number of commercialisation projects at universities has increased, as has the number of people at universities working with commercialisation of research results, but this was from a low level, 19 FTE in 2010 (for 14 universities) compared to 41 in 2013. The number of patent applications fluctuated between 50 and 100 per year with no clear upward trend, licensing revenues in 2013 were lower than in 2010, as was the number of companies founded by researchers (41 in 2010 compared to 32 in 2013).

The cuts in Tekes' funding can be argued to have shifted resources away from long-term industry-academia collaboration (particularly with larger firms) and from commercialisation and technology transfer. The effective termination of public funding of the strategic centres for science, technology and innovation and therewith perhaps of the government's most ambitious effort to establish industry-academia networks and linkages as well as more industry-driven research agendas has not been mitigated by the introduction or ramping up of other initiatives for more long-term platforms or strategies for industry-academia research and innovation co-operation.

There are, however, numerous examples of close and mutually beneficial co-operation between large and medium-sized companies (Wärtsila, Oilon, Stora Enso) and universities and UAS in the form of investments in research infrastructure, donating equipment, student interns, etc. Such companies work closely with universities where they are located to secure the long-term supply of competence and knowledge resources. These forms of co-operation and interaction are hard to capture with quantitative indicators such as patent, licensing or co-publication data. Aalto University has strategic partnerships with ABB and Nokia involving research and education. In addition, HEIs are engaging in new forms of innovation and entrepreneurship initiatives which, increasingly, involve students, start-ups and SMEs (see for example the Open Innovation Partnership [OIP] in Tampere described in Box 4.1).

The OIP approach in Tampere also has several locally important qualities in terms of knowledge transfer (Raunio, Räsänen and Kautonen, 2016). As a new form of civic engagement and university-industry collaboration, the OIPs, as a part of the regional innovation ecosystem offering an innovative trial and testing environment for firms and other organisations, provide a stronger role for the new university in the region, and maybe even globally. The role of students as innovators is stronger in OIPs than in more traditional cluster projects; the link between learning and education with innovation is strong and direct.[12]

Box 4.1. **Knowledge triangle and three open innovation platforms in the Tampere region**

Clusters and regional or national innovation networks have evolved towards an Open Innovation Partnership (OIP) approach in the Tampere region, which encompasses research, education and innovation as well as entrepreneurship. OIPs frequently bring together multiple higher education institutions (HEIs) and other stakeholders and are examples of partnerships

Box 4.1. **Knowledge triangle and three open innovation platforms in the Tampere region** (*cont.*)

with private and/or public partners at institutional level. OIPs in the Tampere region are diverse and accommodate different activities and nature of universities and universities of applied sciences. Examples of OIPs in the Tampere region include:

- **Demola:** This case illustrates the OIP serving a large coalition of universities as it accommodates students from all three HEIs of the region, and occasionally also students from other universities outside of the region. It also clearly supports the idea of related variety, as the student teams in Demola are always multidisciplinary.
- **Mediapolis:** This case focuses on an institution with a strong regional profile, as the Tampere University of Applied Sciences (polytechnic) is a key HEI. It is based on strengthening a fairly weak knowledge base (symbolic) as no strong media cluster exists in Tampere. To some extent, it also supports related variety by bringing different knowledge bases of media (symbolic) and ICT (synthetic) together.
- **Campus arena** is located on the campus of the technical university and builds on the strongest knowledge base (synthetic) and clusters (ICT and machinery) in Tampere.

There is an emerging network of open innovation platforms in the region as this is a systemic challenge, rather than simply an organisational one. Further, OIPs also have links to wider urban development (e.g. citizen participation, innovative procurement), provision of public services (e.g. digital platforms, open data) and business development practices beyond knowledge transfer. The national 6Cites programme's OIP spearhead projects have heavily used the experiences from the work done in Tampere with OIPs, and in New Factory (est. 2008) especially. The 6Cities strategy in Tampere is implemented by teams from the city of Tampere, Tredea development agency, the University of Tampere and the Tampere Regional Council, as a joint effort.

Source: Raunio, M., P. Räsänen and M. Kautonen (2016), "Tampere: Open innovation platforms as policy tools fostering the co-creation and value creation in knowledge triangle".

Internationalisation: A continuing challenge

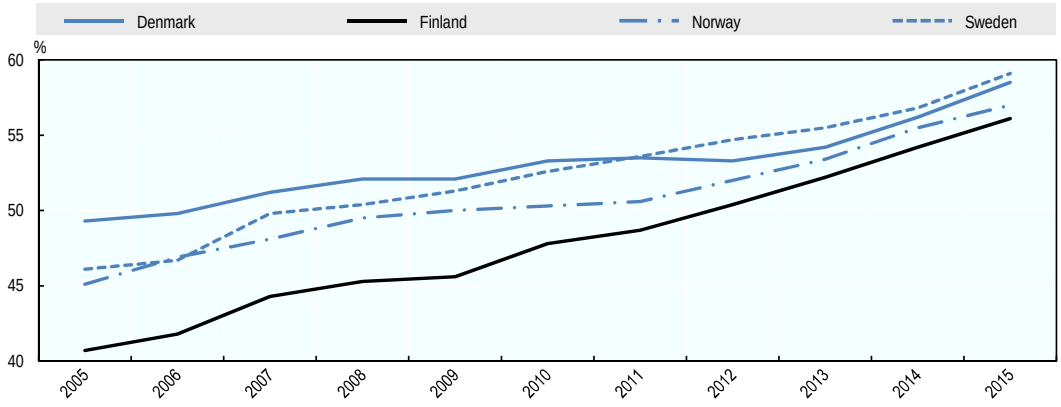
Finland has a relatively small share of international students considering that it is a relatively small country and does not charge tuition fees for non-EEA students, although it plans to introduce tuition fees in 2017. In 2014 only 19% of all doctoral students were international students, which is lower than in all the other Nordic countries (excluding Iceland for which data were not available) and 8 percentage points lower than the OECD average (OECD, 2016a).

Availability of courses or programmes in English is an important determinant of a country's attractiveness to international students (OECD, 2016a). UAS are a lot more active than universities in tailoring undergraduate education to international students. They also currently rely heavily on third-country (non-EU) students. Thus, in February 2017, there were 81 bachelor programmes in English in UAS on the "Study in Finland" website. When it comes to master's programmes in English, Finnish universities currently offer 283 programmes leading to a degree, as opposed to 44 at UAS.

