Osaamispääoman hyödyntäminen ja vaikuttavampi julkisten T&K-voimavarojen kohdentaminen

Liite 1: Kuuden maan tutkimus- ja innovaatiopoliittinen vertailu

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Research and Innovation Governance in Six Countries

Austria, Denmark, Germany, Netherlands, Sweden, UK

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1 Research and innovation governance in six countries

The purpose of this chapter is to identify steering and governance practice and reforms in six national research and innovation systems, which may be of relevance in thinking about how to improve the Finnish system. We do not here make explicit comparisons with Finland – the main report draws conclusions for Finland from the experience we describe here.

The countries we examine are

- Austria – which has been moving from a follower position to one where the national investment in GERD is high, driven by large government investments, and indicators of research and innovation performance are rising, despite the tendency for traditional and corporatize governance arrangements to impede reform
- Denmark – a high performer in research and innovation that uses centralisation of research and innovation policy to a single ministry as a coordination mechanism
- Germany – a large federal system where the regions have high influence on higher education and performance is variable. There are many complex and large-scale organisations in place and the government attempts coordination through overlaying cross-cutting strategic interventions
- The Netherlands – where academic research performance is fairly strong but GERD is below the European average, owing to a structure of industry with a heavy services component and where considerable efforts have been made to focus and improve the national effort in research and innovation through governance reforms and a policy shift towards focused areas of the economy
- Sweden – traditionally a high performer in research and innovation but where the share of GERN in GDP has been declining towards the Barcelona Goal and where there is an increasing crisis of confidence in the quality of university research and where lack of coordination and the difficulty of modernising governance impede reform
- United Kingdom (UK) – a centralised system with high-performing and internationally competitive universities, few institutes and a comparatively low business expenditure on R&D (BERD) reflecting a manufacturing industry that, while containing a number of competitive and research-intensive firms, is weak overall

A description of each system is provided in an Annexe to this chapter. The reader interested in more detail or in accessing the sources underlying our analysis is referred to these.

1.1 Austria

1.1.1 Systemic governance

While Austria is a federal state, most power related to research, higher education and innovation is concentrated at the federal level. Some of the regions run their own funding programmes and agencies, but these are complementary to national policy – either adding regionally important themes or adding a further layer of subsidy to national innovation grants.

Austria is often regarded as the prime example of 'corporatism' surviving in Europe, with the social partners (employers and trades unions) together playing large roles in governance. While this means there is a degree of implicit coordination across different policy areas in practice it has also impeded change. For example, governance of the former (FFF) innovation agency by the social partners meant it was very reluctant to evolve in line with changing needs, so the state set up a range of other agencies to take on the new tasks. Finally, these were merged into today's FFG, which became an agency of the BMVIT Federal Ministry of Transport, Innovation and Technology. The enterprise development agency AWS is also governed by the social partners. A merger is being discussed between AWS and FFG that would take it out of their hands and turn it into a government agency. The research council, FWF, ha similarly suffered from the effects of being governed by its beneficiaries – in this case, the academic community – a fact that induced conservatism in its agendas, too. The case of the Austrian Institute of Technology (AIT) whish is about 49.5% owned by Austrian industry and 50.5% by the state is less well documented but it appears similarly to have found the strong and conservative voice of industry to be an impediment to change.

Austria's innovation governance system essentially has a 'two pillar' structure. That is, there is an industry ministry responsible for innovation policy and a science or education ministry responsible for research. Each has a separate high-level council to advise it on policy; the Rat-FTE advises BMVIT and the Austrian Science Council advises the Federal Ministry of Science, Research and the Economy (BMWFW). The Rat-FTE comprises a mix of academic, industrial and foreign experts while the Science Council is a wholly academic body. A consensus has emerged that the Rat-FTE recommendations apply to both ministries, while BMWFW continues to get more specific scientific advice from the Austrian Science Council. However, there are no formal coordination mechanisms that extend from the two pillars to the other ministries.

The government in the last few years has tried to overcome this problem by creating a national innovation strategy, sponsored by the Chancellor of the Republic and five ministers. A lot of this is bland – recommending that the state should do similar things to the present but better, this improving the quality of research and so on. But there are also important policy changes signalled, notably increasing competitive research finding at the expense of institutional funding and imitating the German idea of an Excellence Initiative to focus efforts on a limited number of industrial and technological priorities. An inter-ministry task force has been charged with coordinating the strategic effort, so the strategy acts as an 'overlay' on the existing government structures rather than challenging them.

Vertical steering is characterised by increasing use of New Public Management (NPM) principles such as the use of performance contracts with research and innovation finding and performing organisations including the universities and the public research organisations (PROs). In practice, the delegation of authority seen elsewhere under NPM regimes is not so advanced in Austria. For example, the university performance contracts slot into a ministry-level strategy, though the implementation is wholly a matter for the universities. Ministries often engage themselves in the detail of agency work so, for example, individual FFG programmes and even project funding decisions may have to be approved by BMVIT.

1.1.2 Governing research-performing organisations

The reform of 2003 made the universities formally autonomous from the ministry, with responsibility for their own strategies, human resource management and other matters. The Act made rectors more powerful and required the creation of governing councils with a majority of external members, thus shifting the governance model away from the traditional continental one and towards the more managerialist, Anglo-Saxon approach. The use of performance contracts seems to have had mixed success – on the one hand encouraging a more ambitious and modern approach to improved university performance but on the other failing to drive strategic specialisation among he universities. There are no real penalties for failing to deliver the planned results of a performance contract. On the other hand, the increased use of formula- and performance-based funding as part of universities' institutional funding has encouraged improved performance. The position of Austria's research system seems to be improving, compared with international competition. The increasing ratio between competitive, third party funding and institutional funding appears to have played a role in this development. Structural reform among the research-performing organisations has been encouraged by a number of' 'centres' programmes that create larger scale concentrations of research activity.

The PROs are also steered by performance contracts. Some organisations such as the Academy of Sciences ÖAW are little constrained by these while others like AIT are more clearly directed by its ministry.

1.2 Denmark

1.2.1 Systemic governance

In recent years, Denmark has sought to solve governance and coordination problems through centralising research and innovation into a single ministry. The Danish Council for Research and Innovation Policy (DFiR), comprising nine prominent personalities from business and academia, advises the Minister for Higher Education and Research and the parliament but has no coordinating power.

The agency level has been rationalised in recent years so there are now three main funders – the Danish Council for independent Research, which contains five thematic research councils, the Danish National Research Foundation, which tackles curiosity-driven research that would not find funding elsewhere in the system, and the Innovation Fund Denmark, which funds innovation and entrepreneurship, mostly via large-sale academic-industrial collaboration projects.

An apparent weakness of these centralising reforms is that (as with 'two pillar' systems) the coordination with other ministries is poor. The government has sought to overlay (separate) national strategies for innovation and research on the existing structures. These are based on wide consultation and drive budget allocation to five major themes. The Innovation Strategy, in particular, points out that while Denmark's universities perform at a very high level in terms of research, the ability to do technological innovation in the country seems to be more modest, suggesting that there is insufficient coordination between the research system and its industrial and societal 'users'.

In 2007, the main government labs ('sector research institutions') were merged into the universities. It was hoped hat this would at once raise quality and allow the labs to continue to provide research and other services to government. An evaluation of this reform as part of a wider pattern of university mergers was done in 2009 and was cautiously positive, based on the fact that there was so far little evidence. While increasingly clear performance contracts have been developed between the labs and their parent ministries, it is argued that the sector ministries have too few scientific resources to manage the labs well. An academic faction argues that their funding should be subject to competition among universities (and, by implication, that the labs should be completely absorbed by the university system). In contrast, the research and technology institutes (GTS) have stayed independent, though they maintain research links with certain universities. The GTS institutes have low core funding and hence work with problems that are closed to market than those tackled by organisations such as Fraunhofer, TNO or VTT. Past evaluations have been positive. A new one is just starting. The very applied nature of the GTS institutes supports the idea of a capability gap between Danish industry and the universities, referred to in the Innovation Strategy. It is not clear how this is being addressed in practice.

1.2.2 Governing research-performing organisations

Denmark has a strong NPM tradition and makes extensive use of performance contracts – including with the universities and PROs – even though it is not clear how strongly the ministry can enforce these contracts in the case of non-delivery.

The 2003 university reforms required the universities to have councils with a majority of external representatives and increased the internal power of the rectors, this pushing them a little in the direction of the Anglo-Saxon managerial university model.

Universities have seen significant income growth in recent years, followed by cuts in the lifetime of the current government. They receive a very high proportion of their income for research in the form of institutional funding. A small proportion of the institutional funding is now driven by a performance-based research funding system (PRFS), largely modelled on the Norwegian one.

Universities' performance contracts with the ministry focus on quality in education, greater relevance and transparency, better coherence and collaboration, more internationalisation and the promotion of social mobility. Individual universities can insert other aims. So the ministry does not attempt thematic steering through the block or institutional funding.

1.3 Germany

1.3.1 Systemic governance

The German system is large and, because of the important role of the Länder in higher education and research, also complex. The Länder have primary responsibility for organising the universities. At federal level, Germany operates a 'two pillar' system, involving the Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Technology (BMWi). This is generally mirrored at Länder level and the Länder have their own research and innovation policies.

The Deutsche Forschungsgemeinschaft (DFG) is in effect an agency of BMBF and functions as the national research council, providing competitive project-based funding for investigator-initiated research – both at the level of small projects and of various centre-like arrangements that encourage scale or inter-university cooperation. BMWi uses a handful of large intermediary organisations as programme managers (Projektträger) to operate researchoindustry collaboration programmes, so there is no single innovation agency. Projektträger compete to win programme management contracts, so while they accumulate operating experience they do not play the kind of strategic or policymaking support role performed by innovation agencies.

In addition, there are significant private foundations (such as the Bosch and Volkswagen Foundations) that support academic research and can sometimes be more flexible in their choice of themes and funding arrangements than the federal arrangements.

Several other sectoral or mission ministries have their own research and innovation policies, maintain their own government labs and carry out their own strategic activities such as foresight exercises. There are said to be poorly coordinated with each other and with the two 'pillar' ministries, BMBF and BMWi.

Several bodies advise the government on research and innovation.

- The Wissenschaftsrat is sponsored equally by the federal state and the Länder and provides advice on the development of the university system, science and research
- The Commission of Experts for Research and Innovation (EFI) reports to the Chancellor of the Republic and advises on research and innovation policy
- The Leopoldina national academy of sciences also offers advice in cooperation with the National Academy of Science and Engineering and academies from Berlin and the Länder
- The Joint Conference on Science (GWK) coordinates research and innovation policies between the federal and Länder levels
- The Innovation Dialogue is a platform comprising high-level representatives of academia and industry with the BMBF and BMWi ministers, intended to advise on the overall shape and framework conditions for research and innovation

The plethora of organisations and structures makes the entire system especially hard to coordinate. Government has tried to address this problem not by restructuring but by overlaying strategic initiatives such as

- The High-Tech Strategy, which organises funding for a focused set of cross-cutting technologies and societal missions such as climate change
- The Excellence Initiative, which focuses research funding on a minority of universities with the aim of creating a cadre of elite universities able to compete better at a global level
- The Higher Education Pact, which is a joint effort of the federal and Länder levels to fund expansion of the higher education system, in line with rising demand

Nonetheless, the scale and complexity of the German system makes it slow to respond to policy impulses – and the policy fragmentation induced by the Länder only exacerbates this.

1.3.2 Governing research-performing organisations

The fact that the Länder run the universities means that there is a huge diversity of steering arrangements in place. Many Länder award some of the institutional funding for research based on performance, but the ways in which they do so vary among them. Equally, some universities are able to organise their own governance while in others the Land appoints the executive leaders.

The PROs are organised in four institute groups: The Max Planck Society, which essentially does basic research the Fraunhofer Society, which comprises a chain of RTOs; the Helmholtz Association does long-term research on behalf of the state and society in Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space; the Helmholtz Association, which comprises applied research institutes using large and expensive equipment – typically too expensive to be funded within the university system. They all tend to have strong links to universities. In the Fraunhofer Society, institute directors also have to be professors at a university (often but not always adjacent to the institute). All four groups are funded jointly by the federal and Länder levels, but with the central state paying the lion's share (except in the case of Max Planck, where the costs are shared equally between the two levels). Both are represented in the governance of the institute associations, though the institutes themselves in practice have a high degree of autonomy. The extent to which they rely on third party funding varies. The Max Planck institutes are almost entirely funded from their block grants while Fraunhofer institutes get about one third of their income from core funding, the exact amount depending in part on their success in winning various forms of third-party funding. The funding and governance structures mean that it is difficult to exert policy influence on the PROs, except in the form of incentives from third-party funders.

'Sector' ministries in Germany maintain their own set of government labs and fund them almost 100%. They are tightly controlled by their parent ministries and appear to be hard to involve in horizontal research issues that go beyond the remit of their ministry. As a result, they only play a small role in the wider research and innovation system.

1.4 The Netherlands

1.4.1 Systemic governance

The Netherlands operates a 'two pillar' form of organisation with the Ministry of Economic Affairs (EZ) maintaining a substantial innovation agency (RVO.nl – itself the result of a series of mergers of more specialised agencies) – and the ministry of Education, Culture and Science (OCW) funding research through the national research council (NWO) and the Royal Dutch Academy of Arts and Sciences (KNAW). KNAW also plays an advisory role to the government and runs a number of research institutes. One of the sub-councils of NWO funds innovation research and is financed by EZ; another sub-council for medical research is financed by the health ministry, so NWO functions to a degree as a multi-principal agency, though there appears to be little cooperative funding of NWO projects or programmes. In total, ten ministries have research budgets.

EZ additionally has responsibility for funding the PRO sector while individual ministries maintain about ten government labs.

While KNAW and some other bodies provide advice to government about research policy, the main advisor on research and innovation is the Advisory Council for Science, Technology and Innovation (AWTI). However, government coordinates research and innovation policy in cabinet sub-committee on economic affairs, infrastructure and the environment. As a cabinet committee, this brings together ministers from multiple ministries. The government operated an 'Innovation Platform', under the prime minister, between 2003 and 2010, but this was abandoned when the government adopted a 'Top Sector' policy in 2011. The Top Sector policy transfers to industry-led groupings of industry, academia and government the act of strategic planning for the research and innovation needs of key sectors of society. EZ and OCW have increasingly been obliged to realign their research and innovation priorities to favour the Top Sectors. In practice the nine Top Sectors are a continuation of previous innovation policy priorities. It is argued in some quarters that focusing on these sectors also implies focus on established industry, transferring resources from new areas of potential growth to existing industry, while excluding mid-sized firms, which in the Netherlands tend to suffer from an innovation deficit.

Each Top Sector operates under a (non-binding) contract with EZ. Over time, the focus of the Top Sectors has shifted so that they not only address key industrial sectors but also start to tackle the societal challenges. A total of nineteen Top consortia for Knowledge and Innovation (TKIs) implement the sector research strategies. To achieve this, the TKIs are absorbing the former Technological Top Institutes (which considerably antedate the Top Sector policy and effectively comprise virtual competence centres).

Since 2014, there has been a parallel effort to develop a national science strategy, grouped into five main themes and implemented by a 'knowledge coalition' that includes the universities association (VNSU), KNAW, the TNO research and technology organisation and NWO.

- People, environment and the economy
- Individual and Society
- Diseases and Health
- Technology and Society
- Building blocks of life

Individual funders are responsible for their own part of the 140 research questions that underlie these themes – the Knowledge Coalition only monitors progress. While some NWO grants are expected to be influenced by the agenda, it appears to be a rather weak form of coordination.

The RTOs have grouped together to form the TO2 organisation, with the intention of making their overall service offering more transparent and effective.

A key aspect of governance in the Dutch system, therefore, is the generation of specific policy at an intermediate level – that of the Top Sectors, NWO, KNAW, TO2 and so on rather than

either attempting to produce a comprehensive strategy top down from the government or simply relying on bottom-up aggregation of demands for research funding. While this means that there may be gaps in policy, it also may achieve a better horizontal coordination than is normal in countries that rely solely on formal coordination among ministries. At the same time, the coordination (especially in the Top Sectors) uses more generic funding instruments than in the past, rather than having specific instruments for specific sectors. Such a policy may also be vulnerable to the kind of lock-ins by beneficiaries observed in the Austrian system and to funding mediocre research because it happens to fit with Top Sector priorities, and make it difficult to achieve more generic objectives such as research excellence.

1.4.2 Governing research-performing organisations

University reform began earlier in the Netherlands than in some of the other countries considered here, with reforms enacted in 1997 tending to shift university governance from co-management with the faculty towards a more managerialist model with an empowered rector where the traditional collegiate mechanisms were purely advisory. The ministry appoints the supervisory board, which in turn appoints the executive.

Formula funding was introduced as early as 1993 but while some of the indicators used measure outputs such as degrees awarded, there is not a PRFS in place in the sense of a system that tries to measure and evaluate research outputs. Peers using the so-called SEP protocol evaluate universities periodically, but their findings are advisory. While the original policy intention was that the SEP protocols would help the ministry steer the universities, this hope has not been realised.

Since 2008-11, the universities have signed performance protocols with the ministry, which **do** affect funding equivalent to 7% of the teaching income. Failure to meet targets can result in a reduction of funding in the subsequent three-year period. Owing to opposition from the universities, it is unclear whether this mechanism will continue to be used in the future.

NWO and KNAW each controls a small number of research institutes, I some cases providing instrumentation and other facilities to others in addition to doing their own research. They do not seem to be much affected by wider research policy. Ministries maintain a small number of government labs, which they manage directly via performance agreements.

The RTOs moved from being controlled by OCW to EZ in 2011, since when EZ has tried to integrate their work more thoroughly with priorities set in the Top Sectors. Their core funding comprises a small element that provides continuity and a larger one that funds themes agreed with EZ, which should in principle be consistent with wider policy priorities. Since core funding is used by RTOs to fund research and other forms of knowledge acquisition in order to provide the intellectual base for their overall activities, this mechanism is expected to affect the overall pattern of activity in the RTOs. Government steering is therefore strongest in the government labs and RTOs and weaker in the other institutes and the university sector.

1.5 Sweden

1.5.1 Systemic governance

Sweden also has a 'two pillar' system, with the ministry of Enterprise and Agriculture on the one hand and the Ministry of Education and Research on the other together accounting for over 80% of the government's R&D expenditure. By tradition, Swedish ministries are small and act through large and capable agencies. While the big lines of policy are decided at ministry level, therefore, the agencies maintain their own strategic intelligence and tend to initiate and design programmes. The Swedish universities have since the 1940s been assigned the task of acting also as 'research institutes' for the state and society. As a result, the institute sector is Sweden has been small – though in the last decade or more successive governments have recognised the weakness of this position and the inability of the universities to fulfil such a wide roles, increasing core funding from about 10% to about 15% and organising the RTOs into a holding company in order to build a VTT-like structure out of the existing rather fragmented set of institutes, many of which began life as branch institutes.

The Swedish Research Council is by far the largest of the agencies in budgetary terms, reflecting the de facto power of the education ministry. The industry ministry's Vinnova agency is less than half the size. Two other agencies – Formas and Forte – are multi-principal agencies that fund a mixture of basic and applied research.

Private foundations are major funders of research – the Wallenberg Foundation disburses something over a billion crowns per year, which is something over half the size of Vinnova's budget. A group of 'wage-earner fund foundations were set up with state money but outside the state's effective control in 1994 and pursue semi-independent funding roles. The largest – the Strategic Foundation – took over a number of areas of funding of new and emerging technologies from Vinnova's predecessor. Like the other wage-earner fund foundations, it now finds itself working in an area of funding from which the state system more or less abstains, yet with dwindling resources. No effort appears to have been made to reintegrate these areas (especially strategic research, environment and the funding of the regional universities and colleges) back into the state's funding portfolio.

There is no strong intra-governmental coordination mechanism beyond the normal operation of government. The education ministry and minister lead discussions of research in the government and write the periodic research bills (most recently a 'research and innovation bill' that was nonetheless essentially crafted by the education ministry).

For many years, a series of academic advisory committees (*forskningsberedningen*) have advised ministers of education on science policy, there has never been a high-level council responsible for providing the government with overall advice about research and innovation policy. The current government has established an 'innovation council' that is supposed to furnish it with innovative policy ideas but it appears to have neither power nor influence and is widely derided as a 'coffee club'. Overall, therefore, the Swedish system is rather decentralised and uncoordinated – at least from above. In practice, the major funding agencies often jointly fund initiatives; sometimes the state's funders are instructed by government jointly to implement new policies, such as the 'strategic innovation areas' (SFOs).

The SFOs arose in the form of an increment to universities' institutional funding for research, but they had to compete to win thematic programmes in order to access the money. In principle, once the programme period of five years expires, they are free to reallocate the incremental institutional funding. A corresponding initiative from the industry ministry is the launch of strategic innovation areas (SIOs). These are industrial-academic consortia that launch Strategic Innovation Agendas and then may persuade Vinnova to launch project competitions to implement the agendas. (Vinnova retains control of the proposal assessment and funding decisions.)

Not only the lack of coordination but also the form of governance used appears to impede the development of research and innovation policy. In particular, the three research councils have governing bodies dominated by elected academics, which are therefore somewhat immune to policy. Vinnova, in contrast, has a governing policy chosen by the government.