Finland is the least internationalised of the Nordic countries in terms of international co-publications and co-inventions, though the differences are relatively small and the gap has been shrinking in recent years (Figures 4.9 and 4.10; Academy of Finland, 2016). The

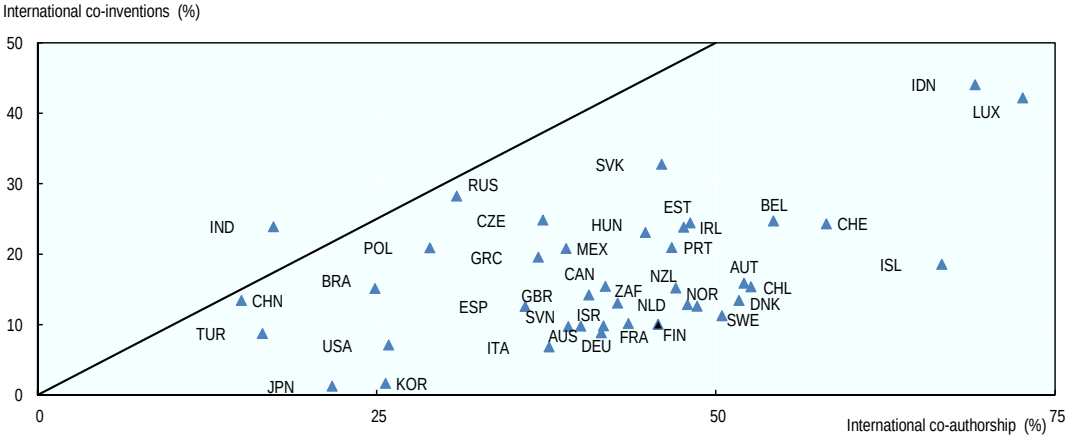
improvement is largely explained by Finland catching up to the other Nordic countries in the fields of medical science, engineering and technology, and natural sciences. The largest and most persistent gap is in the humanities, which is the area where Finland has traditionally had a very low level of international co-publications (based on the Frascati Manual [OECD, 2015b] research area classification). Overall, the Nordic countries' level of co-publications is lower than for Switzerland or Singapore, the latter of which departed from a much lower level than any of the Nordic countries only ten years ago.

Figure 4.9. **International co-publications as a share of total publications, 2005-2015**



Source: Authors calculations based on SciVal® database, Elsevier B.V., www.scival.com, downloaded on 18 October 2016.

Figure 4.10. **International collaboration in science and innovation, 2003-12**



Sources: OECD, *STI Micro-data Lab: Intellectual Property Database*, http://oe.cd/ipstats, June 2015; OECD and SCImago Research Group (2016), "Compendium of bibliometric science indicators 2014", http://oe.cd/scientometrics.

A comparison of some of the top universities (in terms of publications) in Finland, Norway and Sweden reveals some interesting insights (Table 4.2). Finnish institutions tend to have fewer foreign institutions among their top collaborating institutions than their Swedish or Norwegian counterparts. For all institutions, the Field-Weighted Citation Index is higher for international co-publications than for all publications (mirroring other analyses on citation impacts of international co-publications).

Table 4.2. **Comparison of Finnish, Norwegian and Swedish universities, selected indicators, 2011-15**

	Number of foreign institutions among top ten collaborating institutions	Total number of scientific publications	Largest publication areas	Field-weighted citation index (FWCI)	FWCI for international co-publications	Top corporate co-publication partners
Comprehensive universities with large medical faculties						
University of Helsinki	4	26 632	NS (39.6) MS (33.6)	1.87	2.44	Novo Nordisk (66) Nokia (65)
University of Turku	3	10 658	NS (39.4) MS (34.3)	1.64	2.07	Nokia (23) Novo Nordisk (22)
Lund University	6	27 177	NS (38.5) MS (33.5)	1.88	2.36	Novo Nordisk (117) Astra Zeneca (101)
Uppsala University	4	24 929	NS (42.6) MS (32.8)	1.88	2.31	Astra Zeneca SE (259) Astra Zeneca UK (79)
University of Oslo	7	25 588	MS (39.6) NS (35.4)	1.86	2.47	Lockheed (56) Statoil (52)
Technical universities						
Aalto University	2	13 389	NS (51.0) E&T (30.7)	1.65	1.93	Nokia (207) Nokia Siemens (35)
Royal Institute of Technology (KTH)	6	18 059	NS (52.4) E&T (34.4)	1.67	1.92	ABB (110) Ericsson (104)
Norwegian University of Science and Technology (NTNU)	4	18 678	NS (42.9) E&T(24.9)	1.6	2.04	Statoil (211) GE Healthcare (27)

Notes: MS = medical sciences; NS = natural sciences, E&T = engineering and technology. Institutions have been selected according to their size (top national institutions according to publications) and their comparability (in terms of makeup of research disciplines).

Source: SciVal® database, Elsevier B.V., www.scival.com (downloaded 18 October 2016).

The government has tried to promote internationalisation by including four internationalisation indicators in the budget formula according to which it allocates basic funding to universities. International student mobility, the share of Master's degrees awarded to international students, the share of international research and teaching personnel, and the share of research funding obtained in international competition (or from non-Finnish sources) account for 1%, 2%, 2% and 3%, respectively, in the funding model for 2017, for a total of 8%. However, it has removed the share of PhD degrees awarded to foreign nationals, which made up 1% of total funding in the 2013 and 2015 funding models.

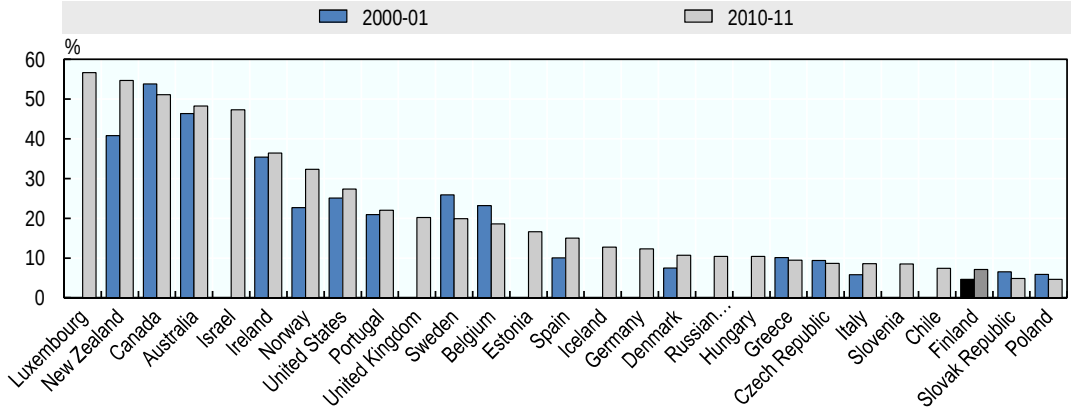
Overall, internationalisation has been given considerable attention in the new university funding models. Judging from the Swedish experience, the introduction of tuition fees for third-country students is likely to lead to a significant drop in the number of these students. Sweden suffered a nearly 80% decline in non-EEA students after it introduced tuition fees.

International mobility is an important driver and determinant of the globalisation of science, technology and innovation. According to Athreye and Cantwell (2016: 76), the ethnic composition of the inventive workforce of firms based the United States "… is an important factor in whether the firm engages in international collaboration". Similarly

Kerr and Kerr (2015: 6) argue that "[e]thnic networks have been shown to play important roles in promoting international trade, investment, and cross-border financing activity, with recent work particularly highlighting the role of educated and/or skilled immigrants…". The low share of foreign-born doctorate holders (Figure 4.11) – around 7% in 2010-11, compared to 32% in Norway and 20% in Sweden – as well as the low share of highly educated individuals in the immigrant population (Figure 4.12) and the relatively large gap between immigrant and native populations compared to other OECD countries indicate that Finland is currently not attracting global talent to the degree it could.