1.5.2 Governing research-performing organisations

The state universities are formally agencies, so they are steered via annual letters of instruction by the education ministry. In recognition of their autonomy, however, the requirements that these instructions impose upon the universities are rather, general, leaving them essentially free to define their own roles and strategies. University governance has slowly been modernised in recent years and since 2011 they have been free to choose their internal form of organisation and have a small majority of external stakeholders. The role of academic elections in determining internal governance is diminishing, except in the traditional, broad-spectrum universities. While the government appoints rectors, it has to do so while taking into account the views of the faculty and students, so the effectiveness of the governance reforms can be questioned. Arguably, much of the university system involves sufficient academic self-governance to limit its ability to devise strategy and indeed the responses of the university sector to government requests for it to strategise have been rather weak.

The university research funding system has a high proportion of third party funding, approaching 50%, so it is highly competitive and recent governments have sought to mitigate this by increasing basic funding. However, the universities tend to respond to this by hiring more faculty, perpetuating their high dependence upon third party funds, rather than by consolidating the positions of established faculty.

The high proportion of external funding means that the universities have to be sensitive to external incentives, of which research council funding is the largest. Despite the high level of competition, however, there is concern that the Swedish system does not produce much research at the very highest international levels. Conventionally, the universities blame the lack of core funding for this, which is regarded as something of a crisis. A PRFS has been in operation since about 2010, allocating an increment of 10% to institutional funding that was announced in the previous Research Bill. However its redistributive effects have been very minor and a proposal to refine the system and apply it to 20% of funding appears to have stalled.

Difficulties caused by the governance system for the universities are therefore recognised, but the governance itself appears to be allowed to impede significant change.

1.6 The UK

1.6.1 Systemic governance

The UK has abandoned the two-pillar system and now has a single ministry – the Department for Business Innovation and Skills – in charge of both research and innovation funding. It allocates two 'streams' of funding for research to the universities: institutional funding for research (almost all of which is allocated through the REF PRFS); and competitive funding through the research councils and their umbrella organisation RCUK on the one hand and the Innovate UK innovation agency on the other. There is also a powerful private foundation sector, dominated by the Wellcome Foundation, which focuses on health research. More than 50% of UK university research funding comes from third-party sources. Given that almost all institutional funding is also competitive (via the REF), the UK system is clearly one of the most contested in the world.

There is currently a debate about whether to merge RCUK and Innovate UK into a Norwegian-style combined research and innovation agency, though the policy purpose remains obscure. The REF is being reviewed, with the hope that its cost and complexity can be reduced. The government has reallocated research council and development aid funding to provide a cross-council Challenge Fund within the research councils. Its effectiveness has yet to be determined.

All ministries have a Chief Scientist, providing scientific advice for policy. There is a high-level Council for Science and Technology that advises the prime minister on scientific matters (as well as a dedicated Chief Scientific Adviser to the prime minister), but there is no coordinating body for research and innovation policy.

The government does little to steer the direction of the university research effort. Having in past years reduced the funding and scope of the government labs and the RTOs, there is not much more in the system that it could in any case influence. The weakness of UK manufacturing industry means that BERD is small compared with the size of the country. Some see a paradox in running one of the most highly performing university research systems in a country that is little able to make use of the research results.

1.6.2 Governing research-performing organisations

The low level of institutional funding of the universities and their increasing dependence of what are by European standards very high tuition fees means that they are very dependent upon markets, compared with other European universities. University autonomy is an old-established principle. Many of the older ones were granted independent charters by the monarch and are therefore in principle untouchable by policy. Government is therefore forced to make heavy use of economic incentives in order to steer the system. This, combined with the need to concentrate research resources into a minority of institutions in a country that has over 120 universities that would like to perform research, probably explains the need to resort to such an extreme PRFS as the UK uses (the REF). In practice, beyond this steering towards quality, the government makes little impact upon the agendas of the universities. Any thematic steering comes through the work of the research councils, and this is focused on investigator-initiated rather than strategic research.

The 2014 iteration of the REF extended its scope from scholarly performance to consider the societal impact of research at the universities that had in earlier been judged as 'excellent'. (That is, the impact of lower-quality research does not count.) This may be seen as part of the government's 'impact agenda', under which research council funding applications also have to explain their potential societal benefits as well as their academic merits.

The research councils maintain a small number of scientific research institutes. Many government labs have been privatised since the 1980s and depend upon a mixture of ministry and third party funding. Support to the RTO sector was dropped in the 1980s, so that many closed and others became private consultancies. 'Catapult centres' are advertised as new Fraunhofer-style RTOs for the UK, but in fact are technology-push organisations in a small number of high technology fields, so there is still little of the kind of PRO infrastructure in the UK that one would see in other European countries. Correspondingly, there is little for government to steer.

1.7 Lessons

An obvious but important observation is that individual innovation systems are idiosyncratic. Context, history and culture matter, so great care is necessary in transporting ideas from one system to another. That said, the six countries studied suggest the following observations.

While a two-pillar structure built around the industry and education ministries is the most common for, the single-ministry solutions adopted in the UK and Denmark do not necessarily improve matters. In practice, at the agency level research and innovation policies and implementing mechanisms remain separate. Only in the Norwegian system have these in any sense been integrated. Either way, the problem of coordinating with the other sector ministries remains – and this is an increasingly important issue in the light of the need to address the societal challenges, which cut across many sectors of society and where there is a need to manage systemic transitions (for example, between socio-technical systems).

Various kinds of high-level advisory councils are in use but they seem rarely to have a decisive effect on policy. They can only coordinate if they have the legitimacy of government and if the government wants to be coordinated. Despite the urgency of improved horizontal coordination in research and innovation policy, most government structures seem to be inimical to coordination. New and creative solutions are needed here.

In our view, none of the countries studied has made significant progress in addressing the societal challenges. Partial successes seem to be enabled by putting in place new coordination layers, strategies or platforms rather than trying to reform the existing structures of ministries and agencies. A small step on the way may be represented by the growing use of multi-principal agencies to tackle common interests among ministries. Whether it is necessary to drive this to the Norwegian extreme (where RCN answers to sixteen ministries) is perhaps an open question, but the agency level clearly provides opportunities for topic-by-topic coordination of research and innovation policy. More generally, powerful and capable agencies appear well positioned to make and implement strategy. They understand more about their areas of responsibility than ministries and are better positioned to operationalise policy needs.

Incumbent beneficiaries in governance arrangements are a significant force encouraging systemic lock-ins and preventing change. Whether in the governance of funders or research performers, despite their importance as stakeholders, their influence tends to be pernicious. Care must be taken to disenfranchise them in ways that nonetheless retain their valuable inputs as stakeholders.

Complexity appears to impede change and indeed to encourage further complexity as – in rigid systems like the German one – government overlays platforms and initiatives. The trend towards simplification at the agency level seems therefore to be useful. The drive towards having only one or two agencies responsible for research and innovation is easier to accommodate in small than large countries. For example, it is not obvious that an integrated Norwegian-style structure could work in the UK, which is about fifteen times the size of Norway.

While it is nice for the taxpayer if there are private research funding foundations on the scene, and they certainly encourage some degree of diversity, they are also beyond the reach of most policies. The state has to decide when and where it is prepared to invest in research and innovation funding, independently of outside interests, and to monitor the work of the foundations to ensure that changes in their behaviour do not result in unfortunate gaps in the national funding portfolio, as is arguably in the process of happening in Sweden.

University systems are in transition, with reforms moving them in an Anglo-Saxon, managerialist direction at varying speeds. This is clearly necessary in order to enable the universities to change significantly and, indeed, to respond to pressures in the global markets for higher education and research. The more this model is implemented and the greater the extent to which the universities face market forces, the more they will respond to incentives provided by government. So steering moves from instruction to incentivising.

The use of PRFS and performance contracts clearly has an initial impact on behaviour and performance when new systems are introduced. But university systems have strong conservative tendencies and once these initial impacts have been observed it is not clear that such systems remain effective indefinitely – though it does seem quite likely that they induce a behavioural additionality in which the universities learn new and better behaviours. These may well persist beyond the life of the performance-stimulating interventions.

There is no clear relationship evident between the proportion of university research income that comes from institutional sources and the excellence of the system. What **is** evident is that a significant element of competition is helpful and that those in the system are incentivised to perform well. Successful systems seem to have no room for free riders. There is a great deal of discussion about whether there can be too much competition or too much pressure to perform, inducing perverse effects. This should not be dismissed out of hand – but a reasonable level of competition is clearly a force for good.

However, driving research excellence alone may create a systemic problem, as in the UK and Denmark where the university systems appear to perform at global levels of excellence but the industrial system performance is poor. There is a clear mismatch between supply and

needs at the national level generated by failure to steer the research and innovation systems in a coordinated way.

The Netherlands in particular is devising innovative ways to steer the PROs towards societal and policy needs. It is more difficult and less fruitful to do so in countries where the PRO system is itself weak. Nonetheless, coupling them to national need seems to be a useful act of coordination.

Finally, one clear message from the country studies is that no one is reorganising the research and innovation systems in a very significant way towards the societal challenges. There are many small steps being taken, but it seems reasonable to ask whether these are adequate to the task and whether more radical reform is needed.

Appendix A Austria

A.1 Coordination of national systems

A.1.1 Composition of the system

This section chapter gives as overview of the composition of the system and a brief description of the actors. Further information concerning horizontal and vertical coordination, as well as governance and funding are dealt with in following sections of this chapter and/or in the next chapters.

A.1.1.1 Distribution of responsibility for R&I policy-making

The research, development and innovation (R&D&I) system in Austria is determined by the federal structure of the country[1] although the system shows many differences from Germany, especially in terms of the division of competencies between the federal level and the Länder. In general, the Federal Government of Austria retains much of the competencies in the R&D&I policy, including funding and higher education governance. Länder rather complement the federal policy although the trend shows that the regional influence over R&D&I has been growing over the past years (see below).

At the federal level, the **Committee on Research, Innovation and Technology** of the Austrian Federal Parliament and the **Science Committee** comment on legislative bills and briefings referred to it by the plenary. As in cases of similar parliamentary bodies across Europe, the results of the Committee's actions are forwarded to the plenary in the form of a recommendation, together with a background report. This is then subject to voting of the plenary, which is the only to give the final decision. However, in practice, the main debates over the R&D&I, take place outside the Parliament, within the ministries.

The executive power at the federal level is exerted by the Government and its ministries. The structure of the ministries changed in 2013 after the general elections and the competencies over the R&D&I policy, governance and funding are shared by two ministries, the **Federal Ministry of Science, Reseach and Economy (BMWFW)** and the **Federal Ministry of Transport, Innovation and Technology (BMVIT)**. The BMWFW is responsible for tertiary education and for basic research in Austria and for non-university research institutions such as the **Austrian Academy of Sciences (ÖAW)** and the **Ludwig Boltzmann Research Society (LBG)**. It is also responsible for the **Austrian Science Fund (FWF)**. More specifically, the competencies (except funding) of the BMWFW lie in:

- Governance of higher education and of the **Institute of Science and Technology Austria (IST)**
- Representation of Austria at the European level, including issues of international mobility and the Horizon 2020-related issues
- Promotion of science-business cooperation, innovation and entrepreneurship

[1] Austria is a federal republic composed of nine federal states (Länder).

The BMVIT manages the largest public budget in applied research. The BMVIT is responsible for (except funding) policy setting in applied research and governance of the **Austrian Institute of Technology (AIT**; previously the Austrian Research Centers**)**, in which BMVIT holds 50.46% of the shares.

The **Federal Ministry of Finance (BMF)** governs the allocation of financial resources and sets, at least implicitly, standards for the design, implementation, evaluation and monitoring of programmes. Therefore, it plays an important role within the R&D&I system even though it is not directly responsible for the R&D&I policy. Moreover, the national funding for some research institutions is directly allocated by the BMF, e.g. for the **Institute of Advanced Studies (HIS)** and the **Austrian Institute of Economic Research (WIFO)**.

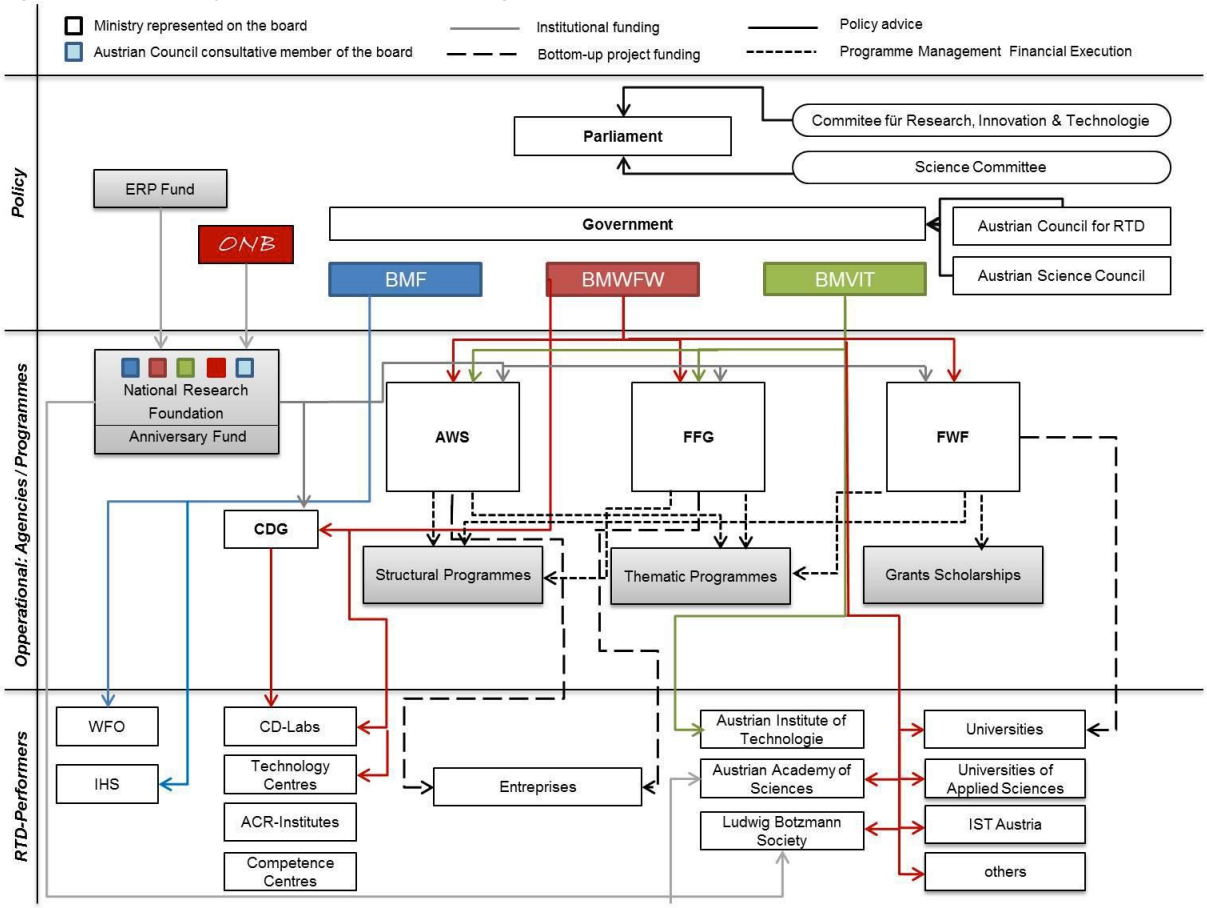
Sectoral ministries, such as the Ministry for Agriculture, the Ministry of Health etc., also govern and fund research activities within their respective resort coverage. However, they do not usually participate in the R&D&I policy making.

At the Länder level, science and research have become gradually priority for the Länder governments and many of the Austrian regions have developed R&D&I strategies and adopted regional programmes. For example, in Lower Austria, the Government adopted the Research, Technology and Innovation Programme.[2]

Figure 1 gives an overview of the structure of the Austrian R&D&I ecosystem.

[2] More information can obtained at: http://www.noe.gv.at/Bildung/Wissenschaft-Forschung/FTI-Strategie.html.

Figure 1 Structure of the Austrian R&D&I ecosystem



Source: ERAWATCH

A.1.1.2 Distribution of R&D budget across sector ministries

The main policy target, as set in the Research, Technology and Innovation Strategy of the Austrian Government[3], adopted in 2011, is to invest 3.76% of the Austrian GDP for R&D&I by 2020, based on a public versus private split of 1:2. The 2.88% for 2014 are a valuable progress towards the goal.

In funding, the division on competencies between the two federal ministries (the BMWFW and the BMVIT) is the following:

BMWFW

- Institutional funding of public universities, of the ÖAW and of the IST
- Provision of budgets for several funding agencies, ie the FWF and the FFG
- Competitive funding mainly of basic research, implemented by intermediary agencies
- Provision of budgets, together with the BMVIT, for the **Christian Dopler Society (CDG)**, for the LBG and for the **Austria Wirtsschaftservice (AWS)**

[3] Available at: https://www.bmvit.gv.at/en/innovation/policy/rti_strategy.html.

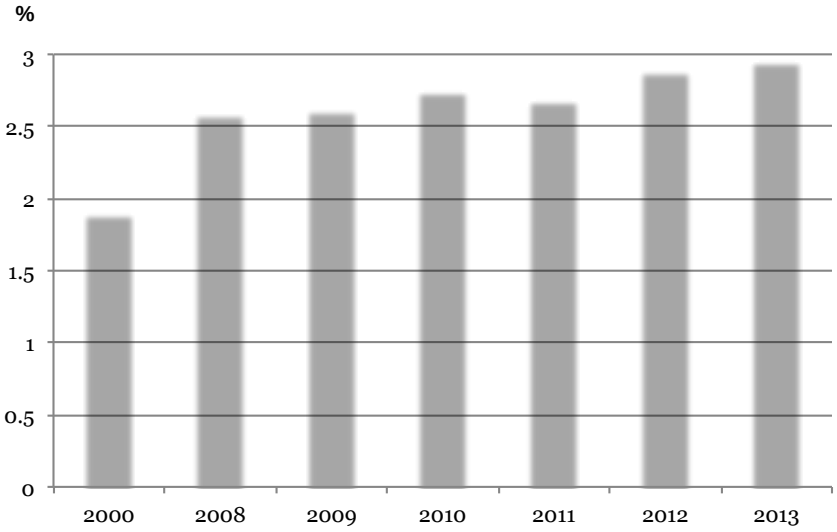
BMVIT

- Funding of applied research
- Funding of its agency FFG
- Institutional funding and governance of the AIT, in which BMVIT holds 50.46% of the shares, and for institutional funding of several other research organisations
- Provision of budgets, together with the BMWFW, for the CDG, for the LBG and for the AWS

Total Austrian R&D&I expenditures for 2015 are expected to exceed the €10 billion. It is estimated that the public sectors will finance €3.77 billion or 37.3% of total research expenditures in Austria in 2015. The federal government accounts for the greatest proportion with €3.21 billion and the financing proportion attributable to the regional governments is expected to be €443.23 million.[4]

The BMWFW has got by far the highest share of the federal R&D&I expenditure, amounting to €2.104 billion in 2015, followed by the BMVIT (€450 million), by the Federal Ministry for Agriculture, Forestry, Environment and Water Management (€71 million) and other federal ministries (all under €50 million).[5]

Figure 2 Gross domestic expenditure on R&D (GERD) as a percentage of GDP



Source: OECD Main Science and Technology Indicators: Volume 2015/1

A.1.1.3 Main funding agencies

Three main funding agencies, the FWF, the FFG and the AWS manage the funding for R&D&I on behalf of the federal ministries. In a nutshell, the FWF is Austria's central funding organisation for basic research. The purpose of the FWF is to support the on-going

[4] BMWFW and BMVIT (2015) Austrian Research and Technology Report

[5] BMWFW and BMVIT (2015) Austrian Research and Technology Report

development of Austrian science and basic research at a high international level. The FFG[6] is the national funding institution for applied industrial research in Austria. The FFG offers a comprehensive range of services for Austrian enterprises, research institutions and researchers, from the management of public funding programmes to consulting services in all phases of technology development and innovation.[7] The AWS is Austria´s national promotional bank. It offers a broad range of company-specific investment, promotion programmes and services, such as financial assistance and consultancy for companies, from the pre-seed phase up to the expansion stage.[8]

The Foundation for Research, Technology and Development (Stiftung-FTE)[9], established in 2004, and subsidised by **the Austrian National Bank (ÖNB)**, acts as a "funder of funders" as it finances R&D&I policy measures implemented by the agencies at the federal level (e.g. the FWF and the FFG).

A.1.1.4 Main PROs/universities

The Austrian public research landscape is highly diverse and differentiated. It consists of universities and public non-university research organisations. Austria has 22 public universities which all enjoy full legal capacity and autonomy, 13 private universities and 21 universities of applied sciences (Fachhochschulen). While the universities play an outstanding role with their dual responsibility for basic research and scientific training, the focus of the non-university research institutes is normally directed towards the application of knowledge. However, in many cases, they also make important contribute to basic knowledge, for example the ÖAW. The non-university research organisations have a broad spectrum of research themes and disciplines.

The public non-university research comprises the following main organisations :

- The ÖAW
- The CDG
- The IST
- The LBG
- The AIT
- Länder research institutes – eg Joanneum Research
- Sectoral research institutes at the federal level

Non-university research organisations are subject to Chapter A.3 .