Figure 4.11. **Foreign-born doctorate holders, 2013**

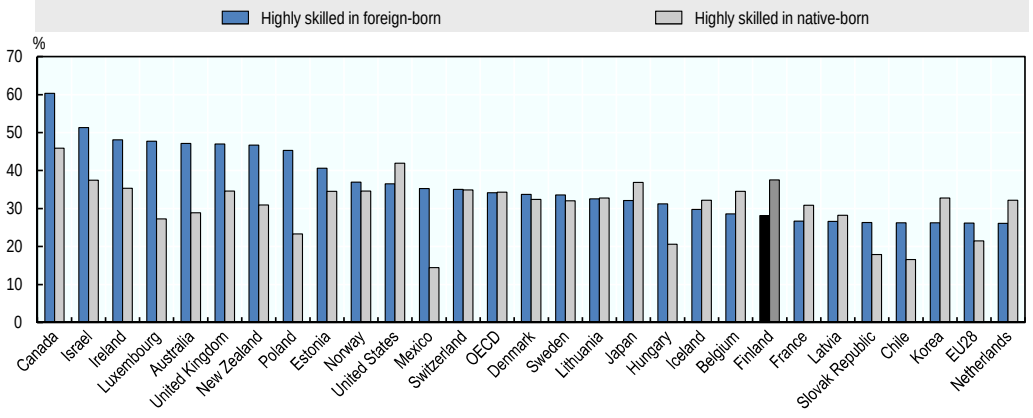
As a percentage of all doctorate holders



Source: OECD (2013), *Database on Immigrants in OECD Countries* (DIOC), www.oecd.org/els/mig/dioc.htm.

Figure 4.12. **Highly educated individuals in immigrant and native-born populations, 2013**

As a percentage of relevant group, 15-64 year-old population not in education



Note: Data for Japan are for 2010; for Chile and Israel for 2011; and for Mexico and the United States for 2012.

Source: OECD/European Commission (2015), *Indicators of Immigrant Integration 2015: Settling In*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264234024-en.

The mobility of students and researchers, though improved, remains a challenge for Finland. This constitutes an untapped potential for strengthening the research, innovation and competitiveness of Finnish actors. Greater international mobility of students and researchers could contribute significantly to strengthening the linkages of Finnish firms to emerging and strategic markets and innovation hubs. Currently, however, given the limited degree of internationalisation of Finnish HEIs, this avenue is sorely underexplored. The expected introduction of tuition fees is likely to result in a drop in international inward mobility of students, unless it is accompanied by other initiatives to strengthen Finland's attractiveness to international students and international talent more broadly speaking.

Box 4.2. **STINT Internationalisation Index**

STINT, the Swedish Foundation for International Cooperation in Research and Higher Education, has developed a tool to measure how international a higher education institution is. The STINT Internationalisation Index covers several aspects of internationalisation. The results indicate large differences between the 28 Swedish institutions that have been studied. With this internationalisation index, STINT offers a novel opportunity to measure in a relatively comprehensive manner how international a higher education institution is. Data come from established sources such as Statistics Sweden, the Swedish Higher Education Authority and Elsevier. Six aspects of internationalisation are covered:

1. research collaboration using international co-publications
2. student mobility in and out
3. international PhD students
4. educational offer in English
5. staff's international academic experiences
6. leadership's international academic experiences.

Overall the Stockholm School of Economics receives the highest value and scores five stars in the STINT Internationalisation Index. Other higher education institutions (HEIs) with a clear scientific profile such as KTH, the Royal Institute of Technology, Karolinska Institutet, the Swedish University of Agricultural Sciences and Chalmers University of Technology score high and some of the comprehensive HEIs are not far behind. The younger and smaller HEIs are, on the other hand, often considerably less internationalised.

To conclude, after a long period of continuously increasing public funding (in real terms), Finnish universities have recently entered a period of funding stagnation and even real-term cuts. The concurrence of increasing focus on research excellence – as defined by peer-reviewed papers in top journals – combined with drastic cuts for funding of long-term industry-academia co-operation (partially through Tekes' budget cuts and Tekes' reorientation towards SMEs) as well as cuts in research institutes' funding does not appear to be part of a grand design or explicit strategy. It has, however, unintended and potentially rather damaging consequences for the utilisation, relevance and societal impact of Finland's public research and the long-term competitiveness of Finnish enterprises.

In general, it seems that a large redimensioning of public funds for research and innovation has taken place and is still taking place without a clear direction, strategy or vision of what the government wants to accomplish. Particularly, the cuts in Tekes'

budget seem to have, at least to some extent, an unintended consequence of general fiscal consolidation rather than being based on a conscious shift in policy emphasis away from industry-related research and innovation funding.

There are some signs that the emphasis that has been placed on peer-reviewed publications in the new funding models, combined with the cutbacks for industrially oriented collaborative research, have led to an excessive focus on peer-reviewed top-tier publications in "safe-bet areas" at the expense of societal interaction; more explorative, experimental or interdisciplinary research; problem-oriented research; and the utilisation of research results.

Public research institutes

Public research plays a key role in innovation systems by providing new knowledge and pushing the knowledge frontier (OECD, 2014a). Public research institutes (PRIs) in Finland carry out a substantial part of the country's public research funding, totalling EUR 501.9 million in 2016 (Statistics Finland, 2016). Research performed by PRIs and government agencies accounted for 8.2% of total research in 2015, down from 10.6% in 2000 (OECD, 2016c; 2017a). The comparable figures for Sweden and Norway for the same year were 3.4% and 15.1%, respectively, though it should be pointed out that the Swedish figures do not include the research performed by the industrial research institutes or research and technology organisations grouped under the umbrella organisation Research Institutes of Sweden (RISE), since these are categorised as enterprises. The Finnish PRI sector is thus larger than in Sweden in terms of the share of total research performed, but smaller than in Norway (Table 4.3). GERD as a percentage of GDP performed by PRIs was 0.30% in 2014.

An important research performer in Finland

Historically, government research institutes have constituted an important component of the Finnish research system (Lemola, 2014). Their importance was especially pronounced from their creation in the late 19th century up until the 1960s, when there were only few universities in Finland and business sector R&D was low. Since their existence, Finland's PRIs have adjusted their objectives over a broad range of activities, governance mechanisms and funding structures, reflecting the evolution of technologies and subsequent policy priorities.

Originally, many research institutes were set up to target specific research needs of industrial sectors important within the Finnish economy, such as agriculture and forestry or health. The formation of a Finnish innovation system was facilitated in particular through the formulation of science and technology policies from the mid-1960s to the mid-1970s, building the basis of Finland's innovation system. These policies were partly triggered as a response to sluggish private sector R&D that was considered low compared to international levels (Oinas, 2005). In 1967, the Finnish National Fund for Research and Development was established to provide research and development grants financed from the revenues the fund generated over the long-run (Torregrosa, 2016). Eventually though, the allocation and administration of competitive R&D funding was assigned to the Finnish Funding Agency for Innovation (Tekes) with its inception in 1983.

Following the initial phase that had built the foundation of Finland's innovation landscape, policies increasingly focused on the support of technological innovation (Georghiou et al., 2003). Over the course of the 1980s, policies to frame Finland's national innovation system emphasised technical research along with the rapidly evolving

ICT sector (Oinas, 2005). Subsequently, Tekes' distribution of competitive research grants was adapted to funnel R&D financing increasingly to firms and research organisations, with the goal to eventually improve interaction and co-operation across firms, universities and public research institutes in Finland (Lemola, 2003).