A.1.2 Horizontal coordination

Austria enjoys a particularly well-developed system of co-operation between the major economic interest groups, both among each other and the government. This system, commonly referred to as "social partnership", created the basis for further economic growth

[6] More information available at: www.fwf.ac.at

[7] More information available at: www.ffg.at

[8] More information available at: www.awsg.at

[9] More information available at: http://www.stiftung-fte.at/

and social stability. Developed over time, this cooperation of the various interest groups is mostly of an informal nature and not regulated by law. The Austrian social partnership extends to practically all areas of economic and social policy, including R&D&I. For this reason Austria is considered an excellent example of corporatism, i.e. comprehensive and co-ordinated representation of group interests.[10]

A.1.2.1 Coordination between the Federal Government and the Länder

The Austria's R&D&I policy is organised at the federal level and the competencies of the Federal Government in R&D&I are broad. However, in recent years, the Länder have increasingly recognised R&D&I as a policy field of their own interest and have set clear accents in this area. This has manifested itself in increased Länder budgets and the development of separate research institutes and research funding in the Länder, such as the Tyrolean Future Foundation, the Styrian Future Foundation or Upper Austrian Research. Most Länder have developed R&D&I strategies and mobilised substantial financial resources to implement them. This development has raised the question of the interaction of the federal R&D&I policy with its Länder counterparts. At this stage, no clear-cut model has evolved. Whereas some Länder follow a strategy of complementarity, others focus resources on funding that supplements federal funding.

An interesting example of how federal R&D&I policies can interact with Länder is the Kplus programme[11] launched by the BMVIT. This programme supported research platforms that brought together scientific research and innovativev firms. Public funding was provided jointly by the federal and Länder governments. The federal R&D&I policy set programme goals and defined the rules for implementation. The Länder co-funding increased commitment to the programme and to the established platforms. Other examples include programmes AplusB and REGplus. AplusB supported incubator facilities at universities or other public research institutions, REGplus focused on technology centres and supported regional competence building and networking. These examples showcases that the co-ordination mostly takes place on the basis of specific programmes. The federal funding clearly has taken the leading role, creating a certain level of competition among the Lânder, which often take the federal policy as the basis on which to build their own policies.[12]

By establishing agencies and research organisation, the Länder have made a strong contribution to broadening the landscape of non-university research. To give an example, based in Styria, the **Joanneum Research**[13] is a research organisation founded at the Länder level with the longest tradition. On the other hand, the R&D&I system has been becoming increasingly complex. As a result, the efficient co-ordination of federal and Länder activities might therefore become challenging for the R&D&I policy to tackle potential duplication and sub-optimal masses.

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[10] More information available at: http://www.advantageaustria.org/international/zentral/business-guide-oesterreich/investieren-in-oesterreich/arbeit-und-beruf/sozialpartnerschaft.en.html.

[11] Biegelbauer, P. (2007) Learning from abroad: the Austrian Competence Centre Programme Kplus. In Science and Public Policy 34, 9

[12] Jörg, L. (2005) Policy making in a competitive environment: Governance in the Austrian STI Policy Framework in Governance of Innovation Systems: Volume 2: Case studies in Innovation Policy, OECD

[13] More information available at: http://www.joanneum.at (not to be confused with Fachhochschule FH Joanneum http://www.fh-joanneum.at/?lan=en, which is a Styrian university of applied sciences).

The Länder created an informal platform to discuss various topics, including the R&D&I, the **Conference of Governors (Landeshauptleutekonferenz)**. The role of the Länder governors is in implementing the federal policy, which makes them rather strong actors. The have met regularly twice a year since 1970. The Conference aims at defining a common line to represent the interests of the individual Länder. This common position then helps in negotiations with the Federal Government. The Conference is, next to the Bundesrat - the second chamber of Austrian parliament, the politically most important body of the federal coordination. Because the Bundesrat is considered little influential in Austria, the Conference is generally regarded as the most powerful means of Länder towards the Federal Government. The importance is also reflected in the fact that, although it does not formally exist, numerous legal texts refer to it.

A.1.2.2 Coordination at the Cabinet level

There is no formal mechanism of horizontal coordination between BMWFW and BMVIT beyond the standard procedures applicable to the work of all the ministries within the Government, such as Government / Cabinet meetings and formal consultations on legislative bills and policy documents.

There are two advisory bodies at the federal level, the **Austrian Council for Research and Technology Development (RAT-FTE)**[14] and the **Austrian Science Board**.[15] Established in 2000, the RAT-FTE advises the Government in all matters related to R&D&I. The RAT-FTE provides a strategic orientation for R&D&I policy in Austria, to identify emerging thematic areas of research and to propose appropriate assistance for them.[16]

The Austrian Science Board is the main advisory body in all university-related matters to the BMWFW, the Parliament and the universities.

Although the RAT-FTE's mandate does not include formal decision-making power for approving proposed programmes or initiatives, in fact, the RAT-FTE exerts this power because the BMWFW commited itseld to follow the RAT-FTE's recommendations. In fulfilling this task, the RAT-FTE has set up a programme assessment scheme which includes explicit requirements for monitoring and evaluation. The establishment of the RAT-FTE and the commitment of the BMWFW to follow its advice brought something new to the system.[17]

A.1.2.3 Funding agencies

Historically, the Austrian R&D&I funding system was built on the three main funding agencies (see above). There is a long tradition of involvement of beneficiaries into decisions on funding (they were members of the agencies' governing boards), which limited policy steering capacity. Consequently, the agencies have acted more as servants of their beneficiaries than as agents of the R&D&I policy. Furthermore, the strong involvement of beneficiaries seems to have caused a general reluctance to adopt new, more strategically

[14] More information is available at: www.rat-fte.at.

[15] More information is available at: www.wissenschaftsrat.ac.at.

[16] BMBWK, BMVIT and BMWA (2006) Austria – Land of Research

[17] based on Jörg, L. (2005) Policy making in a competitive environment: Governance in the Austrian STI Policy Framework in Governance of Innovation Systems: Volume 2: Case studies in Innovation Policy, OECD

oriented ways of funding. A fairly autonomous funding system with strong involvement of beneficiaries in the allocation process apparently makes it difficult to set priorities. Increased programming led to the establishment of new programmes and agendas for the agencies. As a result, the funding system became increasingly fragmented. A new process is in place, which should result in a merger of the funding agencies into two.[18] This partly explains why programming, as a way to concentrate available resources on selected priority areas, entered Austrian funding practice relatively late.

Agencies can implement programmes for various ministries. Several agencies operate in parallel with no clear specialisation pattern in terms of target groups, applied instruments, competence and visibility. The growing importance of knowledge and research as part of the responsibilities of all ministries means that agencies working for multiple principals will increasingly be needed.[19]

A.1.2.4 Performer level: alliances between universities and/or PROs

Coordination between research performers in Austria takes several forms. In the higher education sector, some universities get together in research clusters, multiannual agreement between research organisation that are geographically close to each other but they do not share the same exact location, such as for example the research cluster between the University of Vienna and the Medical University of Vienna.[20] The Universities Act adopted in 2002 facilitated co-operation between universities and other organisations. Research policy has recognised and promoted cooperation with the programmes AplusB, and uni:invent (aimed at patent exploitation).

The **Austrian Conference for Higher Education (Österreichische Hochschulkonferenz)**[21] was established in May 2012 as an advisory body to the BMWFW. The aim is to develop the Austrian higher education area and to facilitate the nation-wide coordination within the sector. The Austrian conference for higher education serves as an instrument to improve communication between stakeholders in higher education and higher education institutions. The Conference is composed of the core group and of thematic groups. The core group's members are various higher education stakeholders, such as the BMWFW, Universities Austria (UNIKO), the Conference of Universities of Applied Sciences, Austrian private universities conference, the RAT-FTE and the Austrian National Union of Students. The thematic working groups formulate recommendations that serve as an input for the national development plan for higher education and also as guiding recommendations for higher education institutions, in particular with regard to their development plans and performance agreements. The Conference is not a representative of interest of universities, unlike Universities Austria (see below), it is rather a forum to facilitate discussion between various stakeholders.

[18] Jörg, L. (2005) Policy making in a competitive environment: Governance in the Austrian STI Policy Framework in Governance of Innovation Systems: Volume 2: Case studies in Innovation Policy, OECD

[19] Jörg, L. (2005) Policy making in a competitive environment: Governance in the Austrian STI Policy Framework in Governance of Innovation Systems: Volume 2: Case studies in Innovation Policy, OECD

[20] More information available at: https://lifesciences.univie.ac.at/research/internal-programs/research-clusters/.

[21] More information available at: http://www.hochschulplan.at/.

Universities Austria (UNIKO)[22] is an association of the 21 Austrian public universities established by the University Act in 2002. It coordinates the common voice of universities in the basic issues of policy, such as research, teaching, governance or funding. UNIKO issues regularly papers and opinions on various themes and provides a forum to create a uniform opinion on certain issues towards the Government. UNIKO also provides support to the universities in the fulfilment of their tasks and responsibilities. UNIKO has been active especially in the field of the Bologna process, where universities initiated discussion on many questions themselves. UNIKO issues its decision in the form of recommendations so they are not legally binding for its members. Although based on a voluntary principle, UNIKO represents a strong voice as it brings together the whole public university sector.

In the public non-university research sector, **Forschung Austria (FA)**[23] is the umbrella organisation, predominantly in the field of applied and business-related research and technological development. The main aim of FA is to bring together and concentrate efforts within the non-university research landscape and to reinforce the expertise found within its member organisations. Some of the larger organisations that are members or associate members of FA are AIT, Carinthian Tech Research (CTR), Research Burgenland, Joanneum Research, Salzburg Research and Upper Austrian Research.

The coordination between the university and non-university sector also takes place in the form of "dual appointment", ie researchers participate in research projects implemented by a non-university organisation and, at the same time, they are involved in training of young researchers, such as doctoral students, at universities. Examples include the IST and the LBG.

A.1.3 Vertical coordination (steering)

Vertical coordination of R&D&I in Austria is determined by the federal structure of the country although, partly due to the size of the republic, the steering does not tend to be overly complex. In this regard, the Austrian R&D&I steering is to be distinguished from systems in other federations, such as Germany. In a nutshell, the R&D&I governance in Austria is rather centralised, ie at the federal level, with Länder complementing the federal policy making process (see above).

The overall trend in vertical steering in Austria is characterised by a profound shift in steering regimes, which is very much in line with the New Public Management paradigm. The policy level has tried to withdraw from the operational level and has set up control and incentive structures. The best example is university reform, which has introduced performance agreements as the central steering instrument between policy and the university.[24]

The federal government uses a structure of intermediaries (agencies), which is reflected also in the way R&D&I government funding is allocated. In general, the BMWFW and the BMVIT

[22] More information available at: http://uniko.ac.at/.

[23] More information available at: http://forschungaustria.ac.at/.

[24] Jongbloed et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science. CHEPS

keep the decision-making power over the institutional funding, while the competitive funding is set by the agencies, with the BMWFW and the BMVIT setting out the framework.

The Austrian R&D&I Strategy

The Austrian R&D&I Strategy "**Realising potentials, increasing dynamics, creating the future – Becoming an Innovation Leader**"[25], adopted by the federal government in 2011, defines Austria's strategic and operational goals, sets priorities, and sets out support measures aimed at promoting research, technology and innovation. The Strategy is central for the formulation of Austrian R&D&I policy. It is implemented at multiple levels with a broad-based and systemic approach to organising and supporting the system of innovation. The "**RTI Task Force**" functions as an important coordinating tool for implementing the strategy, as it supports the strategic and systems-oriented coordination efforts between the relevant ministries. Led by **the Federal Chancellery**, it includes representatives of the BMF, the BMVIT, the BMWFW and the Federal Ministry of Education and Research (BMBF). Intense and regular contact and exchange of information at a higher administrative level has made a crucial contribution to increasing cooperation between the ministries over the last few years.

Smart specialisation of regions

Austrian universities play an important role in the implementation of the EU Smart specialisation policy of regions. Universities are asked to become actively involved in R&D&I strategic processes at the Länder level and to play a role in designing and setting regional priorities. Additionally, universities should put greater emphasis on their regional environment and its inherent potential for the development of specific profiles, by the creation of respective location concepts. This role of universities has become a part of the performance agreements (see below) and the majority of universities have already incorporated it in their performance agreements.

A.2 Steering and financing system of university research

A.2.1 University governance

From a legal perspective, the Universities Act in 2002 was one of the most far-reaching changes to higher education in Austria, establishing universities as independent legal bodies from federal administrative control. Besides that, performance-based university funding was also introduced, together with planning for longer-term strategy and priority-setting. Since the Act came into force early in 2004, all universities have enjoyed full legal capacity and are now able to define the way they wish to position themselves in research and teaching in the future autonomously. The definition of special and distinct profiles now demanded from the universities should lead to a concentration of departments and degree courses. On the other hand, however, the focus of research is to an increasing degree being defined outside the universities as the level of funds raised from third parties for commissioned projects rises.

[25] More information available at: https://era.gv.at/directory/158/attach/RTI_Strategy.pdf.

A.2.1.1 Different types of institutions and roles

There are three types of institution within the Austrian higher education system:

- Universities (including medical universities and art and music universities)
- Universities of applied science (Fachhochschulen, UAS)
- University colleges of teacher education (Pädagogische Hochschulen)

The three types of institution are governed by different bodies and rely on different regulations. They can be established as public as well as private bodies.[26] Due to its bottom up character, university research is of a highly heterogeneous nature.

Universities of applied sciences (UAS), introduced in 1993, offer their students professionally oriented higher education. This is reflected in their curricula, which include mandatory career-oriented practical training units or job-based internships. The number of students per year and programme is limited, and for this reason most of the programmes have an entrance exam in place. With the Universities of Applied Sciences Studies Act, which came into force in 1993, science policy made provision for a new model of academic study with a greater vocational orientation. Firmly anchored in the regions and with a strong role as intermediaries to SMEs, the universities of applied sciences have in the recent past gained a new role in addition to that of teaching, namely that of applied research.

Besides the state universities, the nine private universities licensed in Austria are also actively involved in research.

A.2.1.2 Governing bodies and their competencies and linkages

The Universities Act of 2002 removed the universities from federal administration, bringing serious changes in the Austrian higher education system in the recent past and thereby initiating a fundamental reorientation of university management and steering mechanisms. As a judicial subject with fully equal rights under public law, universities can now autonomously conclude contracts and work contracts under private law. The Act meant adoption of a new internal governance structure at universities, in particular the introduction of the university councils, acting as governing boards and shifting the position of the rector to be more powerful. The university council has important supervisory functions, including the appointment of the rector. Members of the councils are appointed by the university senate (internal representation) and the ministry. The ministry usually seeks to involve external stakeholders (customers) of the universities. Thus, university councils can be seen as an intermediary between internal and external stakeholders. The aim was to strengthen the autonomy of the universities and to diversify the higher education system. It was also intended to increase efficiency using the profiling of institutions and steering by performance contracts to avoid the duplication of small/special research and teaching areas.

However, in practice, this turned out to be very difficult. The increased autonomy of universities made it difficult for the ministry to steer the higher education sector as a whole. The assumption that some kind of self-regulation would take place, which in turn would lead

[26] Jongbloed et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science. CHEPS

to a diversified set of universities with distinct profiles, has not fully become a reality. An inter-university communication and cooperation structure has not really evolved. To better align national goals and institutional actions and allow some governmental steering, new communication structures have been established through the national development plan for higher education (Nationaler Hochschulplan).[27]

In the case of the public universities, the University Act 2002 also implied substantial reorganisation at the universities and the BMWFW alike, as many administrative tasks and responsibilities (e.g. human resources) were transferred to the universities or even newly established (e.g. quality management). Moreover, the ministry had to find its new role on a more strategic level; some people still seem somewhat unsettled. There is an ongoing debate within the ministry on how to optimize the new governance system, especially with respect to the performance contracts.[28]

A.2.2 Financing of universities

The annual expenditure for the university sector amounted to €3.8 billion in 2013.[29] The establishment of autonomy for the universities and their intensified orientation towards performance has changed the structure of funding for R&D&I activities carried out at universities. In 2002, 91.4% of research performed at Austrian universities was financed by the state; this figure fell to 85.8% by 2011. In contrast, increasing significance has been attributed to research funding from the business sector and from abroad.[30]

As a result of the University Act 2002, a partially performance-based university funding system was also implemented (in 2007) and longer-term strategy and priority setting, both regionally and internationally, was pushed by the universities. The law also stipulates that universities will be funded at the federal level by the BMWFW and the BMF that decide the amount of funding individual organisations, which needs to be in line with the regulations in the Federal Budget Act (Bundeshaushaltsgesetz).

The global budget provided by the Federal Government for a period of three years remains the most important financial instrument for universities. The majority of this is allocated via a basic budget based on three-year performance agreements which set out specific measures and objectives aimed at fulfilling the universities' mission statements. The second financing component covers the granting of a defined proportion of the global budget based on quantitative performance indicators and a competitive proposal for start-up financing for cooperation projects. The increased importance of efficiency and performance indicators in university financing presents university management with new challenges.

Financing of Universities

The basic budget provided by the Federal Government to the universities, which still remains the most important financing instrument, is awarded on the basis of three-year performance

[27] Jongbloed et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science. CHEPS

[28] Mahieu, B. et al (2015) R&D Evaluation Methodology and Funding Principles: Background report 6: R&D governance and institutional funding in international practice

[29] BMWFW (2014) Universitätsbericht 2014

[30] BMWFW and BMVIT (2015) Austrian Research and Technology Report

agreements with the BMWFW (see below) and is coupled with specific measures and priorities. Furthermore, since 2013, a fixed amount of the state's university budget, which is called the Higher Education Structural Fund, is awarded on the basis of quantitative performance indicators and a competitive call for submissions for start-up financing of cooperative projects. The increased importance of efficiency and performance indicators for university financing is also presenting new challenges to university administrations. The Higher Education Structural Fund is composed of formula funding, performance contracts and competitive institutional funding (specific projects selected in informed peer review). At present, these financial resources are not earmarked, except for the competitive element.

The formula funding is calculated based on the following indicators:

- Number of enrolled and active students (weighted by discipline)
- Number of graduates (weighted by discipline)
- Revenue from Knowledge Transfer
- Revenue from private donations
- Funding of Cooperation - with this indicator, the Government funds projects that intend to increase universities' cooperation activities (internally and externally with partners from industry, universities of applied sciences and other partners). These funds are competitively allocated: universities had to apply for the money to fund up to one third of the costs of projects that had been implemented to strengthen collaboration/cooperation in teaching, research, advancement and appreciation of the arts, and administration. Those projects that contribute to the establishment of excellent structures, such as clusters, were particularly likely to be funded.

Traditionally, institutional funding and bottom-up project funding were the main instruments. However, recently, increased programming, together with increasing public expenditures on R&D&I, has resulted in a very diverse policy mix. Although institutional funding still plays an important role, the development of the higher education sector in Austria is clearly headed in the direction of performance orientation and autonomy. This also intensifies the demands on universities to compete for and win funding. Competitively acquired funds have therefore become an essential component of research funding for universities.[31]

The University Act 2002 limits the maximum amount of budget cuts to the public universities in order to safeguard stability and planning security. Therefore, the university's block grant for a given three-years funding period must not be less than 96% of the block grant in the preceding period. Maximum budget cuts for the annual appropriations are restricted, too. Although a cut of 4% over three years might seem small, it can actually account for a large share of the "disposable" budget a rector can use, given the large share used to cover more or less fixed mandatory expenditure. Hence, even this seemingly small cut certainly sends out a strong signal.

Financing of Universities of applied sciences

[31] Jörg, L. (2005) Policy making in a competitive environment: Governance in the Austrian STI Policy Framework in Governance of Innovation Systems: Volume 2: Case studies in Innovation Policy, OECD

The federal level funds the universities of applied sciences through a so-called norm cost model. This means that the federal level contributes to the operating and personnel costs of the universities of applied science. The costs are calculated based on a detailed analysis per study place. The BMWFW funds 90% of the costs per study place. In addition to funds from the ministry and from the tuition fees, the universities of applied sciences are funded by local authorities, Länder and companies.

Importance of private funds for the University funding

In Austria, the importance of private funds for university funding and general low for the financing of tertiary education. This is demonstrated by appropriate quotas and domestic ternational comparisons. Austria is public spending on tertiary Region with a GDP share of 1.4% over the EU average (1.2%) and the OECD Average (1.1%). Comparing other hand, the GDP share of public plus private education gave (1.5%), the positioning deteriorates discrimination considerably. Responsible for this is the low GDP share of private expenditure 0.073% (OECD average 0.5%, EU Average 0.2%). While in OECD Average 31%, the EU average 21% Expenditure on tertiary educational institutions of gene derived from "private", it is in Aus- terreich only 13%.[32]

A.2.3 Performance contracts

Performance agreements (Leistungsvereinbarung) were introduced to the Austrian higher education funding system in 2007. They are bilateral contracts between the federal level (represented by the BMWFW) and the individual universities. The performance agreement is a public contract that stipulates the activities of universities and the federal level and runs for a period of three years. It contains complex information on the financial allocation from the Government to the university, including capital investments. [33]

The first funding period was from 2007 to 2009, the second from 2010 to 2012 and the current contracting period started at the beginning of 2013 and will run until 2015. The negotiations between the universities and the BMWFW (as representative of the federal level) start a year in advance.

Since 2007, the BMWFW has developed a number of routines and guidelines to facilitate the process. The starting point is the national development plan for higher education, which informs the universities' development plans. The performance agreements are based on these development plans as well as on the regulations in the University Act. The performance agreements also form the basis for the internal target agreements within the universities.

In practice, the negotiation process leading to the performance agreements is initiated and controlled by the BMWFW. Based on the national development plan for higher education the university rectors receive a letter asking for a first draft of the performance agreements. This letter indicates the general strategic goals for the upcoming funding period and specific goals for the individual university. The BMWFW will establish a special task force at the ministry that is responsible for the negotiations with the universities and the development of a simplified scheme allowing for comparisons of universities' performance agreements with

[32] BMWFW (2014) Universitätsbericht 2014

[33] Jongbloed et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science. CHEPS

their development plans. Based on this, the BMWFW drafts the so-called Expectation Paper that includes different goals for the universities. Over the years, the BMWFW and the universities have become more professionalised with regard to the negotiation process and different routines around the negotiation processes have become institutionalised.

When the BMWFW and a university cannot agree upon a performance agreement, the University Act specifies that a commission will decide about the performance agreement and inform both parties about its decision by an official notification. The Act also includes the possibility of changing the performance agreement if basic parameters or conditions change.

Different instruments have been implemented to control the implementation of the contract Universities have to report on their spending, including a number of indicators and on the goals stated in the performance agreement.

The universities and the BMWFW are in close contact on the implementation of the performance contracts. They meet to discuss the performance agreement's progress every six months. Within these discussions, the BMWFW might also inform the universities about potential upcoming budget cuts and can give recommendations to the universities.

A.3 Steering and financing system of governmental research organisations

A.3.1 PRO role

There are more than 250 public non-university research organisations in Austria, which comprise a number of very different institutions. Their tasks range from basic research to providing R&D&I services for industry. As research performers, they represent a much smaller sector, compared to the university sector and business sector.

Their internal governance is determined by a number of factors. Some of them are "umbrella" organisations bringing together many research institutes with higher or lower levels of autonomy. The legal status is also important. Some research organisations are established by law, others are limited companies under private law. As a result, although Austria is relatively a small country, the landscape of non-university public research is diverse.

ÖAW

The ÖAW[34], founded in 1847, is Austria's largest academic non-university organisation and comprises 60 institutes. In the recent past, the ÖAW has taken new paths by founding research companies. With the aim of promoting research particularly in the emerging thematic areas of biotechnology and the life sciences, the Academy has founded the Institute of Molecular Biotechnology (IMBA) and the Gregor Mendel Institute of Molecular Plant Biology (GMI).

The Presiding Committee is the governing body and the highest executive organ of the ÖAW. It comprises the President, the Vice President and two Division Presidents. The members of

[34] More information available at: http://www.oeaw.ac.at/.

the Presiding Committee are elected by the General Assembly of the full members of the ÖAW. Their tenure is restricted to four years, after which they can be re-elected for one more term of office. In line with the dual control principle, the President and the Vice President are responsible for the management and agendas of the ÖAW's research institutes and the two Division Presidents are responsible for the management and agendas of the learned society.

LBG

The LBG[35] is a research platform for 18 institutes. It focuses on human medicine, the humanities, social and cultural sciences.

The LBG is a private non-profit society. The parent organisation of its research institutes is a private limited company (GmbH), which is wholly owned by the association. The LBG's Board of Directors oversees the strategy of the society and its institutes. Members of the Board have backgrounds in industry, politics, the media, academia and research. Two General Managers head up the team at the LBG's central office, which is responsible for administration and legal matters. Institutes and clusters work independently on research programmes that are agreed and evaluated in accordance with central guidelines. Each institute and cluster is treated separately for accounting purposes. Quality assurance procedures were put in place as part of the society's strategic reorganisation.

The LBG Central Office provides operational and administrative support and handles all legal matters. This largely consists of drafting and concluding contracts – for example funding and cooperation agreements – as well as human resources administration. The Office processes all contracts of employment and contracts for services. It also provides guidance on human resources and management issues.

IST

The IST[36] conducts basic research in the natural and mathematical sciences, and educates future researchers. It fosters interdisciplinary interaction between scientists. IST is governed by a number of boards, each of them responsible for precisely defined tasks. The members of the boards are selected according to the basic principle of independence from any influence other than scientific or administrative excellence.

The Board of Trustees is responsible for approving the statutes of the organization and its strategic direction, the appointment of the President, the Scientific Board, and the Managing Director. The Board of Trustees consists of 16 members. Nine of them are internationally well-known scientists, four are appointed by the Federal Government, and three are appointed by the Government of Lower Austria.

The Executive Committee is a sub-committee of the Board of Trustees and acts on behalf of the Board of Trustees in all matters between the meetings of the Board of Trustees. The Executive Committee consists of six members.

[35] More information available at: http://www.lbg.ac.at/.

[36] More information available at: https://ist.ac.at.

The Scientific Board prepares recommendations on scientific direction and on ensuring a high degree of scientific productivity. The Scientific Board consists of ten researchers who are internationally recognized at the highest level and an additional (non-voting) member with outstanding management experience. The members are appointed by the Board of Trustees for a term of 6 years.

CDG

The CDG[37] promotes cooperation between science and industry, in particular by establishing and funding of Christian Doppler Laboratory (CD Laboratory) at universities and other research institutions and Josef Ressel centers (JR center) at colleges. The CDG is a non-profit association. The members are small or large companies that are active in CD Laboratories and / or JR centers. Specifically, it is expected of the member companies that they enter into a long-term partnership with one or more research units and are able to implement the knowledge acquired there in new products or processes. Representatives of public authorities, scientists and business representatives cooperate in the bodies of the CDG in the following ways:

- The General Assembly, composed of all partners, appoints the Board of Trustees and shall take decisions on the Statutes and the audit of the CDG.
- The Board of Trustees makes all decisions in policy and structural issues that are not reserved to the General Assembly, and is responsible for the leadership of the CDG. It consists of up to 20 members from the business community and representatives of the BMWFW and of some other research organisations. The Board of Trustees appoints the Senate and takes all decisions relating to research units and membership of companies.
- The Senate is the scientific advisory body to the CDG and ensures the quality of research. The Senate designs the scientific framework, takes decisions on the establishment of CD Laboratories and JR centers and requests for organisational changes in existing research units. The Senate is composed of 40 highly qualified people from science and industry.

AIT

The AIT[38] is the largest non-university research institute in Austria performing applied research. The AIT covers the entire spectrum from taking up emerging technologies, first proof of concepts, applied research to transferring these emerging technologies into specific applications up to demonstrators and prototyping. With the Republic of Austria, represented by the BMVIT, as the majority shareholder, and numerous business enterprises as minor shareholders, the AIT concentrates on key areas such as nano-technologies, materials research, embedded systems and traffic technologies, environmental system research and bio-informatics. As a national and international hub at the interface between science and industry, the AIT is strongly at linking research and business together. The AIT is jointly owned by the Republic of Austria (BMVIT) and the Federation of Austrian Industries. As a

[37] More information available at: http://www.cdg.ac.at/.

[38] More information available at: http://www.ait.ac.at/.

research institute of international stature, the AIT is fully integrated in associated research and partner networks.

Länder research institutes

Besides the public non-university research organisations with a national coverage, there are a number of research institutes that are established by the Länder. Despite their regional character, some of the carry out world-class research and many of them participate in the Competence Centres programme.

Joanneum Research[39] is located in Styria and Carinthia. The Land of Styria is also the majority shareholder. The organisation comprises four institutes and units. The Joanneum Research provides activities in the field of applied research and technology development. Joanneum Research's self-financing ratio of approximately 80% represents a top position among research organisations in Europe. The Joanneum Research's main bodies are the General Assembly, the Supervisory Board and the Scientific Advisory Board, acting in accordance with the legal basis or in the context of the partnership agreement and appropriate terms of reference for the good of the company.

In 2000, Salzburg Research[40] became the research company of the Land of Salzburg. Its activities focus on applications of the information and communications technologies. The province of Upper Austria owns Upper Austria Research.[41] This institution carries out research and development work in the fields of plastics and medical technology, biomedical nanotechnology and sensor technology.

Departmental research institutes at the federal level

Departmental research institutes perform R&D&I in support of a sectoral ministry's work, such as in the fields of environment, agriculture, forestry, water management, education etc. Some of them also provide knowledge for specific clients or to the public, the Austrian Meteorological and Geophysical Office (ZAMG) being an example of the latter.

A.3.2 Financing

A.3.2.1 Institutional block grants

In Austria, there is no single mechanism for allocating institutional research funding to public non-university research organisations. There are different systems in place for different research organisations or types of research organisations. The funding systems for those research organisations that, taken together, receive the largest share of public institutional research funding have been reformed during the past decade and in some cases they are still changing. Before the new governance of funding, the budgets were based on history and negotiation skills.

Public institutional funding is normally granted as block funding and is not ear-marked for research (in the cases of organisations that fulfil also other tasks than research, which means

[39] More information available at: http://www.joanneum.at/.

[40] More information available at: http://www.salzburgresearch.at/.

[41] More information available at: https://www.uar.at.

that research organisations may use the funding as they like as long as they use it to fulfill their tasks). In other words, it is within the research organisations autonomy to decide upon the allocation of the funding to its different tasks (teaching, research, administration etc.).[42]

The ÖAW receives its institutional funding through a performance contract covering the entire institutional funding from the BMWFW. The first contract was signed for the period 2012 to 2014. The Academy of Sciences also fulfils additional tasks on behalf of the BMWFW, e.g. the management of several scholarship programmes. These are contracted separately.

The AIT receives its institutional funding through a performance contract with the BMVIT, covering the entire public institutional funding. BMVIT is also the major shareholder of AIT.

The IST Austria was founded by law in 2006 and established as a Greenfield investment. Funding is granted through long-term funding agreements lasting until 2026. There are two providers of institutional funding: the Land of Lower Austria finances the infrastructure (construction and maintenance), and the Federal Government represented by the BMWFW for all other cost. This part of the funding is partly conditional and indicator based: A maximum amount of money has been set aside for a period of 10 years (2007 – 2016), broken down into annual appropriations. Two-thirds of each annual appropriation are paid unconditionally. The size of the remaining share equals the amount of third party funding (grants, donations) IST Austria has received in the year before (up to the maximum amount specified, i.e. one third of the annual appropriation).

The largest recipients of public institutional research funding have had their governance systems changed towards multiannual funding arrangements (mainly performance contracts) and more autonomy to the research organisations (i.e. the largest players in the system as described above). The advantages of this system for the beneficiaries are more autonomy and higher planning security. The performance contracts are concluded for three years, which is a big advantage compared to annual budgeting. The BMWFW and BMVIT also consider the longer funding periods beneficial, although they seem to fear a loss of control and a lack of information.

A.3.2.2 Competitive public funding

In general, public funds for R&D&I in Austria are more often distributed through institutional than through the competitive funding, roughly accounting for ¾ (institutional) and ¼ (competitive), respectively, of all public funds. This relation has not changed significantly in the recent years. However, the share of institutional funds allocated on a competitive basis in Austria has been weakly increasing. For example, the share of project-based funding in total public funds in Austria almost doubled between 2000 and 2008.[43]

The shift from core to project-based funding could bring about a frequent issue of a limitation of long-term career development options to excellent researchers as project-based funding is always for a certain time. However, examples, such as the ÖAW shows that even in the environment of project-based funding, this issue can be tackled. The ÖAW does not

[42] Mahieu, B. et al (2015) R&D Evaluation Methodology and Funding Principles: Background report 6: R&D governance and institutional funding in international practice

[43] Cuntz, A. (2015) JRC Science and Policy Report: RIO Country Report Austria 2014

differentiate between core-funding or project-based funding. Hence, all researchers are offered the same career development measures while employed. According to the "equality principle", the ÖAW supports excellent researchers independent of the source of financing.

The Austrian equivalent to a "Centres of Excellence" is a "Spezialforschungsbereich (SFB)". These are funded by the FWF. This programme aims at establishing research networks based on international standards through autonomous research concentration at a single university location and to build up highly productive, tightly interconnected research establishments for long-term and interdisciplinary work on complex research topics. Funding is granted for up to 8 years, with a stop-or-go decision after a mid-term evaluation. SFB are not established as independent legal entities, therefore this funding is not institutional but targeted funding.

"Centres of Competence" in Austria are established and publicly funded through competitive programmes for a limited period of time (7 – 10 years, depending on the programme). They are intended to strengthen the links between research institutions and the users of their results (industry in most programmes). The main types are established under the LBG institutes, CDG institutes and COMET centres (K1 and K2). Generally, the Centres are not considered "research organisations", especially by the funding ministries and their implementing agencies, but "projects", implemented by research organisations. Although in some programmes, in particularly the largest, COMET, the Centres have to be established as legal entities, the public money they receive is not considered institutional, but targeted funding. Therefore, this can be considered a hybrid type of financing which could be labelled "temporary institutional funding".[44]

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Appendix B Denmark

B.1 Coordination of national systems

B.1.1 Composition of the system

B.1.1.1 Distribution of responsibility for R&I policy-making

The Ministry for Higher Education and Science (MHES) is the main actor in Danish research policy and policy is largely formed within this ministry. The Danish Agency for Science Technology and Innovation (DASTI) is, in effect, a sub-ministerial department under the MHES and is involved in the policy-making process. The annual budget negotiations are central to identifying new R&D initiatives and the Finance Ministry plays a role as 'meta' ministry in this connection.

Politically, research policy is usually subject to broad agreements between the major political parties. Consequently, the policy area tends not to be politicised and does not usually change dramatically following a change of government. Even so, there are differences within the overall agreed policy framework, as illustrated by the budget cuts to science and research introduced by the recently elected government.[45]

The Danish Council for Research and Innovation Policy (DFiR) advises the Minister for Higher Education and Science as well as Parliament. It is made up of nine prominent personalities from universities and business and is able to commission research on topics they choose. Unlike its Finnish namesake, it does not include policy-makers but is tasked with giving independent advice. The council is sometimes depicted at top of the Danish R&I system (LINK), but with three full time staff and limited resources, their role does not extend to creating or coordinating Danish research policy.

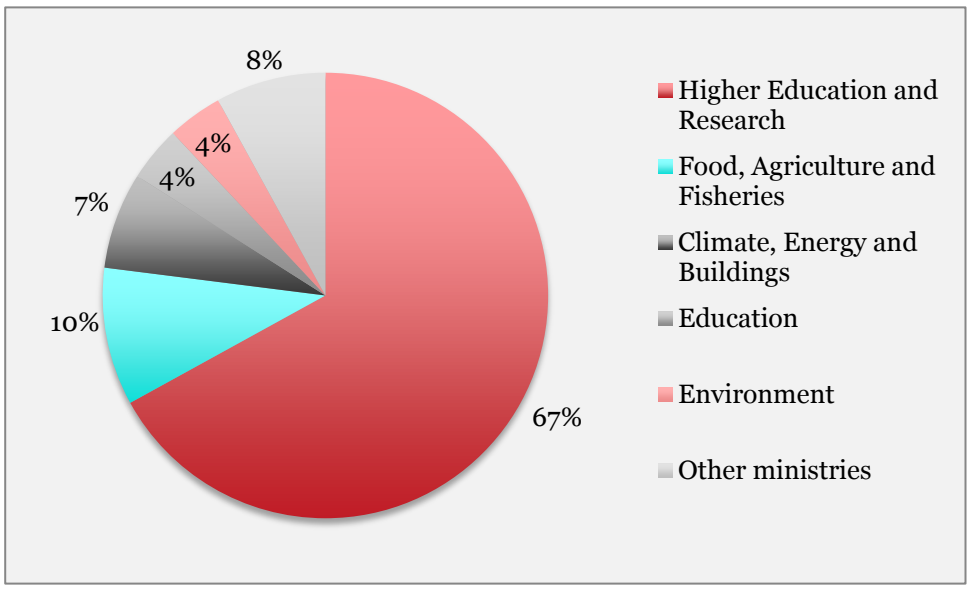
B.1.1.2 Distribution of R&D budget across sector ministries

The MHES accounts for the majority of government R&D spend, an estimated 75-80%. In practice, the discretion of the MHES over R&D spending is not as significant these figures might suggest. A large proportion of the R&D budget that is administered by the ministry consists of 'automatic' payments such as block grants, which change little from year to year.

Looking at the subset of R&D funding given out as 'programme funding' (as opposed to 'basis' or institutional funding), sector ministries with research budgets include the Ministry of Food, Agriculture and Fisheries (10% of programme funding), Climate, Energy and Buildings (7%), Education (4%) and Environment (4%); see figure below.

[45] *Forsknings- og innovationspolitisk redegørelse 2015*, [Statement on research and innovation policy], Danish Government, December 2015.

Figure 3 Research budget of Danish government departments, 'programme funding' (excl. institutional funding), 2014



Source: DASTI (2015a, p. 18)

B.1.1.3 Main funding agencies

The Danish funding system was restructured in 2013. The system had been criticised for being too complex and confusing for potential users, not least in the business sector. There are now three public funding bodies:

Danish Council for Independent Research (DFF) consists of five subject-specific councils and a joint Board of Directors. It has two main functions: support research initiatives based on researchers' own initiatives (responsive mode funding) and provide advice on research.

Innovation Fund Denmark (IFD) was created in 2013. Replacing three funding bodies – the Council for Strategic Research, the High Growth Fund, and the Council for Technology and Innovation – the fund covers the range from strategic research to innovation and entrepreneurship support. The main purpose of the new fund is to help turn ideas, knowledge and innovation into value for the economy and society. The bulk of of IFD's 1.6bn DKK annual budget (210m EUR) is invested in 'large scale projects', funding public-private partnerships covering strategic research, high technology projects and 'societal partnerships' aimed at addressing societal challenges. Other schemes include SME support (e.g. innovation vouchers), individual grants and support for international collaboration.[46]

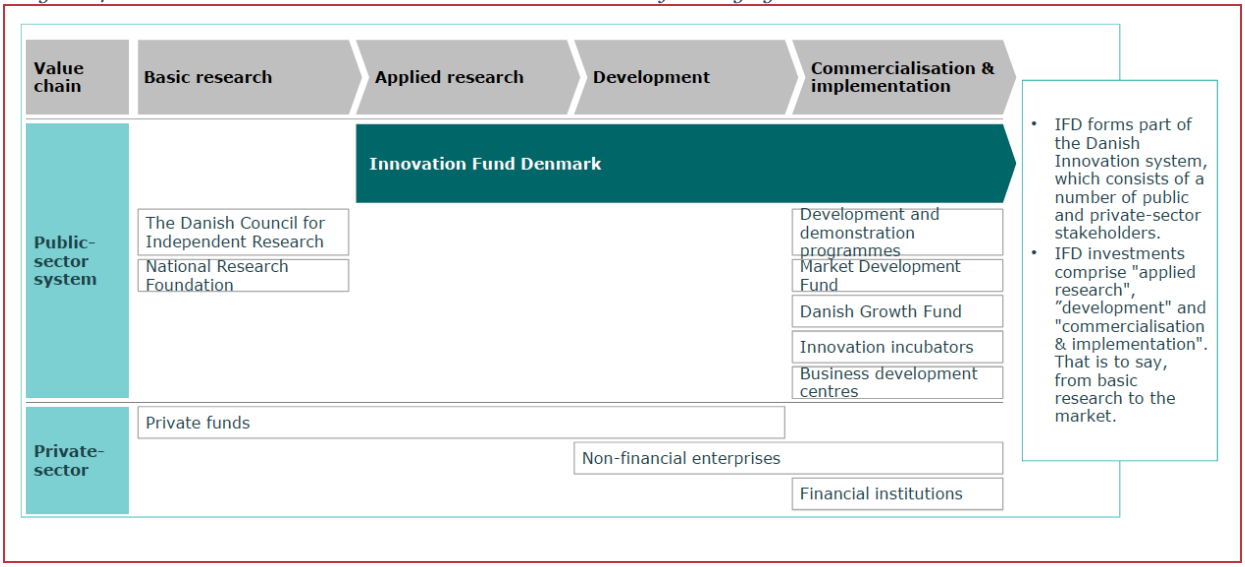
Danish National Research Foundation (DNRF) was set up by Parliament in 1991 with the objective to fund curiosity-driven research that would not otherwise be funded by the research councils or the universities. DNRF's main funding mechanism is the Centre of Excellence programme, which makes long-term investments (5-10 years) to create the best

[46] http://innovationsfonden.dk/en/about-ifd (Accessed 27 November 2015)

conditions for the most talented researchers. Other smaller schemes are set up to support internationalisation of Danish research.

Figure 2 below provides an overview of the current funding system.

Figure 4 Innovation Fund Denmark in the Danish research funding system



Source: Innovation Fund Denmark (2015, p. 13)

B.1.1.4 Main PROs/universities

Denmark has an almost entirely university-based system. Higher Education R&D (HERD) accounts for 32% of total R&D expenditure and the eight research universities receive about 75% of public R&D funding. The universities play somewhat different roles: 3-4 (including Copenhagen and Aarhus universities and the Technical University of Denmark) are part of the global market for research and education, whereas the remaining four or five play more of a regional role.