With increasing evidence of the need to complement the support of innovative technologies with strategies to facilitate the development of innovative services, Tekes' innovation support strategy over the past decade has shifted, while sector-specific technology programmes, such as in the healthcare sector, have remained an important focus area of the agency (Toivonen, 2007). As a reaction to this call for better aligning research activities along innovative services that reflect economic and societal challenges, institutional responsibilities have shifted, and new capacities have been created, such as at Tekes and the Technical Research Centre of Finland (VTT). In addition, with shifting industrial and technological specialisation, policy design increasingly reflects changing priorities in Finland and other OECD countries (Georghiou et al., 2003). To facilitate the funding of long-term and programme-based research addressing major societal challenges in Finland, the Strategic Research Council (SRC) at the Academy of Finland was created. Chapter 6 of this report provides a detailed overview of the SRC.

Today Finland is a country with a strong, but not overly prominent, research institute landscape. There has been a trend towards increasing the share of state-funded R&D in the higher education sector, both in Finland and internationally, with a concurrent reduction in the share of R&D resources allocated to research institutes (Arnold, Barker and Slipersæter, 2010). This trend has been witnessed across all Nordic countries.[13] Finland, the Netherlands, and Norway have retained a policy of supporting a strong system of research institutes focusing on applied research and development. Sweden on the contrary "has consolidated and strengthened its rather small, applied industrial research institute system and slightly increased its core funding in recent years" (Loikkanen et al., 2013).

Yet the Finnish PRI sector's share of R&D has fallen since 2000 (Table 4.3), primarily reflecting cuts in basic government funding, and is likely to fall further as the brunt of further government budget cuts will be applied between 2015 and 2019. Public funding of PRIs has been slashed both as part of overall austerity measures and as a result of a reform specifically targeting the PRI sector, which will be discussed in greater detail below. The changes in the Finnish PRI sector are not as dramatic as those in Denmark, where many government research laboratories were merged into universities. At the same time, as opposed to Germany and the Netherlands, where R&D expenditure in the PRI sector has been relatively stable or even slightly increased, Finland's PRI sector has been shrinking continuously since 2009 and is likely to contract even further in the coming years, unless the significant cuts in public funding can be matched by increases in external funding.

PRIs made up 6 of the top 20 Finnish publishing institutions between 2011 and 2015. In Norway 7 public research institutes are among the top 20 largest publishing institutions, while in Sweden there are not any. Overall, Finnish PRIs and government agencies account for around 11% of total Finnish publications, compared to around 14.5% in Norway and less than 3% in Sweden for the period 2011-15 (calculation based on data from SciVal). The comparison underlines the greater importance of PRIs in Norway and Finland compared to Sweden, but also the fact that with SINTEF and VTT, Norway and Finland have large industrial research institutes that dominate their national contexts, while also being significant international players.

Table 4.3. **Percentage of gross domestic expenditure on R&D (GERD) performed by the government sector**

	2000	2009	2010	2011	2012	2013	2014
Austria	..	5.34	5.24	5.14	4.58	4.44	4.44
Denmark	..	2.07	2.21	2.03	2.37	2.32	2.32
Finland	10.58	9.10	9.25	8.85	9.01	8.92	8.65
France	17.32	16.31	14.02	13.85	13.16	13.03	13.10
Germany	13.58	14.81	14.79	14.52	14.34	14.88	14.83
Netherlands	12.04	12.75	11.74	10.78	11.84	12.23	11.85
Norway	..	16.38	16.41	16.44	16.42	15.98	15.24
Sweden	..	4.37	4.87	4.31	4.80	3.68	3.75

Note: .. = data not available.

Source: OECD (2016c), "Main Science and Technology Indicators (Edition 2016/1)", *OECD Science, Technology and R&D Statistics* (database), http://dx.doi.org/10.1787/db23df7c-en.

There is one research and technology organisation in Finland: VTT, under the Ministry of Economic Affairs and Employment. Other PRIs under other ministries are mission-oriented, with a broad range of research objectives. Some of them are primarily focused on research (both basic and applied), while others have a number of additional responsibilities, such as monitoring, data collection and management, certification and inspection. VTT has been unique in Finland, both due to its size and its role as a research and technology organisation with a strong focus on industry-oriented R&D (Loikkanen et al., 2013). In 2015, VTT accounted for 47.8% of all researchers (FTE) in PRIs, and it allocated 50.3% of all R&D funding, 91% of all R&D funding from Finnish companies, 97% of all R&D funding from foreign companies and 61% of all EU funding (Ministry of Education and Culture, 2016). An evaluation of VTT in 2013 concluded that "research institutes are especially important for industry in Finland because companies are more dependent on external innovation partners than is the case in the other Nordic countries or the Netherlands" (Loikkanen et al., 2013: 19).

In 2013, i.e. before the reform of public research institutes that is discussed in detail below, basic or institutional government funding accounted for 49% of PRIs' total research funding (Halme et al., 2016). In Norway, basic funding accounts for 12% of total R&D funding on average (Kotiranta and Rouvinen, 2016). In general, basic funding from government accounts for a significantly higher share of institutes' total revenue than for corresponding institutes in Norway or Sweden. At VTT, Finland's largest public research institute, basic funding from government has accounted for 20-30% of total public funding, whereas for most other institutes the share of basic public funding is 50-80%. In Norway, "block funding as a share of total operating revenue varies among the institutes, it is on average 7% among the technical-industrial institutes and 12-14% in the other arenas" average (Kotiranta and Rouvinen, 2016). For the Swedish industrial research institutes, which should be compared primarily with VTT, basic funding from the government has accounted for 18-20% of total funding in recent years (RISE, various years). By comparison, for the German Fraunhofer institutes as a whole, basic funding from the government accounted for 29% of total research funding in 2015; this does not include major infrastructure capital expenditure and defence research (data supplied by Fraunhofer Gesellschaft).[14]

A far-reaching reform of Finnish public research institutions

In September 2013, the Finnish government adopted a Resolution on Comprehensive Reform of State Research Institutes and Research Funding,[15] which focuses on building up multidisciplinary, high-level research of significant societal relevance and research in support of government decision making. The resolution covers the reorganisation of PRIs, reallocation of some public research funding to competitive research funding, and the creation of a new, strategic research funding instrument within the Academy of Finland to support long-term research on challenges facing Finnish society. The Team Finland Strategy published in June 2013, which is becoming an essential element of Finnish science, technology and innovation (STI) policy, will be updated annually but not continually reinvented, in order to maintain its long-term perspective and continuity. A first-ever evaluation of the Research and Innovation Council was conducted to support the development and strengthening of the operation of the council. The government is also carrying out the Central Administration Reform Project (KEHU) to improve co-ordination and coherence in government (OECD, 2014a).

Leading up to this reform, the Finnish government has significantly changed the funding and structure of the country's public research institutes over the past decade. The number of national research institutes has declined from 19 in 2009 to 12 in 2016 as a result of several mergers, the integration of 2 institutes into the University of Helsinki and the fact that the Institute for the Languages of Finland (KOTUS) is no longer a PRI as its research activities have been transferred to universities. Table 4.4 lists public research institutes in Finland, their mission, vision or tasks, ministry affiliation, budget and staff. The institutes vary considerably in terms of research scope, and particularly the extent to which they focus on basic academic research, as opposed to applied research, with the goal to facilitate innovation in specific sectors.