The government sector (GovERD) accounts for 2% of total R&D expenditure. There are currently three sector research institutes whose role it is to perform research-based public sector services for government ministries. In addition, nine RTOs make up the 'GTS' Advanced Technology Group of approved technological service providers.

B.1.2 Horizontal coordination

B.1.2.1 Cabinet and ministry level

Coordination of research policy in the Danish system is mainly achieved through the combination of the main knowledge sectors – higher education, research and innovation – in a single 'super ministry' (Koch, 2008). There is no central coordinating body or mechanism at the cabinet level. Research is not specifically covered in any of the government's standing committees although the research minister has previously had a seat on the powerful 'coordination committee', which includes the Prime minister and the Finance minister. Coordination between sector ministries is largely informal in nature, and not a central concern given the concentration of budget and policy-making powers within MHES.

Concerns have been raised that the 'super ministry' approach will lead to less effective coordination with other ministries (e.g. Koch, 2008). There are currently discussions about strengthening coordination of sector research. It has been argued that the individual sector ministries lack the in-house expertise to be an effective 'principal' to the research performing bodies (i.e. mostly universities).

While there is no permanent structure to ensure coordination, several 'one-off' exercises have addressed this coordination need. The 2005-06 **Globalisation Council** assembled a cross-ministerial group chaired by the Prime Minster, including five sector ministers and representatives from businesses associations and labour unions, with the aim to form a coherent strategy on science, technology, innovation and education (Koch, 2008, p. 257)

Following the 2006 Globalisation Agreement, it was decided that the basis for political priorities should be improved. It was agreed that a catalogue of suggested priorities should be presented every four years going forward. A consultation involving representatives from science, business and other stakeholders led to the identification of national research priorities in the '**Research 2015'** agenda (2008), and the subsequent '**Research 2020'** (2012)[47]. In the latter, 14 research themes are combined into five 'societal visions' (MSIHE, 2012):

- A society with a green economy
- A society with health and quality of life
- A high-tech society with innovation capacity
- An efficient and competitive society
- A competent, cohesive society These

An innovation catalogue, INNO+, following a similar process was presented in 2013. A new 'Research 2025' is currently under preparation. Although ultimately aggregated by the ministry, these catalogues represent an attempt to include a variety of viewpoints.

In 2012, the government launched its first comprehensive '**Innovation Strategy'** based on contributions from involved sector ministries and other stakeholders. The main problem the strategy was to address was the discrepancy between the 'world class' research system in Denmark and the somewhat more modest ability to create (economic) value from research results. Thus, the main issue was about coordination between research and innovation.

B.1.2.2 Agency-level

Until 2010, the Danish Research Coordination Committee was tasked with promoting coordination and collaboration across the five funding bodies under the MHES. A 2013 reform has greatly simplified the Danish funding system. The new Innovation Fund Denmark (IFD) was created, taking the place of three previous bodies, thereby enhancing coordination between these areas.

[47] http://ufm.dk/en/research-and-innovation/political-priority-areas/research2020 (Accessed 25 November, 2015)

B.1.2.3 Performer level: alliances between universities and/or PROs

Similarly to the ministerial level, coordination at the research performing level is primarily achieved through a concentration of responsibilities and resources on a small number of actors. The eight research universities are responsible higher education and research. Following the 2007 mergers whereby the majority of research institutes were made part of the universities, universities now also perform research-based public sector services commissioned by government ministries.

Coordination between universities is currently somewhat limited. The umbrella organisation, Universities Denmark (formerly the Rector's Conference), allows universities to speak with one voice in negotiations with the Government. Previously, cross-national collaboration was more common but following the last decade's reforms, the universities now each focussing on establishing their own position domestically and building international partnerships.

In the government sector, GTS Advanced Technology Group represents its nine constituent member institutes, negotiate political aims. The GTS-net was first introduced in 1973 to introduce minimum standards for the various institutes that existed.

B.1.3 Vertical coordination (steering)

The governance of Danish research policy is heavily influenced by New Public Management and makes extensive use of 'steering by results' based on performance contracts (Koch, 2008; Aargaard and Mejlgaard, 2012).

B.1.3.1 Priorities and the 'Research' agendas

The 'Research 2015' and '2020' agendas represent a 'bottom-up' approach to priority-setting but also involves steering: The catalogues are developed independently of policy-makers but the allocation of funding for strategic research is decided in political negotiations about the annual national budget. Out of the five 'visions' or over-arching themes in Research2020, most funding has been allocated to the 'Green economy' (Grimpe, 2015). Within relatively broadly defined allocations in the annual budget, the IDF will then interpret exactly what is funded through the formulation of calls for proposals.

B.1.3.2 Ministry steering of funding bodies

With respect to the **Council of Independent Research (DFF),** the ministry steering works according to an 'arm's-length' principle. The ministry does not set out priorities for research funded through the DFF but does give out targets on horizontal issues like internationalisation and doctoral training. Still, the councils are hosted by the ministerial subdivision DASTI, and the minister appoints the Members of the Board who must be prominent researchers. A recent evaluation (DASTI, 2014a) questioned whether the ties between the DFF and the ministry were too close.

DNRF is not funded through annual science budget but based on an initial grant of 2bn DKK, supplemented by another 3bn DKK in 2008 (approximately 670m Euros in total). On this basis, DNRF aims to allocate 400m DKK annually (about 54m Euro) until 2026. This gives the Foundation a large degree of discretion to operate within the boundaries of its legal mandate (DASTI, 2013).

Unlike its predecessors, **Innovation Fund Denmark** (IFD) was created outside the ministerial agency, DASTI. The Minister also appoints the board but it must contain a majority of members with business experience as well as a majority of prominent researchers or active scientists.

The creation of IFD has arguably made it more difficult for government to implement political priorities. Compared to its predecessors, e.g. the Council for Strategic Research, the IFD have interpreted their mandate in a way that puts focus on business support. As a consequence, there is no longer a natural funding body that is able to allocate funding for 'public' strategic research. This arguably represents a gap in the current research funding system.

B.1.3.3 Research-based public-sector services

The 2007 mergers saw the majority of sector research institutes and thereby the responsibility for research-based public-sector services transferred to the universities. This led to a change in the nature of the relationship between the sector ministries and their providers. Previously, the sector institutes were relatively small and often had a ministry as their sole or primary customer. In this context, ministries could often have close and informal contacts to institute staff. According to a recent review, the transfer to the universities has led to a formalisation of that relationship, including more structured meetings and contracts concerning needs and expectations (SVU, 2015).

Reportedly, there are on-going cross-ministerial discussions about the sector research. Some argue that sector ministries have insufficient in-house expertise to steer the universities effectively and absorb the knowledge provided. Closer coordination between the sector ministries and with MHES could be introduced to address this. It has also been argued that funding for sector research contracts should be subject to competition and not automatically awarded to the universities.

B.2 Steering and financing system of university research

B.2.1 University governance

B.2.1.1 Different types of institutions and roles

In Denmark, there are eight research universities, a number of vocation education institutions as well as a small number of university-level institutions in the performing arts and design. The eight research universities account for the vast majority of publicly performed R&D. Among the eight, there are five general universities covering most disciplines and three more specialised universities, including Denmark's Technical University (DTU), the IT universities and Copenhagen Business School (CBS). In addition to teaching and research, five universities also have assignments to carry out research for sector ministries and universities (see below).

B.2.1.2 Governance

Danish universities have status has independent, government-funded institutions. The 2003 reform of the University Act set out to give universities more autonomy as well as more

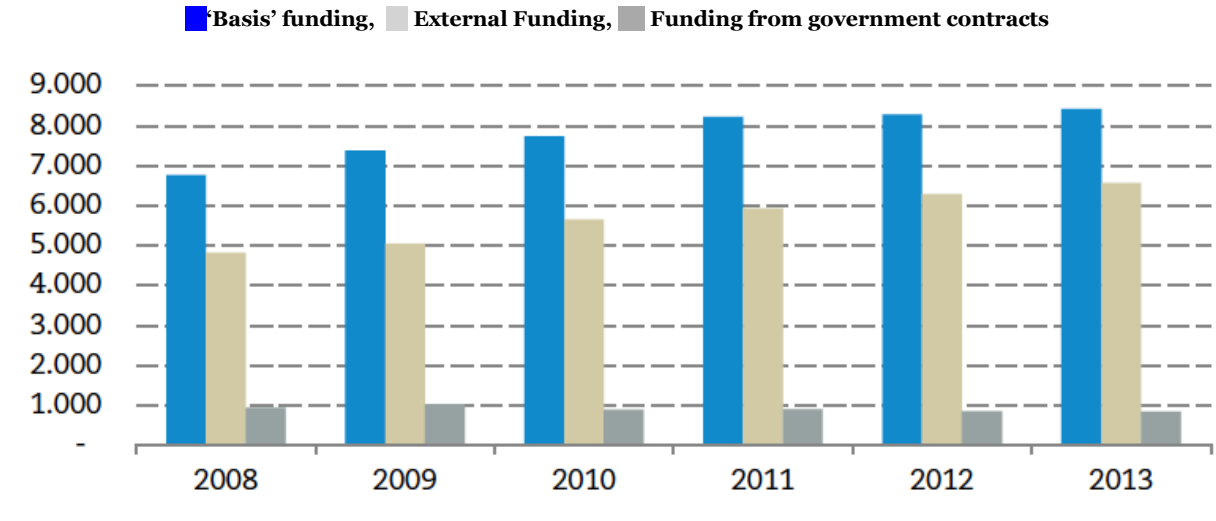
accountability. It introduced a new governance structure: The previous system whereby the universities were governed by representatives elected by university staff and students was replaced by a 'management' approach whereby a board with a majority of external members gained the power to appoint the university management. A subsequent reform in 2011 further centralised power in the hands of the university Rector and also modified the performance contracts to include fewer mandatory goals and more institution-specific goals.

This has been described as a development from self-governing democratic institutions towards service providers continuously adapting to external demands (Degn and Sørensen, 2012).

B.2.2 Financing of universities

Universities are the main performers of publicly funded research in Denmark. They have seen a significant increase in funding over the past decade, although a decrease might now be in the cards following the recent change of government. In 2013, the universities received approximately 60% of their funding from government block grants (education and research) and 40% from 'external sources' including competitive grants, government contracts, private and international funding.

Figure 5 Universities' research revenue, in million DKK



Source: Universities Denmark, 2014.

B.2.2.1 Institutional Block grants for research

Institutional grants for research represent approximately 31% university income (2013). Out of this about 50% is allocated on the basis of historical principles and only changes incrementally over time.

Some 30% of the research block grants – covering the 'new basic grants' introduced with the globalisation package' and 2% of existing funding (the so-called restructuring fund) – is allocated according to a performance-based formula. One of the objectives of the national Globalisation Strategy (2006) was to create a closer link between funding and research quality. This led to the introduction of bibliometric indicators as part of the funding formula.

The current model was phased in between 2010 and 2012 and allocates 45% according to educational activities (reflecting the research-based nature of education), 20% in proportion to externally funded research, 25% in according to research output (bibliometric indicators) and 10% on the basis of the number of PhD graduates. The bibliometric element was explicitly based on the existing Norwegian model, but unlike the Norwegian model does not influence the allocation between disciplines (Hansen, 2010).

The remaining 20% is for research education (PhDs).

B.2.2.2 Block grants for teaching

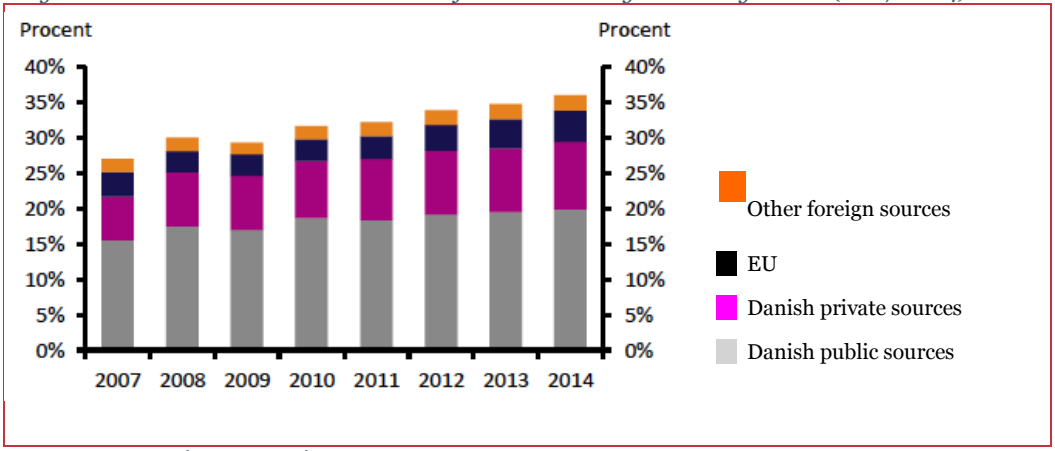
Since 1994, education funding has been allocated according to the 'Taximeter' principle. The majority of funding in this category (91% in 2014) is based on the number of students passing exams. In 2009 an additional bonus has been introduced to reward institutions whose students complete their degrees within a certain time and there is an additional allocation related to the number of exchange students. The rate per student vary according to discipline, ranging from approximately 6,000 Euros for social sciences and humanities to 13,000 Euros for natural sciences (de Boer et al., 2015, p. 54).[48]

In the autumn of 2015, the government announced that it intends to reform the taximeter system. At the time of writing, the details of a new system are not yet clear but indications are that a new system be more focussed on 'societal needs' and award funding on the basis of employability.

B.2.2.3 External funding (Research councils)

Funding from external sources account for some 36% of university income. This figure includes funding from research councils and other public sources, from EU programmes, from private foundations and from businesses, and has increased significantly since 2007 (see Figure 6).

Figure 6 Research subsidies as a share of total university income by source (2007-2014)



Source: MHES (2015, p. 35)

[48] See also the website of the Ministry of Higher Education and Science: http://ufm.dk/uddannelse-og-institutioner/videregaende-uddannelse/universiteter/okonomi/uddannelsesbevillinger/bevillinger-til-universitetsuddannelse (accessed 25 November 2015).

B.2.2.4 Third stream funding

As a consequence of the incorporation of many of the sector research institutes into universities in 2007, five universities are currently contracted to perform research-based services for five sector ministries. In 2013, the level of activity undertaken as part of this arrangement was some 850m DKK (120m EUR).

Danish universities do not derive a significant part of their revenue from the business sector. Where connect directly involved in research collaboration with universities are predominantly large enterprises with more than 250 employees. Increasingly, universities enter into partnerships with GTS institutes to reach smaller companies (IRIS Group, 2014, pp. 52, 93).

B.2.3 Assessment and performance contracts

B.2.3.1 Development contracts

Since 1999, Danish universities have been required to conclude 'development contracts' with the Ministry, intended to strengthen the strategic development of the institutions and to make their efforts to tackle societal challenges more visible. The contracting parties are the Ministry and the University Board of Directors. These contracts contain a mandatory set of aims defined by the ministry complemented by a set of specific aims chosen by the individual institutions themselves. The current contracts cover the period 2015-2017 and include five mandatory aims: better quality in education, greater relevance and transparency, better coherence and collaboration, strengthened internationalisation and increased social mobility.[49]

Each aim is associated with one of more measureable targets ('målepunkter') and the universities report on progress towards the targets as part of their annual reports. The annual reports for 2014 report on goal attainment at the end of the 2012-2014 contracts as shown in Table 1. Universities generally meet most, but not all targets, although this cannot be taken as an overall measure of performance as the goals may have been more or less ambitious at different institutions.

Table 1 Reported goal attainment by Danish universities at the end of 2012-2014 development contracts

University	Targets met	Targets partially met	Targets not met	Pending or N/A
University of Copenhagen[50]	12	1	2	-
University of Aarhus[51]	4	5	3	1
University of Southern Denmark[52]	9	4	1	1
Copenhagen Business School[53]	6	-	9	-

[49] http://ufm.dk/uddannelse-og-institutioner/videregaende-uddannelse/universiteter/styring-og-ansvar/udviklingskontrakter (Accessed 27 November 2015)

[50] http://publikationer.ku.dk/aarlige_udgivelser/aarsrapport/ (accessed 10 December 2015)

[51] http://www.au.dk/fileadmin/www.au.dk/om_au/informationsmateriale/aarsrapport-2014.pdf (accessed 10 December 2015)

[52] http://static.sdu.dk/mediafiles//E/C/D/%7BECD15CCC-931E-4365-937C-8DDED5E3DB19%7D%C3%85rsrapport%202014.pdf (accessed 10 December 2015)

University	Targets met	Targets partially met	Targets not met	Pending or N/A
Technical University of Denmark[54]	13	4	3	-
IT University of Copenhagen[55]	13	-	3	-
Roskilde University[56]	12	4	8	-
Aalborg University[57]	12	0	1	-

Source: Technopolis

The development contracts have been criticised from several quarters: A 2009 university evaluation, carried out by a panel of international experts, concluded that the contracts had become too detail- and process oriented. Instead, the panel recommended using the contracts as instruments for steering by objectives (Bladh et al., 2010, pp. 28-31). Another line of criticism relates to their lack of 'hard' incentives. Development contracts have no strict enforcement mechanisms or sanctions for non-compliance. Their effectiveness as a control mechanism is therefore somewhat uncertain and can rather been seen as "gentlemen's agreements". The 2012 ERAC 'Peer Review' of the Danish Innovation System suggested that financial incentives could be considered.[58] Others do believe, however, that universities have a strong incentive to comply with the contracts in order to keep a good relationship with the Ministry.

1.7.1 Formula funding

As discussed above, the institutional ('basis') funding provided to universities from the ministry is, in part, performance-based. The specific performance-based criteria include the ability to attract external funding and the quality of research output measured by bibliometric indicators.

As described, the funding allocated for teaching is also based on performance, i.e. the number of students passing their exams and finishing their degrees within a certain time.

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[53] https://www.google.co.uk/search?q=DTU+aarsrapport&ie=utf-8&oe=utf-8&gws_rd=cr&ei=6BJvVqPPE6XMyAOnu4nABQ (accessed 10 December 2015).

[54] http://emagstudio.win.dtu.dk/E-books/APK/AnnRep2014/ (accessed 10 December 2015).

[55] http://itu.dk/da/Om-IT-Universitetet/Organisation_tal_og_fakta/~//~/media/DK/Om-ITU/Organisation-tal-og-fakta/Tal-og-fakta/Aarsrapporter/2014/ITU_Aarsrapport2014_DK_9-pdf.pdf (accessed 10 December)

[56] http://www.e-pages.dk/roskildeuniversitet/245/ (accessed 10 December 2015)

[57] http://www.e-pages.dk/aalborguniversitet/350/ (accessed 10 December 2015)

[58] Crasemann, W., Lehto, P., Starzer, O., & Zwan, A. van der. (2012). *Peer-Review of the Danish Research and Innovation System: Strengthening innovation performance*. Expert Group Report prepared for the European Research Area Committee, p. 18.

B.3 Steering and financing system of governmental research organisations

B.3.1 PRO role

The government R&D sector is small in Denmark with 2% of total R&D expenditure (GovERD/GERD). Two main types of PROs operate in Denmark: Sector research institutes and technological service institutes (GTS).

The number of independent **sector research institutes** in Denmark was reduced with the 2007 mergers, which saw many institutes become part of universities (Arnold et la., 2010). The remaining three independent sector research institutes are:

- The National Research Centre for the Working Environment (NFA) under the Ministry of Employment
- The Danish National Centre for Social Research (SFI) under the Ministry of Social Affairs
- Statens Serum Institut (SSI) under the Ministry of Health.

According to the Act on Sector Research Institutions, the institutes should provide advice and carry out government assignments within their area of expertise, as well as disseminate knowledge to public and private stakeholders. They carry out research within their area independently of their parent ministries.[59]

The **Approved Technological Service Institutes (GTS)** are RTOs and form part of the Danish effort to support innovation in the Danish businesses. The nine institutes make up the 'GTS network' authorised by the Government. Catering particularly for SMEs, they provide technological services, access to technological infrastructure for testing and certification of products, and disseminate knowledge. The institutes can also act as an intermediary between businesses and the universities and help adapt it to be applied to solve concrete problems for companies.

The number of institutes has decreased over time through mergers and the current nine institutes vary significantly with respect to strategy, size (from less than 100 to more than 1,000 staff) and research intensity. Over time, the R&D intensity of GTS institutes have fallen somewhat and is currently about 20%. This is relatively low compared to RTOs in other countries and is also reflected in the relatively low proportion of PhD graduates among employees (about 10%) (Åström et al., 2008). Some concerns have been raised that this could make it more difficult for them to work effectively with the universities.

B.3.2 PRO Governance

Sector institutes are governed by a board appointed by the sector minister, within the criteria for scientific expertise set out in the Act. The board enter into performance contracts with their parent ministries. The Ministry for Higher Education and Science have a role in defining the scope and evaluating the institutes.

The GTS institutes operate as independent non-profit organisations and are approved and monitored by the MHES (IRIS Group, 2014, p. 24).[60] The most recent framework for the GTS

[59] http://ufm.dk/forskning-og-innovation/samspil-mellem-viden-og-innovation/sektorforskning (Accessed 25 November 2015)

[60] See also http://en.gts-net.dk/about-gts/who-is-gts/ (accessed 25 November 2015).

institutes (2016-2021) focuses on the strengthening the development of long-term strategic goals combined with clear measurable impacts.

The GTS Advanced Technology Group was first set up in 1973 bringing together the various institutes with the aim to ensure a certain minimum standard for the provision of research-based services. The Group is governed by a Board of Directors, composed of the directors of the nine institutes. The Board appoints the Managing Director who oversees the implementation of overall objectives and political decisions of the group.

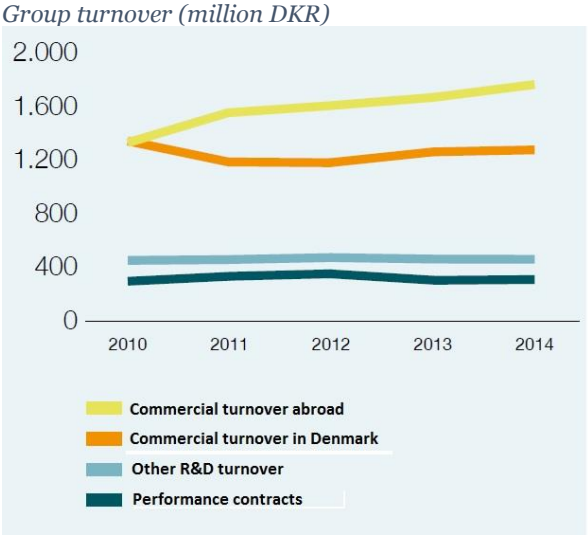
B.3.3 PRO Financing

Sector institutes are funded through a combination of performance contracts with their parent ministries, other funding awards (e.g. research councils and EU funding) and from the sale to external customers. The National Research Centre for the Working Environment (NFA) relies primarily on government funding whereas some two thirds of SSI's revenue stems from external sources. The Danish National Centre for Social Research (SFI) derives its revenue in more or less equal measure from the three types of sources.[61]

The GTS institutes receive government through 3-year performance contracts with the MHES. The contracts provide co-funding for R&D to build up competencies in specific areas. A new steering concept is under development and is due to take effect with the 2019-2021 performance contract period. This will make the allocation of government funding more dependent on direct measures of impact on the target group (DASTI, 2014b).

They derive most of their income, about 80%, from industry. An increasing proportion of their clients are from abroad, and they now generate as much of 50% of their income from this source. Compared to RTOs in other countries, GTS institutes receive relatively little base funding from government and a large volume of international business. The composition of the revenue is shown in Figure 7 below.

Figure 7 Composition of GTS Advanced Technology Group turnover (million DKR)



Source: Adapted from DASTI (2015b, p. 9).

[61] Based on the most recent (2014) annual reports from the three institutes.

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Appendix C Germany

C.1 Coordination of national systems

C.1.1 Composition of the system

C.1.1.1 Distribution of responsibility for R&I policy-making

The research, development and innovation (R&D&I) system in Germany is very complex and composed of a number of actors. Germany is a federal state with 16 Länder that have their own governments and their own Ministries of Science and Ministries of Education. The overall political responsibility over the R&D&I system is thus shared between the länder and the federal levels and the governance can be characterised as multi-level.[62] The system is large and it is characterised by a differentiated division of competences and responsibilities, both horizontally at the federal level, and vertically –between the federal level and the länder. In addition, the Länder can complement the policies at the federal level by their own actions.

At the federal level, the **Committee on Education, Research and Technology Assessment of the German Federal Parliament** (Bundestag) legislative bills and briefings referred to it by the plenary. The results of the Committee's actions are forwarded to the plenary in the form of a "recommendation for a decision", together with a background report. In general, the plenary votes in line with this recommendation, either with or without a debate.

The **Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF)** is responsible for federal science and research policy. Its responsibilities include funding and support for research at public research and higher education institutions and of public research infrastructure, the financing of R&D&I projects in public research institutions and Private Sector enterprises (mainly through thematic programmes), technology transfer, research-/innovation-oriented networking activities and the federal elements of tertiary education policies[63], including activities that concern the availability and mobility of students and scientists. It supervises the biggest proportion of federal research institutes, co-finances many research institutes jointly with the Länder governments and is responsible for all kinds of research and science support schemes.

The **Federal Ministry of Economics and Technology (BMWi)** is responsible for all federal innovation policy and industry-related research. This includes the promotion of innovation, research- and technology-based cooperation and knowledge transfer with a special emphasis on SMEs and on specific sectors (eg energy, aviation and multimedia) and the development of positive conditions for innovation and entrepreneurial activities. It manages some specific nationwide innovation programmes, focusing particularly on SMEs, but also several industry-oriented research institutes.

At the **Länder** level, the governments usually have their own science and technology policies, often shared between two ministries, similar to the structure at the national federal

[62] Stehnken, T. (2010) The German Innovation System at a Glance: Governance and Strategies

[63] Tertiary education in Germany is mostly in the competence of Länder governments.

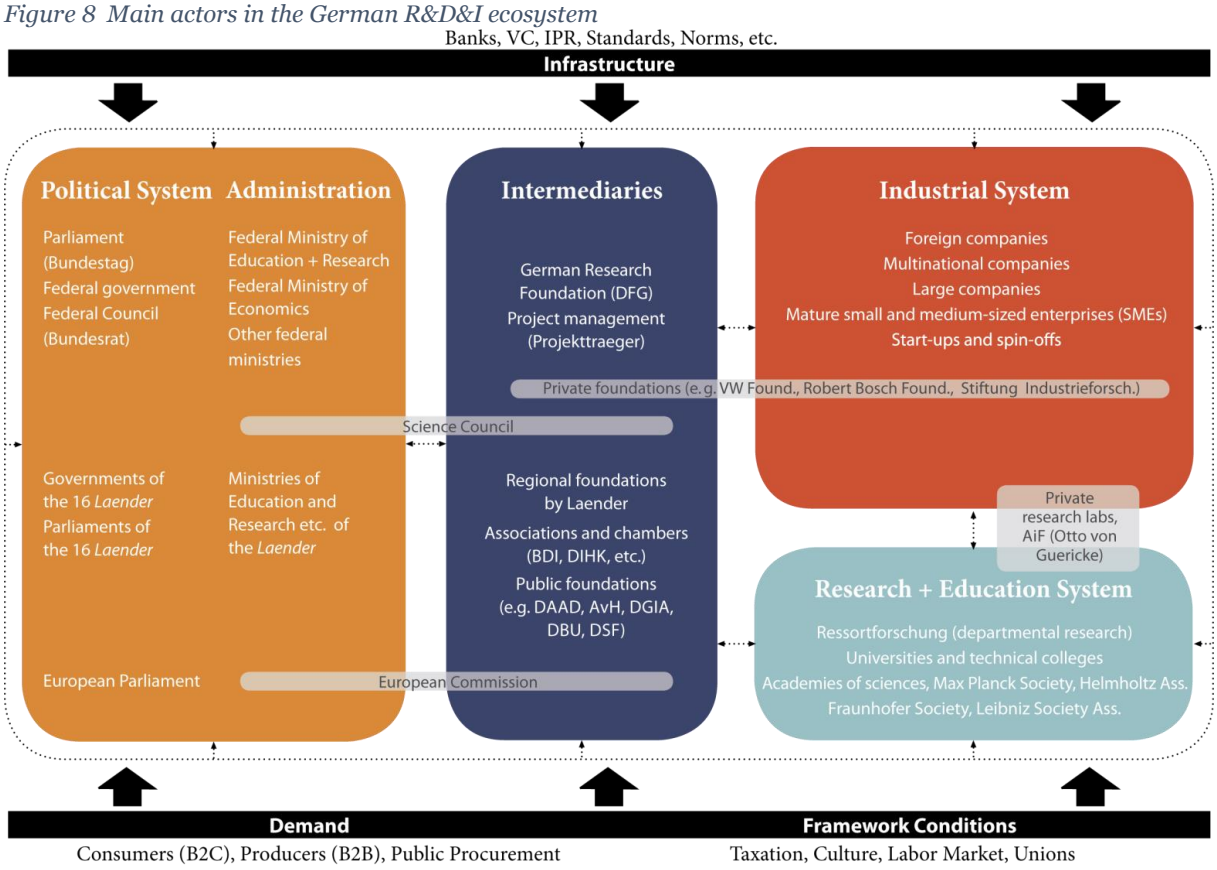
level. Besides the shared competencies for R&D&I policies, the Länder governments are responsible for education policies and institutions, including co-funding the public research institutions. They also have the main competence for the organisation of public universities, in line with the legal provisions in the German Basic Constitutional Law.

To a limited extent, several other Federal ministries also promote or fund research and innovation-related activities in their areas of interest. The most active are the Federal Ministries of Health and of Environment, Nature Conservation and Nuclear Safety (BMUB), the Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry of Labour and Social Affairs (BMAS) and the Federal Ministry of Health (BMG).[64]

The clear division of labor between research organizations and societies and between public and private actors and the fact the whole R&D&I system is relatively strong can be regarded as a strength of the German R&D&I ecosystem.[65]

Figure 1 gives an overview of the main actors in the German R&D&I ecosystem.

Figure 8 Main actors in the German R&D&I ecosystem



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[64] Stehnken, T. (2010) The German Innovation System at a Glance: Governance and Strategies

[65] Stehnken, T. (2010) The German Innovation System at a Glance: Governance and Strategies

C.1.1.2 Distribution of R&D budget across sector ministries

In Germany, there is an implicit consensus at federal and state levels that funding should, by and large, be geared towards bridging the gap between knowledge creation and application. Most funding aims at collaborative R&D&I between public sector research and industry.[66] The federal government of Germany, and Germany's science and industry sectors, have continuously increased their R&D&I expenditure. In 2011, R&D&I expenditure in Germany reached a record level of more than EUR 75 billion.[67] Industry is a huge contributor to the R&D&I expenditure. In 2012, German industry spent nearly 54 billion euros on R&D&I.[68] The Federal Government has also contributed significantly to the achievement of Germany's good position in this category. Between 2010 and 2013, the government invested more than EUR 13 billion of additional funding in education and research. The Federal Government's share of government R&D&I expenditure increased from about nine billion EUR in 2005 to 13.5 billion EUR in 2012. In 2013, federal R&D&I expenditure increased still further, to 14.5 billion euros, and R&D&I expenditure of about 14.4 billion euros was reached in 2014.[69]

The Federal Government coordinates its research and innovation policy with the Länder. The Federal Government's research and innovation policy is oriented to the guidelines of the High-Tech Strategy (HTS, see below). The types of funding the Federal Government provides for research and development include project funding, or targeted funding of short- to medium-term duration, funding for contract research, and institutional funding of medium- to long-term duration.

BMBF implements various instruments, such as grant-based thematic R&D&I programmes and institutional funding for large-scale research associations. Another major task of the BMBF is the institutional co-funding of a broad range of non-university research institutes, organised within one of the four central research associations covering the whole spectrum from basic research to research services. The BMBF shares this task with the state governments, and coordination is linked to joint financing. The funding share of the federal states vis-à-vis the federal level depends on the particular organisation and the status of the institutes.

Private companies account for approximately two-thirds of overall R&D expenditure. Funding for R&D performed is provided by firms themselves as well as for contract research conducted by private and public research organisations and institutes (including universities).[70]

C.1.1.3 Main funding agencies

The Deutsche Forschungsgemeinschaft (DFG) is the main federal competitive research funding organisation in Germany, responsible for funding research that has been

[66] Edler, J. and Kuhlmann, S. (2008) Coordination within fragmentation: governance in knowledge policy in the German federal system

[67] BMBF (2014) Federal Report on Research and Innovation

[68] BMBF (2014) Federal Report on Research and Innovation

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[70] Dawson, J., van Steen, J. and van der Meulen, B. (2009) Science systems compared: A first description of governance innovations in six science systems

initiated by researchers themselves. DFG funds research projects carried out by scientists and academics working at universities or research institutes, selected in a transparent competition process. It funds research projects in all fields of science and the humanities. It also gives awards for outstanding research achievements, and provides funding for scientific infrastructure and scientific cooperation.

An overall majority of the publicly funded R&D&I programmes are administered and managed by a range of **implementation agencies (Project management agencies, Projektträger)** which evaluate proposals, organise the programme and provides support to the beneficiaries. The agencies are not responsible for the underlying policies. The final decision regarding the funding of R&D&I remains with the funding body. Legally private entities, most of the agencies are located in large research centres, with others evolving from such centres. The current list of agencies includes Projektträger Jülich GmbH, VDI/VDE Innovation + Technik GmbH, VDI Technologiezentrum GmbH, Projektträger Karlsruhe im Karlsruher Institut für Technologie, Deutsches Zentrum für Luft- und Raumfahrt e.V. - DLR Projektträger and Deutsches Elektronen-Synchrotron DESY.

Research foundations also fund projects and institutions in Germany. The biggest are **the Robert Bosch Foundation, the Volkswagen Foundation and the Klaus Tschira Foundation**. The projects and institutions spin across a wide range of different science fields. The **Donors' Association for the Promotion of Sciences and Humanities in Germany (Stifterverband für die deutsche Wissenschaft)**[71] is a joint initiative of companies and industries for funding German science and research.

C.1.1.4 Main PROs/universities

The public research sector is composed of university and non-university research.

Higher education institutions

Traditionally, higher education forms the backbone of the German research system with a variety of project arrangements ranging from basic to contract research. There are 427 state accredited universities in Germany.[72] There are three types of higher education institutions in Germany: universities, universities of applied sciences and colleges of art, film and music. Universities of applied sciences (Fachhochschulen) represent a link between science and industry based in the region. The German Länder provides institutional funding for the universities. While R&D&I activities at universities tend to be broadly focused, both thematically and methodologically, research at universities of applied science is largely application-oriented. Training of young scientists and researchers is a key priority for both types of higher education institutions.

Non-university public research organisations

[71] The official website is http://www.stifterverband.org/

[72] Information on the number of German universities is taken from https://www.study-in.de/en/plan-your-studies/types-of-universities_26607.php

In addition to research at higher education institutions, this research sector includes a broad spectrum of non-university research. Such research is pursued at federal and Länder (state) institutions charged with R&D and at numerous private non-profit institutions.

The non-university public research landscape is mostly organized under the four main umbrella bodies:

- **The Max Planck Society (MPG)** is composed of 80 institutes, research units and working groups (with a staff of more than 20,000 persons) addressing a wide range of promising areas of basic research.
- **The Fraunhofer Society (Fraunhofer Gesellschaft, FHG)** manages 60 research institutes with staff of 16,000. It promotes and undertakes applied research of direct utility to private and public enterprise and of wide benefit to society as a whole.
- **The Helmholtz Association** maintains 16 institutes that employ around 25,000 people. The association is Germany's largest scientific research community focusing on research that requires large-scale installations in the interest of science, society and industry.
- **The Scientific Association Gottfried Wilhelm Leibniz (Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e.V., WGL**), composed of 86 institutes with staff of 14,000, operates at the interface of problem-oriented basic research and applied research, covering the whole range from social to natural sciences. Its purpose is to provide private companies with R&D&I services, particularly in the Eastern Germany regions.).

The Max Planck and Fraunhofer Societies, both created just after WWII, are relatively more integrated organisations with a strong headquarters, while the Helmholtz Association and Leibniz Society, formally established in 1995 and 1997 resp., are comparatively loose umbrella organisations of legally independent institutes.[73]

In addition, there are seven Academies of Science, represented by **the Union of the German Academies of Sciences and Humanities**. The Union coordinates the so-called Academies' Programme', a major German research programme in the fields of cultural studies and the humanities.

Departmental research

The Federal Government's departmental research is an important part of the country's R&D&I system. It functions at the interfaces between the science, industry and policy-making sectors. Departmental research applies problem-oriented, practically focused, interdisciplinary approaches, and it covers a broad spectrum of tasks. Its portfolio includes such areas as scientific research on legally assigned tasks; scientific and technical services such as permits/approvals, operation of databases, expert systems and measuring networks, collaboration in development and refinement of laws and standards, and research, studies and social reporting on current socio-political issues.

[73] Dawson, J., van Steen, J. and van der Meulen, B. (2009) Science systems compared: A first description of governance innovations in six science systems

Länder research institutes

The Länder and municipalities operate several research institutes that support state research activities. There are approximately 160 institutes covering a broad range of research areas but predominantly in engineering, in the humanities, health research and natural sciences.

C.1.2 Horizontal coordination

Germany has a number of expert commissions and councils, both at national and state level. Germany allocates a relatively high level of resources on analysis of its R&D&I system[74], on the co-existence of numerous expert and high-level consultation, on coordinating or advisory bodies for research and innovation policy, on the efforts to ensure the provision of independent and evidence- and research-based policy advice.

C.1.2.1 Cabinet and the Ministry level

The federal states are mainly responsible for governing and financing primary, secondary and tertiary education, and they exert this responsibility in a variety of ways. In order to maintain some form of horizontal coordination of education and cultural policies, the Länder associate in a voluntary self-organisation of supra-regional importance called **Kultusministerkonferenz (KMK)**.[75] This is a forum for the exchange of information and is used for informal meetings. The Federal Government is a permanent guest with no voting right in the KMK, but its voice will normally be heard. The decisions of the KMK are not binding, however, for any of the participating states and, since the KMK itself is the object of discussions (the state of Lower Saxony formally left the KMK in 2004), its coordinating function should not be overestimated.

The German Council of Science and Humanities (Wissenschaftsrat) has the task of advising the Federal Government and the Länder governments regarding the development – in terms of both structure and focus - of the country's universities, science and research. It is charged with developing overarching recommendations regarding the thematic and structural development of the science, research and higher education sectors. The Council is jointly sponsored by the Federal Government and the Länder governments, with the federal and Länder sides each providing half of the relevant financing. Its work includes providing recommendations and expert opinions relative to two main task areas of science policy:

- Overarching issues of the R&D&I system, selected structural aspects of research and teaching and planning, evaluation and control of individual areas and disciplines;
- Scientific institutions (universities, universities of applied science (Fachhochschulen) and non-university research institutions), especially with regard to their structure, performance, development and financing.

The Council's current areas of work include:

- Tertiary education
- Research

[74] Schwaag Serger, S., Wise E. and Arnold, E. (2015) National Research and Innovation Councils as an Instrument or Innovation Governance: Characteristics and Challenges

[75] The official website of KMK is at: http://www.kmk.org/

- Evaluation
- Investments in, and accreditation of, higher education institutions
- Medicine

The Commission of Experts for Research and Innovation (Expertenkommission Forschung und Innovation, EFI) advises the German Federal Government on issues of research, technology and innovation policy. Its independent experts compile the latest scientific findings relating to innovation research and, in their annual reports, assess the strengths and weaknesses of the German R&D&I system. Their observations and recommendations for action provide a valuable basis for innovation-policy and research-policy decisions. EFI is composed of academic experts from different areas of relevance to research and innovation. The Commission reports directly to the German Chancellor. The most important instrument of the EFI is its annual report on research, innovation and technological performance in Germany. The EFI presents proposals for national research and innovation policy.[76] The German EFI differs from most other councils in that it only consists of academics and does not include high-level representatives from industry. According to the Chairman of EFI, great care is taken to ensure that members are 'grounded in reality' and have a documented ability to provide policy-relevant advice.

The Leopoldina (the German National Academy of Sciences) represents Germany's scientists in relevant international bodies and organizations. It also participates in scientifically based advice of society and policy-makers, regarding research and innovation issues. In the latter task, it cooperates with **Acatech – the National Academy of Science and Engineering**, **the Berlin-Brandenburg Academy of Sciences (BBAW)** and **the academies of science of the Länder**, and draws on their expertise. Acatech promotes dialogue between science, industry, policymakers and society, and it advises and informs policymakers and the public on a scientific basis, regarding current technology-related issues.

The Innovation Dialogue (Innovationsdialog) is a platform composed of high-level representatives from the government, industry, academia, labor unions and research institutes, as well as independent experts. It is chaired by the President of Acatech and meets 1-2 twice a year to discuss on previously identified themes of relevance for Germany's innovation policy. Aside from the German Chancellor, the group consists of the Minister or Education and Research, the Minister of Economy and Energy, and the Chief of Staff of the German Chancellery and Minister of Special Affairs. The members are personally appointed by the German Chancellor. The mission of the group is to provide independent expert advice on framework conditions for research, science and technological development. The group is supposed to follow and observe important developments, insights and trends in the innovation system.

Since 1999, the BMWi has been responsible for energy and aerospace research, SME-oriented indirect measures and the support of technology-based start-up companies.

Important framework conditions for research are also set by the Ministry of Finance (focus on budget issues) and the Ministry of Justice (legal measures with relevance for research,

[76] Schwaag Serger, S., Wise E. and Arnold, E. (2015) National Research and Innovation Councils as an Instrument or Innovation Governance: Characteristics and Challenges

including intellectual property regulations etc), in close coordination with BMBF and with other ministries involved. The coordination of functionally specialised organisations is a challenge for governance. The BMBF is increasingly confronted with demands to engage in international cooperation across the board of its remit, as a number of policy and funding issues are dealt with, additionally or exclusively, at the supra- or international level.