In addition, evaluation has also taken on greater importance. All the STI institutions have been evaluated, including the Funding Agency for Technology and Innovation (Tekes); the VTT Technical Research Centre; the Academy of Finland; the strategic centres for science, technology and innovation; and the Research and Innovation Council (OECD, 2014b). Subsequent to this evaluation process, changes in the organisational structure of some of the research institutes have been implemented. Thus, since 2015, the largest research institute (in terms of research funding), VTT, is now a not-for-profit, fully state-owned limited company.

The changes were initiated by the 2013 reform of PRIs, which can be argued to have been on the policy agenda since the 1970s, based on a widespread view of the need to reorient institutes in response to a rapidly changing economy and to focus them more on societal needs (see also Solberg et al., 2012). Prior to the reform, PRIs had been "under increasing pressure to ensure more evidence-based decision making and to provide effective and cost-efficient support for the ministries" (Lähteenmäki-Smith, 2014). A special study argued that PRIs' orientation along silos corresponding to individual ministry interests was out of date in the context of today's global challenges, and that they needed to be reorganised into larger, more polytechnic entities, and in some cases be merged with universities (Lankinen, Hagström-Näsi and Korkman, 2012). An international evaluation of the Finnish research and innovation system commissioned by the Ministry of Education and Culture and the Ministry of Economic Affairs and Employment in 2008 and published in 2009 pointed to the need for reform of the PRIs and "sectoral research" more generally in order to better meet the contemporary needs of society and the economy (Edquist, Luukkonen and Sotarauta, 2009).

Table 4.4. **Public research institutes in Finland**

	Mission/vision/tasks	Ministry	Budget[1]	Staff (full-time equivalents)
Technical Research Centre of Finland (VTT)	To create knowledge and know-how which benefits the renewal of business in companies	Ministry of Economic Affairs and Employment	250.7 (turnover) (2015) (34%)	2 057 (2015)
Natural Resources Institute (LUKE)	"a research and expert organisation that works to advance the bio-economy and the sustainable use of natural resources"	Ministry of Agriculture and Forestry	118.7 (2016 est) (65%)	1 319 (2016 est) (person years)
National Institute for Health and Welfare (THL)	– To promote the welfare and health of the population – To prevent diseases and social problems – To develop social and health services	Ministry of Social Affairs	165.2 (2016) 81%	946 (2016) (person years)
Finnish Meteorological Institute	"To provide the Finnish nation with the best possible information about the atmosphere above and around Finland, for ensuring public safety relating to atmospheric and airborne hazards and for satisfying requirements for specialised meteorological products"	Ministry of Transport and Communications	73 (total expenses) (2016) (63%)	627 (2016) (person years)
Finnish Environment Institute (SYKE)	Crucial information and innovative solutions for a sustainable society	Ministry of the Environment	54.8 (2016) (52%)	580 (2016)
Finnish Institute for Occupational Health (FIOH)	Specialises in well-being at work, research, advisory services and training	Ministry of Social Affairs	60.2 (2015) (55%)	590 (2015) (person years)
GTK: Geological Survey of Finland	To create solutions that embrace new technologies, advance emerging business areas and promote sustainable growth	Ministry of Economic Affairs and Employment	48.7 (2015) (73%)	460 (FTE) (2016)
National Land Survey of Finland	Performs cadastral surveys such as parcelling and reallocations of pieces of land, produces map data, and promotes the joint use of such data	Ministry of Agriculture and Forestry	136.7 (2016) (33%)	1 766 (2016)
Government Institute for Economic Research (VATT)	"An expert economics research unit focusing on public economics issues and policy evaluation"	Ministry of Finance	5.5 (2016) (ca. 66%)	ca. 50 (2016)
Finnish Institute of International Affairs (FIIA)	Produces topical information on international relations and the European Union, realising its aims by conducting research as well as by publishing domestic and international reports on current international issues	Parliament	4.1 (2016) (83%)	47 (2016)
Radiation and Nuclear Safety Authority	Protect people, society, the environment from the harmful effects of radiation, while preventing radiation and nuclear accidents	Ministry of Social Affairs and Health	39.9 (2016) (30%)	321 (2016)
Finnish Food Safety Authority	"Ensuring food safety, promoting animal health and welfare, and developing the prerequisites for plant and animal production, and plant health"	Ministry of Social Affairs and Health	55.8 (2016) (86%)	644 (2016) (person years)

1. Of which basic funding from government.

Sources: Organisations' websites.

One of the original and principal objectives behind the reform that was adopted in 2013 was that resources allocated to research institutes should be shifted from basic or primary knowledge creation to more "high value-added areas" addressing economic and social challenges prevailing in Finland. A second objective of the reform was to strengthen knowledge- and evidence-based policy making in Finland. There was also a desire to increase the share of PRIs' competition-based funding. Evaluations, for example of the National Institute for Health and Welfare, found that there was a need to increase the impact of research, and to communicate better the research results to decision makers, customers and citizens, confirming that PRIs needed to become more relevant and responsive to the changing needs of society. Finally, the reform of Finland's PRI sector intended to build their role as intermediaries between firms and universities.

The objectives were to be achieved by cutting funding from the research institutes and reallocating it, firstly, to the SRC established at the Academy of Finland, and, secondly, to a newly established Government Policy Analysis Unit at the Prime Minister's Office. Thus, basic or institutional R&D funding to public research institutes has been cut drastically, from EUR 319 million in 2009 to EUR 197 million in 2016. As a share of the government's total spending on R&D, basic or institutional funding for PRIs sank by one-third, from 15.8% in 2008 to 10.7% in 2016.

The funding cuts were applied evenly across all institutes, using a "cheese slicer" approach, i.e. funding was cut by the same percentage using each institute's government basic R&D funding in 2012 as a basis. As a result, VTT's government basic funding will fall by EUR 20.7 million between 2014 and 2017, accounting for over 30% of the total funding transferred from PRIs to the new instruments, in particular the SRC and the central government's research and analysis resources (Prime Minister's Office, 2013). The share of basic funding the various institutes receive from the government differs greatly, ranging from between 20% and 30% for institutes like VTT – which obtains a significant part of its funding from industry and competitive funding sources – to institutes that receive 70-80% of their revenue in the form of basic funding. In 2015, when cuts had already been initiated, for the largest research institutes after VTT (the Natural Resources Institute, the National Institute for Health and Welfare, the Finnish Meteorological Institute, the Finnish Environmental Institute, and the Finnish Institute of Occupational Health), basic government funding accounted for between 50% and 67% of total funding.

This approach to cutting funding could be argued to hit institutes with a lower share of basic funding significantly harder than institutes with larger shares of basic funding. As of January 2016, the funding cuts and institute mergers had resulted in staff reductions of 335 persons at VTT and 210 full-time equivalents (FTEs) at the Natural Resource Institute (data from the Prime Minister's Office). Overall, the number of researchers or equivalent at PRIs (FTEs) fell by 24.2% between 2011 and 2015 and overall R&D funding fell by 23.6% (Table 4.5). The merger of some of the research institutes was driven by a similar will to overcome disciplinary and ministerial boundaries. As stated earlier, one of the key driving forces behind the reform, adopted in September 2013, is to increase PRI's orientation towards problem-oriented and long-term research targeting solutions to societal challenges.[16] The merger of some of the research institutes, effectuated in 2015, sought to create larger and stronger organisations that can perform multidisciplinary research, rather than being limited by a narrow sector perspective, and that can compete for funding at the European level. Thus, rather than serving one ministry, the ambition is that the research needs of various ministries are well co-ordinated to guide the activities of the reformed research institutes.

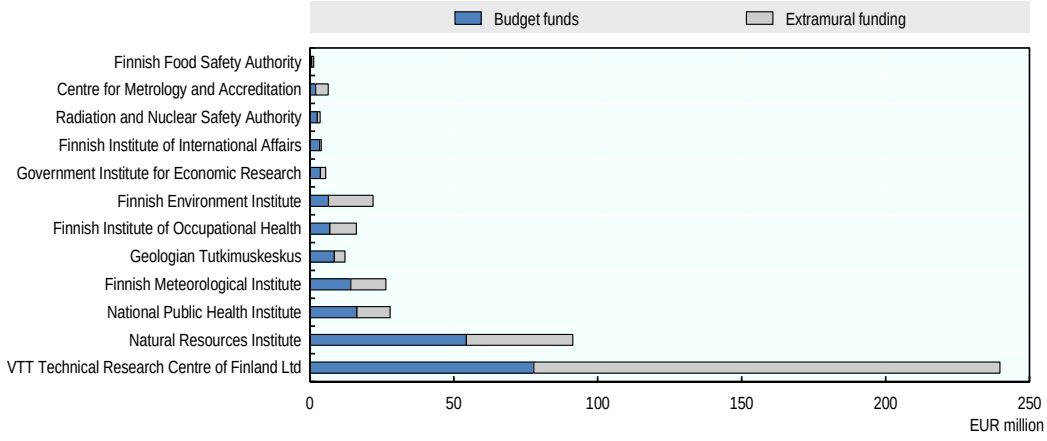
Table 4.5. **Number of researchers and research funding at public research institutes in Finland**

	Researchers and equivalent (full-time equivalent)	Research funding (EUR thousand)
2011	4 023	558 741
2012	3 849	536 947
2013	3 876	517 114
2014	3 522	488 058
2015	3 051	426 866
Change 2011-15	-24.2%	-23.6%

Source: Ministry of Education and Culture (2016), *Higher education and research and development activity database*, https://vipunen.fi/en-gb/higher-education-and-r-d-activity.

The government also expressed a desire for improved co-operation between research institutes and universities.[17] Currently, joint employment between universities and PRIs remains limited; institutes and universities co-operate primarily based on joint research projects. Some of the institutes, such as the Finnish Natural Resources Institute (LUKE), the National Institute for Health and Welfare (THL), and the Finnish Environment Institute (SYKE) maintain regional offices on university campuses, e.g. in Oulu, Turku and Jyväskylä. Figure 4.13 provides additional information of the composition of the R&D budget of public research institutes in 2016.

Figure 4.13. **R&D budget of public research institutes, 2016**



Source: Statistics Finland (2016a), "Statistics on state budget-funded research institutes, research activities, and total research funding in 2016", http://tilastokeskus.fi/til/tkker/2016/tkker_2016_2016-02-25_tau_005_fi.html (accessed 5 March 2017).

VTT was founded in 1942 and is by far the largest of the Finnish PRIs today. It provides research, technology and innovation services in Finland and internationally. VTT differs from other Finnish PRIs in size, the share of funding secured from competitive sources, and its strong focus on supporting innovation in business and industry (Loikkanen et al., 2013). In 2015, the VTT group had a turnover of

EUR 252 million and a total staff of 2 309 (FTE; data provided by VTT). It operates under the mandate of the Ministry for Employment and the Economy.

VTT is the largest multi-technological applied research organisation in Northern Europe. VTT's turnover was EUR 251 million in 2014, external revenue of EUR 163 million (65% of turnover), block funding EUR 88 million (35% of turnover) and revenue from abroad EUR 52 million (21% of turnover). VTT has four subsidiary corporations: VTT Expert Services Ltd, VTT Ventures Ltd, VTT International Ltd and VTT Memsfab Ltd. VTT Expert Services Ltd. offers certification and product approval services, testing and inspection services and calibration services. VTT Memsfab Ltd. provides contract manufacturing services in the area of microelectromechanical systems (MEMS) and other micro- and nanoelectronic devices, while VTT Ventures invests in new ventures in the seed phase. VTT has a critical role in driving Finnish participation in EU research programmes, illustrated by VTT ranking first in Finland in raising funds from EU framework programmes (22% of all framework programme funding allocated to Finland). According to the European Research Ranking, VTT is ranked fifth among research and technology organisations, and tenth among all European research organisations (public research organisations, HEIs, research units of enterprises, funding organisations) based on a composite score of project funding, number of projects, networking rank or reputation, partner constancy and project leadership (Halme, Saarnivaara and Mitchell, 2016; www.researchranking.org). This puts VTT at the top of all research organisations (including universities) in the Nordic countries. VTT Group receives basic research funding from the government to carry out its principal task, the creation of knowledge and know-how to benefit the renewal of business in companies.

For about 15 years, Nokia was VTT's primary customer, contributing up to EUR 15 million in annual funding at its peak. By contrast, in 2016 VTT only invoiced around EUR 1.5 million to Nokia. However, VTT has successfully diversified its customer base and has become an important international actor in recent years, with income from foreign sources of funding tripling in the past five years. VTT has been one of the largest recipients of EU funding in Finland in recent years, channelling around 35% of total EU funding allocated to Finland. In recent years, VTT has been targeting areas of research that could attract multinational companies to Finland (e.g. Internet of Things, healthcare). It is currently organised according to three principal business areas: "knowledge-intensive products and services" (including sensing and integration, connectivity, and data-driven solutions), "smart industry and energy systems", and "solutions for natural resources and environment". Traditionally, collaboration with universities in Finland and abroad has been extensive, very much driven by a bottom-up approach, i.e. the collaboration of individual researchers or research groups.

In terms of public funding, VTT has been hit particularly hard by the recent reforms and budget cuts to PRIs. Prior to these reforms, approximately one-third of VTT's budget for basic funding came from the government; another third came from Tekes, the Academy of Finland, EU programmes and other sources of competitive funding; and the remaining third from industry (both domestic and foreign). The reform of PRIs will lead to a significant reduction in VTT's basic funding from government (this does not make sense and the point has been said already in many other places). Furthermore, cuts in Tekes' budget have led to a sharp decline in direct funding of VTT, which was expected to drop from around EUR 50 million in 2015 to EUR 39 million in 2016. Cuts in Tekes' funding indirectly impact VTT's revenues, as large companies receiving funding from Tekes have fewer resources available to purchase research and development services from VTT. The impact of Tekes' budget cuts on VTT is expected to increase in 2017

and 2018 in addition to the cuts already applied in 2016. This is a matter of concern as VTT has played a critical role in R&D research that has more of a long-term and strategic orientation as compared to Finnish companies that are more reluctant to invest in this type of research today. Hence, Tekes' funding cuts have adverse effects on long-term and strategic collaboration across industry and academia, but also on the ability to drive radical innovation and on the ability of the private sector to develop and absorb new and enabling technologies.

While VTT continues to be successful in obtaining funding from competitive sources and from industry, the cuts in public funding, either directly from ministries or through Tekes, are restricting its ability to enter new and strategic areas for technological development. This also impedes the commercial application of new technologies with and for companies, as their development requires a long-term horizon, and funding mechanisms that companies are currently unable or unwilling to provide. In particular, Tekes' funding – often funnelled to VTT – can be argued to have been important for more strategic or long-term corporate R&D. Government funding of VTT is project- or programme driven and the result of close co-ordination with the Ministry of Economic Affairs and Employment. In this process the ministry has become more involved in setting the research specificities of VTT as compared to the pre-reform model.