The remaining federal ministries have research and innovation competences and responsibilities of their own, with ministerial research institutes (Ressortforschungseinrichtungen) as a major pillar. They provide scientific knowledge as a basis for funding and support decisions.[77] Sectoral ministries also apply a range of funding instruments, such as thematic R&D&I programmes, institutional funding for large-scale research associations and organisations, participatory foresight processes and horizontal R&D&I activities. Sectoral policy aims have not been systematically linked with policies of BMBF and BMWi and the coordination is overly poor.[78]

The Joint Conference on Science (Gemeinsame Wissenschaftskonferenz, GWK) replaced in 2007 the Bund-Länder Commission for Educational Planning and Research Promotion (BLK). The BLK was a forum for the discussion of all questions of education and research promotion that are of common interest to the Federal and Länder governments. The mission of the GWK is the coordination of national, European and international R&D&I policies with the aim of enhancing Germany's performance and competitiveness. The members, who are Länder Ministers for research, science and finance as well as the respective Ministries of the Federal Government, cooperate in cases of funding of superregional importance. These include mostly the non-university public research institutions and R&D&I related matters at universities. The heads of both Federal and Länder governments are assigned to delegate further tasks to the GWK. In addition, it supports cooperation in funding of research organisations of projects of supra-regional importance, and it is an important decision-making body, in relation to the Excellence Initiative (see below) and to the Higher Education Pact (see below).

C.1.2.2 Agency-level

The two intermediary bodies in the German R&D&I system, DFG and Projektträger agencies do not show any particular patterns in coordination, which might be due to their different functions and focus of activities.

C.1.2.3 Performer level: alliances between universities and/or PROs

The German R&D&I system is highly diverse, in part as a result of the country's federal structure and size. It has a broad range of research areas and facilitates high degrees of specialisation in core areas. On the other hand, German research is highly capable and successful because its many and diverse players are willing to cooperate, for example, by forming collaborative research alliances between non-university research institutes, universities and companies.

[77] Edler, J. and Kuhlmann, S. (2008) Coordination within fragmentation: governance in knowledge policy in the German federal system

[78] Edler, J. and Kuhlmann, S. (2008) Coordination within fragmentation: governance in knowledge policy in the German federal system

The German Rectors' Conference (Hochschulrektorenkonferenz, HRK) represents German higher education institutions. HRK participates intensively in research and education policy debates. The HRK acts as the forum for the higher education institutions' joint opinion-forming process and as their political and public 'voice'. In this role, it provides member institutions with information, formulates and represents policy positions and advises Federal and Länder political and administrative bodies.

The German Federation of Industrial Research Associations "Otto von Guericke" (Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke", AiF) is a registered non-profit association. The task of the AiF is the promotion of applied R&D for the benefit of SMEs. Organised by industry and partly government funded, the AiF supports the efficient usage and advancement of R&D programmes in order to increase the competitive strength of SMEs.

There is also coordination between the groups of non-university research institutes. MPG cooperates with FHG on various levels. The coordination includes the fields of computer science, materials science / nanotechnology and biotechnology, as well as the area of regenerative energies and photonics.[79] The aim of such a venture is to bring to application the knowledge resulting from collaborative efforts, thereby making a direct contribution to the development of new technologies. The coordination takes place against the framework of the Pact for Research and Innovation[80] and its main aim is to bridge the gap between basic and applied research.

C.1.3 Vertical coordination (steering)

Vertical coordination tends to become overly complex and there is no balanced policy mix within and across knowledge sectors, in terms of a coordinated blend of different policy measures. Furthermore, coordination of state programmes with federal programmes is poor. Recently, however, a number of major efforts have been made to better orchestrate and even strategically orientate coordination and cooperation across actors and levels, and the reform of federalism in Germany simplified the situation.[81]

There is an apparent attempt to apply more soft coordination mechanisms such as common standards, monitoring and evaluation activities and peer pressure. Further, coordination needs are decreasing in some areas as competences are shifted down to the research organisations, especially the universities. Finally, coordination is increasingly indirect, through the commitment for shared strategies which are not only cross-cutting, but also backed at the highest political levels.[82]

The High-Tech-Strategy (HTS)[83] was designed as a systemic and cross-departmental framework for the federal level. The greater goal was to create an economic structure

[79] Information taken from the MPG website https://www.mpg.de/cooperation_with_fraunhofer.

[80] More information on the Pact for Research and Innovation is available at http://www.academy.fraunhofer.de/en/partners_collaborative_projects/collaborative_projects/pact_for_research_and_innovation.html

[81] Kuhlmann, S and Shapira, P. (2006) How is innovation influenced by science and technology policy governance? Transatlantic comparisons In Innovation, Science, and Institutional Change: a Research Handbook.

[82] Edler, J. and Kuhlmann, S. (2008) Coordination within fragmentation: governance in knowledge policy in the German federal system

[83] The official website of the High-Tech Strategy is http://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php

conducive to innovation, also in order to sustain in the international knowledge competition. The core concern of the HTS is to orient research and innovation politics towards central missions and challenges, such as the "CO2-neutral, energy-efficient, climate-adapted city".[84] Since 2006, the Federal Government has been addressing such challenges by focusing its research and innovation activities in line with the HTS. This strategy links key framework aspects, such as the conditions for innovative start-ups, the availability of suitable mechanisms for knowledge and technology transfer and the ongoing availability of enough skilled and specialised personnel, with funding for research and innovation. Instead of concentrating separately on individual technologies or research topics, the HTS looks at the "big picture", covering the entire value-creation chain from basic research to applications.

Excellence Initiative (Exzellenzinitiative)[85] aims to strengthen Germany's research landscape for the long run. Thanks to Excellence Initiative funding, universities can make cutting-edge research projects a reality and raise their profile in the international science community. The program supports activities in research and teaching that will enhance Germany's overall performance in science and higher education and thus its international competitiveness. The Excellence Initiative was launched in 2005 and is jointly run by the German Research Foundation and the German Council of Science and Humanities. Between 2012 and 2017, 43 Clusters of Excellence, 45 Graduate Schools and 11 Institutional Strategies are funded through the programme.

Higher Education Pact (2020) is a joint effort of the Federal Government and the Länder governments to accommodate for the rising demand for higher education. This initiative provides additional funding to the German higher education system. For the entire duration from 2007 to 2023, the Federal Governments will provide in total 20.2 billion euros and the Länder will provide 18.3 billion euros.[86]

As far as vertical steering of institutions is concerned, there are several examples. On the cabinet level, the members of the EFI are appointed by the Federal Ministry for Education and Research, after approval by the Federal Government for a period of 4 years. Equal participation of women and men in accordance with the Act of Filling Positions of Federal Bodies is encouraged. The Commission currently consists of 6 members, all of which are academics, and one of whom is foreign. In addition, the independence and objectivity of the experts is emphasized. Thus, according to the statutes of the EFI, experts may not belong to government or a legislative body at national or federal level. Furthermore they may not be representatives of industry associations, labor unions or employer organizations.

The Scientific Commission of the Council has 32 members. All are appointed by the German Federal President. DFG, jointly with MPG, HRK, the Helmholtz Association, FHG and the Leibniz Association nominate 24 of them. The Federal Government and the Länder governments nominate 8 prominent personalities. The Administrative Commission of the Council has 22 members, 16 of whom are Länder representatives, each with one vote, and 6 of whom are federal representatives, with a total of 16 votes. The Plenary Assembly thus has

[84] BMBF (2014) Federal Report on Research and Innovation

[85] More information on Excellence Initiative can be found at: http://www.dfg.de/en/research_funding/programmes/excellence_initiative/index.html

[86] The information is taken from the official website of the BMBF https://www.bmbf.de/de/hochschulpakt-2020-506.html

54 members, with a total of 64 votes.[87] The Council's decisions are taken by the Plenary Assembly, by a two-thirds majority; this promotes finding of consensus solutions.

DFG is a self-governed body, in legal terms an association under private law, whose members are universities, non-university public research institutions, scientific associations and the German Academies of Science and the Humanities.[88] The federal and state Länder authorities which fund DFG are represented on all decision-making bodies, but scientists and academics hold the majority. The Private Sector is not represented on governing bodies, with the exception of one Private Sector Senate member.

C.2 Steering and financing system of university research

C.2.1 University governance

C.2.1.1 Different types of institutions and roles

German higher education institutions (HEIs) are either state or state-recognized institutions. All HEIs are subject to higher education legislation. Universities offer the whole range of academic disciplines and they focus in particular on basic research. Universities have the right to award doctoral degrees and they provide training of the next generation of academics. Universities of applied sciences operate predominantly in engineering and other technical disciplines, business-related studies, social work, and design areas. They are more application-oriented than universities and they focus on professional character of studies, which can include internships at industries, enterprises or other relevant institutions, or cooperation on thesis writing. The third major group comprises the colleges of art and colleges of music offering studies for artistic careers in fine arts, performing arts and music; in such fields as directing, production, writing in theatre, film, and other media; and in a variety of design areas, architecture, media and communication. Their core objective is to allow students to develop as artistic individuals. Almost all colleges of art and music have the right to award doctoral degrees.

C.2.1.2 Governing bodies and their competencies and linkages

Due to the federal system in Germany, responsibility for education, including higher education, lies entirely with the individual federal states. The states are responsible for the basic funding and organisation of HEIs. Each state has its own legislation that governs higher education. Therefore, the organisation of higher education systems may differ from state to state. The management structures of HEIs vary too.

On the other hand, in order to ensure the same conditions of study and to guarantee mobility within Germany certain basic principles have been agreed on by the federal state ministers for science within the KMK. Länder must take these into account when formulating their laws

[87] BMBF (2014) Federal Report on Research and Innovation

[88] Information is taken from the DFG's official website http://www.dfg.de/en/dfg_profile/mission/index.html

and regulations. The German Federal Government can only legislate on issues related to access to higher education and academic qualifications.[89]

The appointment of executive leaders is different in the 16 Länder and depends on the state rules and legislation. For example, in North Rhine-Westphalia, the HEIs have full autonomy over the appointment of rectors and other executives and these are elected by the University Election Assembly (composed of the Senate members and of the University Council members).[90]

C.2.2 Financing of universities

Germany currently invests around 1.1% of its Gross Domestic Product in tertiary education. The majority of the funds stem from public sources.[91] Each of the German Länder has adopted different provisions for higher education funding.

In Thuringia, for example, the funding model for HEIs consists of three pillars: the core budget, the performance-based budget and a 'general, design and innovation budget'.[92] The core budget represents the biggest share (over 80%), leaving narrower manoeuvring space for the remaining two elements. The general, design and innovation budget is allocated according to separate performance contracts (see below). The Minister of Education, Science and Culture, the Minister President of Thuringia, the Minister of Finance and the presidents of the higher education institutions sign the Framework Agreement, a joint four-year agreement between the Land and the nine public HEIs. It provides a baseline for funding and development of the HEIs.

C.2.2.1 Institutional Block grants: no-strings attached vs. performance-based

The Federal Government is primarily responsible for funding scientific research and technological development, including fostering new research talent. It also provides special support for the internationalisation of higher education. On the other hand, Länder are responsible for funding teaching activities at HEIs on their territory. However, an amendment to the Basic Law is planned that will enable the Federal Government to make a permanent commitment to research and teaching in higher education.[93] Funding is awarded on the bottom-up principle based on peer review and mainly allocated to the universities. As university leaders in Germany argues, there is an overall actual decrease in the proportion of basic financing, which results in a considerable financial shortfall, particularly concerning basic infrastructure.[94] Cross-subsidies from teaching to research appear less common in Germany because of the lower spending per student.[95]

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[89] Information available online on the website of the German Rectors' Conference, http://www.hrk.de/

[90] Taken from the Higher Education Act http://www.hs-duesseldorf.de/hochschule/gremien/hochschulwahlversammlung

[91] Information taken from the official website of the HRK http://www.hrk.de/activities/higher-education-finance/

[92] De Boer, H. et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science of the Netherlands

[93] Information provided by the Research in Germany portal http://www.research-in-germany.org/en/research-funding/research-funding-system/government-funding.html

[94] EUA (2015) University Leaders' Perspectives

[95] Hilman, N. (2015) Keeping up with the Germans?: A comparison of student funding, internationalisation and research in UK and German universities

C.2.2.2 Teaching funding

All higher education institutions receive a budget from the responsible Länder ministry of the state in which they are located, based on annual or biennial negotiations. This teaching funding is complemented by additional agreements (see the section below on performance contracts) between higher education institutions and the state concerning the intake of additional numbers of students and the money to compensate the loss of income from tuition fees.[96]

C.2.2.3 Competitive funding (RCs)

The German Basic Law gives power the Federal Government and the Länder to cooperate in cases of supra-regional importance. The joint projects (between the federal and the Länder level) at universities are, however, limited even when efforts are supported by all Länder.

The German Excellence Initiative brings positive as well as negative effects. It has provided an extremely important impulse for the further development of the German R&D&I system. It has generated many high quality research ideas and projects and has clearly increased the international visibility of German science. It also caused structural changes in the German higher education system, which was traditionally based on a concept of equality. On the other hand, it causes governance problems at universities due to the emergence of parallel structures funded through the scheme. Another critical aspect is that it does not reflect the current distribution of the funding provided by the DFG, but is highly biased towards a quite small number of universities. This imbalance in funding is partially caused by a bias in favour of life sciences and natural sciences.[97]

Besides that, competitive funding is provided by the DFG but also by various third parties, such as the European Commission (Horizon 2020 and other instruments).

C.2.2.4 Third stream funding, industry income

The HEIs' income coming from the industry is generally low in Germany, which is related to the low alumni culture and to a general low trust in third-party funding. It is also partly caused by a clear focus of the FHG that is predominantly on the cooperation with industry.

C.2.3 Performance contracts

The rules for performance contracts in Germany vary across the Federation as this competence sits with the Länder governments.

Taking the example of Thuringia[98], the president of each HEI signs a four-year performance contract with the Minister of Education, Science and Culture, which is based on the based on the Framework Agreement (see above) and which has set targets for the given period. These targets include numbers of students and graduates in certain fields, quality assurance process of research and teaching, promotion of new talent, technology transfer, acquisition of third

[96] Hilman, N. (2015) Keeping up with the Germans?: A comparison of student funding, internationalisation and research in UK and German universities

[97] EUA (2015) University Leaders' Perspectives

[98] De Boer, H. et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science of the Netherlands

party funding, fulfilling the gender equality pact, cooperation with national and international research institutes, universities, and industry. If no agreement on targets is reached (an institution disagrees with the performance targets suggested), the ministry can determine the institutional targets after having heard the institution's arguments.

In North Rhine-Westphalia[99], the higher education performance-based funding differs for universities and universities of applied sciences. The current performance-funding model distributes 23% of each institution's basic grant based on performance indicators, so that the amount for each institution is proportional to the whole budget the institution receives. The indicators include the number of graduates weighted by discipline, study length, and degree type, the third party income and the gender composition of professorships. The ministry signs a target and performance agreement with each of the HEIs. The performance agreements cover a period of two years for both universities and universities of applied sciences. Through the negotiation process the goals and targets are specified and institutions have the opportunity to stress the areas where they want to profile themselves further.

Performance contracts in the German higher education systems have had positive impact on internal policy making within HEIs. Institutions started internal discussions on their strengths and weaknesses. On the other hand, there has been some criticism related to them. It is criticised for establishing the winning HEIs and the loosing ones, without considering sufficiently the profile of the institution.[100]

C.3 Steering and financing system of governmental research organisations

C.3.1 PRO role

The non-university public research in Germany is organised mostly into four big groups of performers and within the departmental research.

C.3.1.1 Main function/category

The Max Planck Society (MPG)

MPG is an independent, non-profit research organization that primarily promotes and supports fundamental research at its own institutes. The Private Sector is represented among the society's supporting members, through representatives on the senate and through two top industry managers serving as members of the administrative board (Verwaltungsrat). As a part of its mission, MPG is committed to research co-operation with local universities and with other partners (including Private Sector R&D) and to knowledge and technology transfer. To promote the latter, the MPG has established an own company in 1970: Garching Innovation (GI) advises institutes on matters pertaining to the legal protection of intellectual

[99] De Boer, H. et al. (2015) Performance-based funding and performance agreements in fourteen higher education systems: Report for the Ministry of Education, Culture and Science of the Netherlands

[100] Smitten, S. and Jaeger, M. (2013) Stellungnahme Hochschulsteuerung durch Leistungsorientierte Mittelvergabe in NRW, Stellungnahme zur öffentlichen Anhörung des Aus-schusses für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen am 3. Juli 2013

property, does the necessary patent research, arranges legal counsel and advises the researchers on patent registration procedures in Germany and abroad. In special cases, GI approaches also Private Sector enterprises with inventions stemming from MPG institutes.

The Fraunhofer Society (FHG)

Their services are solicited by customers and contractual partners in industry, the service sector and public administration. More than 900 Million Euro of FHG's annual research budget of over one Billion Euro is generated through contract research. Roughly two thirds of FHG's contract research revenue is derived from contracts with industry and from publicly financed research projects. The remaining one third is contributed by the German Federal and Länder Governments, partly as a means of enabling the institutes to pursue more fundamental research in areas that are likely to become relevant to industry and society in five to ten years' time.

The Helmholtz Association

These centres have been commissioned with pursuing long-term research goals on behalf of the state and of society. The Association identifies and works on the grand challenges faced by society, science and industry through research in strategic programmes in six core fields: Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space. Its senate makes recommendations to the financial sponsors on thematic priorities and funding for research programmes. The senate is chaired by the President of the Helmholtz Association and consists of two members of the German Parliament, five Federal or Länder Ministers or Ministry Representatives, two representatives of other scientific societies, six external scientists and six Private Sector representatives. Collaborative research and knowledge/ technology transfer are important elements of the research centres' mission.

The Leibniz Association (WGL)

The activities of these institutes are grouped in five sections (humanities and education, economic and social sciences, life sciences, physical sciences and environmental research). The institutes collaborate closely with universities and Private Sector partners and position themselves as demand-oriented and interdisciplinary centres of competence. The umbrella organisation coordinates the mutual interests of the associated institutes, represents them in public and is responsible for the development of a comprehensive system of quality management. Institutes are assessed externally at regular intervals by independent experts. Currently, there are no Private Sector representative on WGL's governance bodies. But until November 2005, its president was a previous Managing Director of IBM Germany/Europe and President of the German Industry Association BDI. A subsidiary of the association, LeibnizX, supports value creation from the results of its member institute's research with a focus on spin-off creation and on the stimulation of entrepreneurship.

C.3.1.2 Governance

MPG

The President represents the MPG, sets guidelines for research policy and presides over the Senate, the Executive Committee, and the General Meeting. The Senate elects the President

for a six-year term. The Executive Committee advises the President and prepares important decisions for the MPG. The Executive Committee draws up the overall budget and prepares the annual accounts. Members of Executive Committee include the President, the four Vice Presidents, the Treasurer as well as two other Senators. The Senate elects the members for a term of office that lasts six years. Both the Secretary General and the Executive Committee make up the Board of the MPG.[101]

The Senate is the central decision-making and supervisory body of the MPG. The Senate elects the President, members of the Executive Committee and decides on the appointment of the Secretary General. It also adopts the budget and annual accounts and presents it to the General Meeting, and decides on the organisational changes, such as establishment of new institutes or their mergers. Ex officio Senators include the President, the Chairperson of the Scientific Council, the Chairperson of each of the three scientific sections, the Secretary General, three scientific staff members chosen by each section, the Chairperson of the general works council, as well as five ministers or under secretaries representing the Federal Government and the Länder. The Honorary Members and the Honorary Senators are also members of the Senate and have an advisory capacity.

FHG

At FHG, an umbrella association agrees major elements of strategy, and shapes the key research themes that spin across the 60 individual institutions. However, the institutes have wide powers to negotiate individual research project contracts, and to establish relations on their own. The Presidential Council consists of the members of the Executive Board and the chairmen of the research groups. The Council participates in decision-making processes on questions relating to the FHG's business strategy. The Senate of the FHG is composed of esteemed personalities from science, business, industry, and public life, including representatives of national and regional governments, altogether approximately 30 people. It meets twice a year. The Senate is responsible for decisions concerning basic science and research policy and for decisions concerning the organisational structure, such as establishments of mergers of institutes. The Senate appoints members of the Executive Board. The General Assembly is of the members of the Senate, the Executive Board, institute directors and senior management and the governing boards. The General Assembly meets once a year. It elects the members of the Senate and discharges the Executive Board of its responsibilities.

The Helmholtz Association

A full-time President heads the Helmholtz Association. The President is responsible for implementing the programme-oriented funding system and he works with the Helmholtz institutes to develop the general strategy and represents the Association internally and externally. The central decision-making bodies at the Helmholtz Association are the Assembly of Members, made up of internal members of the association, and the Senate, made up of external members. The members of the Assembly of Members are the directors of the Helmholtz institutes, the members of the Senate are representatives of Federal and

[101] Information taken from the official website of the MPG http://www.mpg.de/en

Länder governments, as well as representatives of science and research, business and industry, and other research organisations.

The Senate commissions evaluation of research programmes by independent experts and receives their review reports. These evaluations serve as a basis for the funding recommendations which the Senate makes to the the Helmholtz Association's funders, who are the Federal and Länder Governments.[102]

WGL

The General Assembly is the supreme body of the WGL. It meets once a year and is attended by the academic and administrative heads of the institutes. The General Assembly Matters decides on fundamental issues, such as the election of the President and Vice President or approval of the budget. The twelve-person Executive Board of the WGL is composed of the President, Past President, Vice Presidents and representatives of some key research fields. The Executive Board prepares important decisions and advises the President. The Senate is responsible for the science policy objectives of the WGL and acts in an advisory capacity. It issues recommendations on both the strategic development of the WGL and its member institutions and on increasing the efficiency and competitiveness of research and services. The Senate is composed of the Federal and Länder Ministers responsible for joint research funding, representatives of some German science organisations and additional co-opted members. The Senate holds meetings at least once a year.