Other research institutions

LUKE: This PRI was created in 2015 as the result of the merger of three institutes – MTT Agrifood Finland, Forest Research Institute Metla, and the Game and Fisheries Research Institute RKTL – and the Information Centre of the Ministry of Agriculture and Forestry (TIKE). LUKE operates under the Ministry of Agriculture and Forestry. Between 2014 and 2016, LUKE's – or the combined amount of its predecessors' – basic government funding shrunk by 20%, amounting to 65% of the institute's total funding in 2016 (LUKE estimate, 2017), compared to 67% in 2014 and 69% in 2015. The funding cuts were implemented mainly through a 20% reduction in staff. Other than in Helsinki, LUKE operates principal offices in Jokioinen, Joensuu and Oulu. LUKE's strategic objectives include the promotion of "new bio-based products and new business activities", "productivity through digital solutions" and "revitalising regions through the circular economy". In addition to research, LUKE monitors natural resources and works with certification of plant production, inspection of control agents, storing genetic resources, collecting data on greenhouse gases, supporting natural resource policies, and producing Finland's official food and natural resource statistics. In 2015, the average age of LUKE's employees was 51.

THL: The primary mission of the National Institute for Health and Welfare, under the Ministry of Social Affairs and Health, is "to promote health and welfare in Finland".[18] Among other things its objectives are to develop and promote measures that improve welfare and public health, and mitigate welfare and health problems. Further, THL is concerned with R&D relevant to meet these objectives, to promote innovation, and put forward initiatives and proposals for developing social welfare and healthcare services promoting the health and welfare of the population.[19] In addition to research, THL performs other major functions, such as operating as statistical authority, managing electronic processing of social welfare and healthcare client data, overall responsibility for state mental hospitals and social welfare units, and ensuring the supply and monitoring the quality of vaccines. In 2014, basic government funding accounted for 67% of its total funding (EUR 111 million). In 2014, THL received EUR 74.6 million from the state budget to cover its operating costs and EUR 50.2 million for specific purposes,

which constitute 82% of its total funding (EUR 152.4 million). By 2019, basic government funding will be cut to EUR 47 million from EUR 74 million in 2014. In terms of staff, THL reduced the number of employees by 23% from 2009 to 2015, from 1 238 to 951.

Finnish Meteorological Institute: The Finnish Meteorological Institute is an institute under the Ministry of Transport and Communications. Its finances consisted of appropriations from the state's budget for its core activities, and revenues from commercial services and co-funded operations. Appropriations from the state budget covered 64% of the institute's expenses. Its budget financing reached EUR 46 million in 2015 and revenues amounted to EUR 26.1 million. The institute provides weather forecasting services and is also the official expert authority on air quality, including research, development and testing of air quality equipment.

SYKE: SYKE is a research centre for environmental expertise under the Ministry of Environment. In 2016, it had 580 staff and an operating budget of around EUR 55 million. SYKE's basic funding as a percentage of total funding has declined from around 70% in 1996 to 52% in 2016. The institute's main objectives[20] can be summarised as follows: 1) produce crucial information and innovative solutions for an ecologically, economically and socially sustainable society; 2) respond proactively to society's ever-changing information needs; 3) support decision making in the public and private sectors through internationally competitive R&D activities and excellence in expertise.[21] SYKE is organised into a number of centres, such as the Natural Environment Centre, the Marine Research Centre, the Centre for Sustainable Consumption and Production, the Freshwater Centre, and the Climate Change Programme. It also has laboratories on ecotoxicology, metrology and environmental chemistry and works with data collection.

Finnish Institute of Occupational Health (FIOH): Basic government funding for the FIOH was around 55% in 2015. Outside Helsinki, the FIOH has offices in Kuopio, Oulu, Tampere and Turku. External funding amounts to a total of EUR 8.5 million in 2015, of which EUR 1.3 million were received from the European Union, EUR 2.4 million from the Finnish Work Environment Fund, EUR 1.3 million from Tekes, EUR 1.2 million from different ministries, EUR 0.7 million from the Academy of Finland, and EUR 1.6 million from various other sources. In 2015, it employed 590 persons, down from 736 in 2011. In addition to conducting research, the FIOH offers training courses in areas of occupational safety and health.

The reductions of governmental support for the three institutes that are organised under the Ministry of Social Affairs and Health – THL, FIOH, and the Radiation and Nuclear Safety Authority – have had a significant impact on research. All of these institutes have redefined their strategies, and the number of staff has continued to decline each year since the beginning of the reforms. For example, the FIOH held three co-operation negotiations between 2013 and 2016, leading to a reduction of 146 person-work-years. The reduction for THL is 287 person-years. This has an impact on further research as well as on the collaboration.

Reform of research funding for more strategic research and better decision making

One principal aim of the reform of public research funding has been to strengthen the ability of research and analytical work to inform and support policy making more systematically. To this end, the government has established lines and programmes for

funding "strategic research". The reform also seeks to strengthen co-operation across research institutes and universities through shared research equipment, laboratories, closer co-operation in research and education that includes shared staff, and the establishment of agreement-based consortia (Kotiranta and Rouvinen, 2016).

Basic funding to public research institutes was cut, and in line with the overall objectives listed above, a new funding instrument for long-term and programme-based strategic funding for research to tackle major societal challenges were set up at the Academy of Finland and the Strategic Research Council. According to the budget cut decision, EUR 70 million will be cut from Tekes, the Academy of Finland and the PRIs by 2017, and reallocated to the SRC and to the so-called TEAS-projects[22] (Prime Minister's Office, 2013).

Funding of the SRC will be around EUR 55 million, and universities as well and public and private research institutes are eligible to apply for funding. The objective is to open up competitive-based funding, which will be allocated to strategic, problem-oriented research aimed at finding solutions to societal challenges, with an explicit emphasis on supporting and strengthening policy making (Regeringens Proposition, 2014).

So far PRIs participate in the majority of projects funded by the SRC. However, relatively few research projects are under the leadership of these same institutes. In 2015, 4 out of 16 projects funded by the SRC were led by PRIs, while in 2016 in 2 out of 14 projects the consortium leader was from a PRI (based on funding decisions listed on the SRC homepage) and 1 from the Research Institute of the Finnish Economy, ETLA. Thus, the vast majority of the projects currently funded by the SRC are led by universities.

Overall, given that many of the changes referred to in this section took place only in 2015 and later, it is hard to gauge the effects of the institute reform, on PRIs and on Finland's innovation system more generally. Overall, the reform of the research institutes and research funding was driven by the desire to make institutes more dynamic, as well as making research (carried out both in universities and at research institutes) more responsive to societal and industry needs, as well as more effective in their ability to meet this demand. Table 4.6 lists the principal objectives of the reform, identifies the measures implemented and provides an assessment of their effects.

The SRC is one of the ambitious efforts to strengthen knowledge-based decision making, particularly on complex policy issues such as societal or grand challenges. These efforts do so by promoting policy-relevant, cross-cutting and multidisciplinary research and analysis on themes selected and prioritised by the government. They also put a strong emphasis on continuous interaction with potential users and beneficiaries of the knowledge produced as an integral part of the projects (particularly the SRC). The SRC requires that around 10% of project funding be earmarked for dissemination activities.

The pooling of resources and the establishment of a co-ordinating function at the Prime Minister's Office addressed an important need to overcome ministerial silos and address horizontal policy issues more effectively, as well as signalling the importance of experimentation as an integral part of innovation policy (for a description of the experimentation unit see OECD, 2017b). The attempt to strengthen knowledge- and evidence-based decision making as well as to train academics to carry out policy relevant analysis is ambitious and quite unique, at least among the Nordic countries. However, it is too early to tell to what extent efforts to strengthen co-ordination have led to improved

policy making and how the reports commissioned by the Prime Minister's Office will be used in policy making and what impact they might have. Furthermore, horizontal policy making might be strengthened further by promoting mobility among ministries, which currently seems to be very low.

Table 4.6. **Reform of research institutes and research funding**

Objective	Measure	Assessment/effect
More strategic research oriented towards societal goals	Strategic Research Council	Not clear this has been accomplished in terms of strategic research on key enabling technologies or prioritised areas, or on applied research and development (with companies and users) for concrete, competitive and scalable products and services. The Strategic Research Council is a good start to strengthen research for policy making and multi-disciplinary research, but not yet matched by translational efforts and innovation.[1]
More dynamic institutes	Cut basic funding, institutes to compete more for funds	Too early to say, but given institutes' rather generous basic funding (especially institutes other than VTT) it should mobilise institutes to seek more external funding (and thus might become more dynamic and relevant)
More knowledge- and evidence-based policy making	Pooling research resources and experimentation at the Prime Minister's Office.	Seems promising to overcome ministerial "silos", but too early to tell how the results of the analysis and research will be used in policy making
Better co-ordination of ministries' research funding and more horizontal/cross-cutting agenda for research/analysis	Ministries annually provide an overview of planned research within their respective area	This has been strengthened
More cross-disciplinary/multi-disciplinary research	Merging of institutes; Strategic Research Council	More needs to be done, such as changing education but also rethinking government programmes and focusing more on policies/initiatives that really address societal challenges; such policies and initiatives need to be both long term and flexible/reflexive; strengthen multi-disciplinary within higher education institutions.

Note: 1. In particular, development of concrete and scalable solutions where companies should play a critical role (so far there are only 3 participating business companies in 31 projects).

Cutting basic funding and merging research institutes makes sense insofar as some institutes receive rather generous basic funding, but one should reconsider the "cheese slicer approach" to institute funding. The latter can be argued to have hit VTT particularly hard, since it had significantly lower basic government funding than all the other institutes. In doing so, it also hit one of the key innovation actors in the Finnish system, and the one that focuses perhaps the most on strategic renewal of Finnish industry and industrial competitiveness.

The relatively slow rate at which external and competitive funding has increased at some institutes in recent years (particularly from the European Union, the Academy of Finland and Tekes) could be seen as a confirmation that some of the institutes could become more dynamic and responsive to changing demands. Some actors are also calling for better collaboration and co-ordination activities among institutes regarding EU

projects and the establishment of a joint venture capital institution to promote commercialisation and utilisation of research results. It is too early to say but the funding cuts, combined with new sources for funding for research on societal challenges – such as the SRC and the Prime Minister's Office's resources for research and analysis – could mobilise institutes to seek more external funding, which in turn could help them become more dynamic and relevant. It is not evident that the reform of the research institutes has led to a reallocation of resources, and a strengthening of more strategic research, which was one of the key objectives behind the reform.

Finally, the research funded by the SRC might be considered to be "strategic" in the sense that it targets important questions in society. However, while systematic efforts to identify and support strategic research and innovation in the sense of investing in the development of "key enabling technologies", or targeting areas identified by the government, such as "bio-economy", "health" or "clean-tech" are under way, there is room for more significant support in these areas. Overall, further developing strategic research, including through adequate steering and funding of public research institutions, remains a challenge.

Notes

1. One of the strengths of the UAS is close interaction with the small and medium-sized enterprise sector as well as developing entrepreneurial competence as a part of higher education curricula.
2. For an overview and analysis of these changes see, for example, Luukkonen (2014a), Aarrevaara and Dobson (2016), and Melin et al. (2015).
3. Ministry of Education and Culture (2009).
4. For further details see Ministry of Education and Culture (2016b).
5. From the same study: "In the UK, the established practice of performance measurement of universities seems to narrow notions of appropriate research content and standards of performance and is becoming an ominous factor in reducing variety and risk-taking in university research. This phenomenon is further developed in the UK, but Finland seems now to be 'catching up'…" (Luukkonen, 2014b).
6. https://www.helsinki.fi/sites/default/files/atoms/files/hu-forstagangssokande-2015.pdf.
7. www.helsinki.fi/sv/studier/kvot-for-forstagangssokande.
8. See, for example, https://www.helsinki.fi/sites/default/files/atoms/files/hu-kvot-for-forstagangssokande-2016.pdf.
9. Although the model is mostly performance-based in principle, all the funding is allocated to universities as a lump sum. Universities then decide internally how it is allocated. All metrics are calculated by using three-year averages to eliminate fluctuation in the institutional funding.
10. http://stat.fi/til/tkker/2017/tkker_2017_2017-02-23_tie_001_fi.html.
11. Starting in 2011, government R&D funding to Tekes was cut, resulting in an overall drop of 47% between 2010 and 2017, in nominal terms. At the same time funding to the Academy of Finland increased by 39%.
12. In addition, there are several practices that support entrepreneurship and innovation initiatives in the Tampere region with links to research and education, e.g. research parks, incubators or technology transfer offices, to promote student entrepreneurship and entrepreneurship training, etc. (Raunio, Räsänen and Kautonen, 2016).
13. For example, in Denmark the merger of many government research institutes into the university system is responsible for the dramatic change that has taken place in the Danish PRI system.
14. Basic funding for the individual Fraunhofer institutes varies widely and is paid out by its central organisation based on a formula including total budget volume, revenue from industry, participation in EU projects and institute spinoffs or start-ups.

15. The study also emphasised that the rest should have access to strategic research funding, some of it disconnected from their "sector" missions, in order to improve or maintain quality and encourage them to carry out more longer term research than is needed to satisfy the short-term needs of their sector masters (Lankinen, Hagström-Näsi and Korkman, 2012).

16. http://vnk.fi/documents/10616/336804/sv.pdf/f137938f-6a22-4add-993c-a2bf93fc8b49.

17. Ibid.

18. www.thl.fi/en/web/thlfi-en.

19. www.thl.fi/en/web/thlfi-en/about-us.

20. www.syke.fi/en-us/syke_info/strategy.

21. According to SYKE, joint publications with universities account for more than 70% of total publications, 20% of joint publications are with foreign universities, but the majority publications is with Finnish universities. SYKE has offices outside Helsinki, namely Oulu, Jyväskylä, Kuhmo and Joensuu.

22. The Government adopts a plan for analysis, assessment and research annually that underpins policy decision making and steers studies and research towards specific priority areas. Under the leadership of the Prime Minister's Office, a specific working group is in charge of formulating the plan. The group comprises experts from all administrative branches. The resources amount to EUR 11 million annually and they will be used for analyses, assessments, foresight reports, impact comparisons of various policy instruments and evaluations of situation awareness scenarios. These TEAS-projects span from a few months to three years.

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