C.3.2 Financing

C.3.2.1 Institutional Block grants: no-strings attached vs. performance-based

All the four big groups of non-university research institutes are funded jointly by the Federal and Länder Governments. The MPG's 2015 budget amounts to approx. 2.1 billion euros. The MPG is primarily financed out of public funds from the Federal Government and the Länder. The annual research budget of the FHG amounts to nearly 2 billion euros in 2015. Approximately one third of the research budget is contributed by the Federal Government and the Länder in the form of institutional funding. The Helmholtz Association's total budget in 2015 amounts to 4.2 billion euros. More than two thirds come from the public-sector funders (jointly between federal and Länder authorities). The WGL's 2015 budget is approximately 1.6 billion euros with an equal share from the Federal Government and Länder (more than one third each). Third-party funding amounts to 23% of the total budget.[103]

The Federal Government and the Länder governments have agreed on funding rules for each research institute. At the Länder level, the rules are based on the so-called Königstein Formula. The formula is calculated on the basis of each Land's tax revenues and number of inhabitants, which are weighted two-thirds and one-third respectively. The GWK is responsible for determining the formula each year.[104] For example, 90% of the institutional

[102] Information taken from the official website of Helmholtz Association http://www.helmholtz.de/en/about_us/die_gemeinschaft/satzung_und_governance/structure_and_governance/.

[103] Information provided by the Research in Germany portal http://www.research-in-germany.org/en/research-funding/funding-organisations/funding-by-research-organisations.html

[104] Information provided by the Research in Germany portal http://www.research-in-germany.org/en/research-funding/research-funding-system/government-funding.html

funding of the FHG comes from the Federal government and 10% money from the Länder. The MPG's basic funding, on the other hand, is equally shared between the federal government and the states.[105]

C.3.2.2 Competitive public funding (RCs)

The ministries at the federal level provide project funding via funding programmes. This is done on the basis of an application for a term-limited project. Project funding can be provided for both individual projects and collaborative research projects involving several partners of equal status. For example, such support is provided for development and enhancement of research infrastructure, for research cooperation, for innovative networks and for personnel exchanges between research institutes and industry. In addition, the Federal Government has funding authority for major scientific projects (such as research projects in the areas of aeronautics, space, oceanography and nuclear technology) and for international research institutes. Furthermore, the Federal Government and the Länder have financing competencies over the departmental research to fulfill their legally assigned tasks and in obtaining advisory support for their political and administrative decisions.

Besides that, competitive funding is provided by the DFG but also by various third parties, such as the European Commission (Horizon 2020 and other instruments).

C.3.2.3 Government service contracts

The Federal departments conduct their own research. Departmental research institutes are 100% publicly funded. Contracts for R&D&I projects are awarded by the respective government departments themselves and by federal institutions with R&D&I tasks. In addition to being conducted via project funding, departmental research is often carried out as contract research. Relevant contract awards are subject to the regulations for public procurement law.[106] This departmental research is always directly related to the respective ministry's field of activity. The total departmental R&D&I budget in 2014 was 910 million euros.[107]

C.3.2.4 Industry funding

Industry funding is typical for the FHG that operates under the so-called Fraunhofer model.[108] The FHG works with industry and universities to scale up cutting-edge research into real working technologies on an industrial timetable. In 2014, the FHG received from industry more than 70% of their revenue on contract research.[109]

[105] BMBF (2014) Federal Report on Research and Innovation

[106] BMBF (2014) Federal Report on Research and Innovation

[107] Information provided by the Research in Germany portal http://www.research-in-germany.org/en/research-landscape/research-organisations/federal-institutions.html

[108] Information is taken from the official FHG website http://www.fhcmi.org/About/model.html

[109] Bressler, P. (2015) An introduction to Fraunhofer Gesellschaft and Fraunhofer USA. A presenation available at: http://www.iie.org/~/media/Files/Corporate/DAAD-Colloquium/Introduction-FhUSA-05-Nov-2015.pdf?la=en

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Appendix D Netherlands

List of abbreviations:

ACTS – Advanced Chemical Technologies for Sustainability

AWTI - Advisory Council for Science, Technology and Innovation

BuZa – Ministry of Foreign Affairs

DLO – Agricultural research institutes

EZ – Ministry for Economic Affairs

GTI – Large Technology Institutes

IBO – inter-departmental policy reviews

KNAW – Royal Netherlands Academy of Arts and Sciences

NWO - Netherlands Organisation for Scientific Research

MUB – Modernising University Act (1997)

OCW – Ministry for Education, Culture and Science

REZIM – cabinet sub-committee on Economic Affairs, Infrastructure and the Environment

RVO.no – Netherlands Enterprise Agency

STW – Technology Foundation

TKI – Top Consortia for Knowledge and Innovation

TNO - Netherlands Organisation for Applied Scientific Research

TTI – Top Technology Institutes

TO2 – Federation of institutes of applied research

UAS – Universities of Applied Science

VSNU – Association of Universities in the Netherlands

VWS - Ministry of Health, Welfare and Sport

ZonMw – Netherlands Organisation for Health Research and Development

D.1 Coordination of national systems

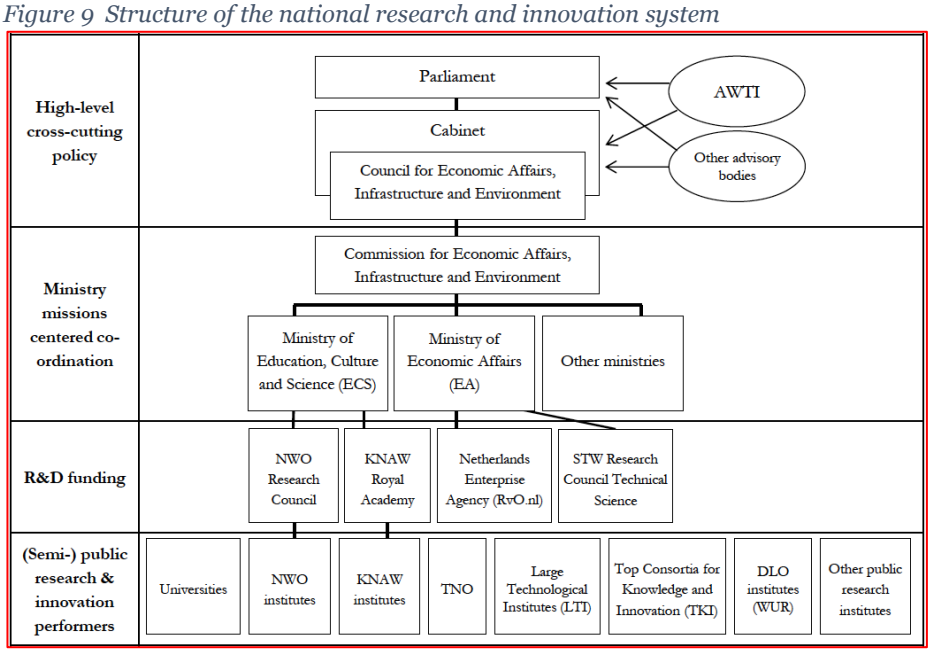
D.1.1 Introduction

The Dutch research system has undergone a thorough evaluation in recent years. For example, the Rathenau Institute and KNAW monitor the Dutch science system,[110] and the OECD published has review of the Dutch Innovation policy (OECD, 2014). A major reform of the system was announced in 2014 and is in the process of being implemented (OCW, 2014).

Government ministries and other bodies will be referred to by their Dutch acronyms, please see the list of abbreviations.

D.1.2 Composition of the system

Figure 9 Structure of the national research and innovation system



Source: Janssen and Hertog (2015, p. 3)

D.1.2.1 Distribution of responsibility and budget for R&I policy-making between ministries

Dutch R&D policy is centralised at the national level, with limited regional initiatives. The ministry of Education, Culture and Science (OCW) has the overall responsibility for the Dutch science system, coordinates policy and strategies (including national science strategies published in 2011 and 2014) and consults with Parliament on behalf of the cabinet (OCW 2012, p. 19). The ministry administers more than two thirds of the government R&D budget (see Table 2 below).

The Ministry of economic affairs (EZ) promotes enterprise and competitiveness and is increasingly involved in R&D policy as this is more closely linked to economic policy. It implements innovation support schemes through the agency Netherlands Enterprise Agency (RVO.nl) and also funds certain activities through the NWO. EZ also oversees, and provides

[110] See: http://www.denederlandsewetenschap.nl/ (accessed 10 December 2015).

funding for, the main RTOs, including TNO and the four Large Technological Institutes (GTIs) and the nine agricultural research institutes (DLO).

Many ministries have developed 'knowledge forums' ('kenniskamer') to promote interaction between ministry officials and research institutions and commission policy-relevant knowledge. Several sector ministries also have their own research institutes. As of 2012, this included the Ministry of Safety and Justice, the Ministry of infrastructure and the Environment[111]

The most prominent advisory body in the Dutch system is the Advisory council for science, technology and innovation (AWTI). The council was set up by law in 1990 and 'innovation' was added in 2014. The 10 members of the council are drawn from public science as well as the private sector and serve in a personal capacity, supported by a secretariat. AWTI advises the government and the houses of parliament on topics of STI policy, and particularly on the connection between science, technology and innovation and socio-economic goals. The Royal Netherlands Academy of Arts and Sciences (KNAW) also has an advisory role, with five thematic advisory councils composed of experts representing the scientific community in their respective fields.[112]

Table 2 Direct R&D expenditure in the Netherlands by ministry (cash basis), in million euros

	2013	2014	2015	2016	2017	2018	2019
Ministry of General Affairs	0.5	0.6	0.6	0.6	0.6	0.6	0.6
Ministry of Foreign Affairs	59.1	53.3	44.3	42.5	42.3	42.3	42.3
Ministry of Security and Justice	22.1	22.2	21.5	21.1	20.7	20.5	20.5
Ministry of the Interior and Kingdom Relations	19.4	20.4	19.9	19.8	19.7	19.7	19.5
Ministry of Education, Culture and Science	3,319.7	3,414.2	3,470.6	3,444.8	3,423.2	3,407.0	3,415.3
Ministry of Defence	59.2	62.8	58.4	57.2	57.0	57.0	57.0
Ministry of Infrastructure and the Environment	100.1	61.0	57.0	50.4	46.2	44.7	44.8
Ministry of Economic Affairs	958.8	1,044.1	882.8	777.4	743.0	711.1	702.3
Ministry of Social Affairs and Employment	0.6	0.6	1.3	1.4	1.4	1.4	1.4
Ministry of Health, Welfare and Sport	255.0	245.6	223.1	215.5	192.6	181.1	187.0
Total	**4,794.3**	**4,924.5**	**4,779.7**	**4,631.0**	**4,546.6**	**4,485.3**	**4,491.4**

Rathenau Instituut

Note: The figures for Education, Culture and Science include the general university funds for research. The Rathenau Instituut has provided an estimate of that amount. The Education, Culture and Science figures include the research funding made available to Wageningen UR by Economic Affairs. The figures for Economic Affairs exclude this contribution (estimated in 2015 at approximately EUR 100 million).

Source: Steen (2015, p. 5)

[111] https://www.government.nl/ministries/ministry-of-infrastructure-and-the-environment/contents/organisation (Accessed 5 January 2015).

[112] http://www.knaw.nl/en/advisory-work (Accessed 20 December 2015).

D.1.2.2 Main funding agencies

The main funding bodies in the Dutch system are Netherlands Organisation for Scientific Research (NWO), Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Enterprise Agency (RVO.nl).

NWO works under the purview of OCW and provides competitive project funding through its research councils and a variety of other programmes and schemes, covering fundamental, strategic and applied research. It also oversees a number of research institutes, research infrastructures and temporary initiatives and generally plays a central role in shaping and implementing Dutch research policy.[113] The main recipients of NWO funding are universities (about 2/3) and the NWO institutes and STW (about 1/3).

NWO's budget has increased significantly since 2000. In 2014, NWO received a total of €820m, an increase of €89m over the previous year. The recent increase is partly related to the 'Top sectors' policy (see below), but may also reflect an effort to strengthen strategic research more generally.

As shown in Table 3 below, NWO is primarily funded by OCW but other sector ministries fund certain activities as well. This includes the Technology Foundation (STW), which focuses on knowledge transfers and is funded by EZ, and the Netherlands Organisation for Health Research and Development (ZonMw), which facilitates health research and is mainly funded by the Ministry of Health (VWS).

Table 3 NWO income by source, 2014 (consolidated statement)

	Income (k€)	**Income (%)**
General government subsidy (OCW)	678,240	82.8%
Specific subsidies (OCW)	10,178	1.2%
Other government subsidies	81,694	10.0%
Of which subsidies from EZ (economic affairs)	*28,480*	*3.5%*
BuZa (foreign affairs)	*17,925*	*2.2%*
The European Union	*16,766*	*2.0%*
Subsidies from third parties	34,580	4.2%
Other income	14,848	1.8%
Total income	**819,540**	**100.0%**

Source: Adapted from NWO (2015b, pp. 71, 97).

NWO has been criticised for being too complex, with over 100 different funding schemes and different types of ad hoc institutional arrangements (Dawson, Steen, & van der Meulen, 2009). The 2014 government white paper on science policy introduced a reorganisation of the NWO and this is now in the process of being carried out. University researchers have been highly critical of the new structure as more management positions within the NWO will be taken up by non-academics (Janssen & Hertog, 2015, p. 27).

[113] http://www.nwo.nl/en/about-nwo/what+does+nwo+do (Accessed 18 December 2015).

In addition to its advisory functions (see above), the KNAW is also the umbrella organisations for (currently) 16 research institutes. KNAW administers a budget of some €150m per year – including 90-95m from OCW – the majority of which funds its research institute but also funds a number of awards and prizes. The organisation was evaluated in 2014 (Weerdesteyn, Breimer, Gelders, & Zeilinger, 2014).

The Ministry of Economic Affairs (EZ) oversees the Netherlands Enterprise Agency (RVO.nl), created in 2014 through the merger of the innovation agency (NL Agency) and the agency for regulations (Dienst Regelingen). RVO is responsible for implementing innovation schemes and providing services to entrepreneurs.[114]

D.1.2.3 Main universities and PROs

The higher education sector account for the majority of public sector research in the Netherlands, see Table 4 below. This is primarily carried out by 14 research universities and 8 university medical centres, whereas 41 universities of applied sciences ('hogescholen') are less research intensive.

The institute sector includes the 'para-university' institutes under NWO (8) and KNAW (16), which primarily carry out academically oriented research and a number of RTOs, including TNO and the four Large Technological Institutes (GTIs) now associated under the TO2 umbrella. Other institutes include the agricultural research institutes, and institutes belonging to sector ministries.

Table 4 R&D expenditure by sector of performance

	2009	**2013**
R&D performed by HEIs (HERD as % of GERD)	40%	32%
R&D performed by Government Sector (GovERD as % of GERD)	13%	11%
All public sector research (HERD + GovERD as % of GERD)	*53%*	*43%*

Source: Eurostat, as cited in Janssen and Hertog (2015).

D.1.3 Horizontal coordination

D.1.3.1 Cabinet and ministry level

D.1.3.1.1 Cabinet-level and cross-ministerial bodies

The Dutch government coordinates R&D policy through the cabinet sub-committee on Economic Affairs, Infrastructure and the Environment (REZIM), including the ministers most concerned with these areas. Higher education, science policy and innovation fall under the purview of this sub-committee. A corresponding committee of civil servants from the departments (CEZIM) prepares the work in REZIM.[115]

[114] http://english.rvo.nl/home/about-rvonl/what-is-rvonl (Accessed 18 December 2015).

[115] http://www.denederlandsewetenschap.nl/en/web-specials/the-dutch-science-system/policy-and-advice/politicians-and-government.html (Accessed 20 December 2015).

Between 2003 and 2010 (renewed in 2007), the 'Innovation Platform', a cabinet committee, played a central role in the coordination of Dutch science policy. Inspired by its Finnish counterpart, it was chaired by the Prime Minister and included other central sector ministers (e.g. OCW and EZ) alongside representatives from business and research organisations. Its working style was informal and it had a 'network-style structure' but owing to the high-level political ownership, it was an appropriate forum for ensuring effective policy implementation (Schwaag Serger, Wise, & Arnold, 2015, p. 49). The discontinuation of the Innovation Platform in 2010 appears to have left a gap as far as formal coordination mechanisms for science policy is concerned, especially with respect to long-term strategy-making and for areas science policy outside of the top sector areas (OECD, 2014, p. 185)

The cabinet also set up inter-departmental policy reviews (IBO) on different policy areas, including science and innovation.[116] The IBOs, sometimes described as 'audits', are organised under the Finance ministry and focus on efficiency of public spending and potential savings. Mostly recently, the results of a study on the science system in 2014 concluded that it was largely working well but also recommended some adjustments (Netherlands Government). The subsequent government science policy white paper responded to these recommendations (OCW, 2014, appendix 2).

D.1.3.1.2 Enterprise policy and top sectors (since 2011)

In 2011, the government launched a new 'enterprise' policy aiming to strengthen the connection between Education, R&D, innovation and entrepreneurship. In effect, this policy now functions as one of the main innovation policy coordination mechanisms in the Netherlands (OECD, 2014, p. 186). The policy introduced the '**top sectors' approach**, identifying nine such sectors with large potential for growth and export:

- Agro-Food
- Horticulture and propagating stock
- High Tech materials and systems
- Energy
- Logistics
- Creative industries
- Life-sciences
- Chemicals
- Water

In terms of thematic focus, the top sectors are essentially a continuation of previous innovation programmes. Concerns have been raised that this approach favours incumbents over newcomers and tends to focus on established sectors rather than trying to identify new developments. Also, it has been argued that its position within the national policy mix is problematic as it fails to reach mid-sized companies, identified as the group with the highest 'innovation deficit' (OECD, 2014). The limitations of a strictly sectoral approach have been

[116] https://www.rijksoverheid.nl/onderwerpen/evaluaties-van-beleid/inhoud/beleidsonderzoek (Accessed 4 January 2015).

acknowledged with the introduction of three 'cross-over domains': ICT, Nanotechnology and bio-based economy.

The approach aims to improve conditions for each of the sectors cutting across government policy and ministerial portfolios, to foster greater collaboration on basic and applied research between the private sector, knowledge institutes and government, and to be driven to a larger extent by private sector demand (Dutch Government, 2011). The initial focus was primarily on the economy, but following criticism from a number of stakeholders within the scientific community the government has done more to align the top sectors with societal challenges and the Horizon 2020 (EZ, 2014).

The initiative builds on a 'bottom-up' approach to governance, emphasising the role of private sector demand: For each top sector, a 'top team' of representatives form the private sector, science and government was set up to make recommendations for priorities and governance arrangements according to the specific needs of the sectors. Each sector initiative has a ministry as contact point with EZ in a central position responsible for five sectors as well as the overall coordination across the nine top sectors. The sectors are governed by a (non-binding) 'innovation contract' between the Top Teams and EZ, detailing the ambitions for the sector and the commitment from the participants.[117] The implementation of the sector initiatives is undertaken by 19 Top consortia for Knowledge and Innovation (TKIs) – one or more for each top sector. The TKI's build partly Top Technological Institutes (TTIs), established on similar principles of coordinating collaboration between state, science and private actors (triple-helix). These are now being subsumed by the TKIs. Compared to previous policies the Top Sector approach has been described as somewhat more formalised and integrated (Janssen and Hertog, 2015, p. 9).

The sectors covered by the top sector approach account for some 87% Dutch R&D expenditure and the total budgets for the 2014-2015 and 2016-2017 innovation contracts amounted to €2bn per year, including approximately equal public and private contributions. One sector, 'High tech materials and systems', account for a significant share of this budget at about 35% (public and private contributions combined). In contrast to its predecessor innovation programmes which benefitted from addition 'FES' funds (from gas revenues), there is relatively little by way of dedicated funding for the top sectors. The TKI allowance scheme and the SME innovation support for top sectors (MIT) provide top-up co-funding for businesses and SMEs contributing to the top sectors. In 2013, these schemes allocated a total of €106m government funding which means that the bulk of the funding has to be re-directed from existing sources to contribute to the implementation of the top sectors. Thus, on the one hand, the effective implementation of the top sectors rely on the partners being forthcoming but this also means that the potential reach of the initiative is greater, as it relates to a much larger share of the R&D expenditure (Janssen and Hertog 2015, pp. 9-11; OECD, 2014, p. 178, 204).

D.1.3.1.3 The National Science Agenda (2014-15)

In addition to the enterprise policy and top sectors, the government announced the intention to create a new National Science Agenda in their 2014 strategy, Vision for Science. It was to

[117] See: https://www.rijksoverheid.nl/documenten/rapporten/2013/10/02/nederlands-kennis-en-innovatiecontract-2014-2015 (in Dutch, accessed 20 December 2015).

be “a ‘co-creation’ of researchers, scientists, the private sector, civil society, the government and other stakeholders” (OCW, 2014, p. 24). Sources of inspiration cited in the document include the Danish Research2020 catalogue and the societal challenge themes in Horizon 2020. The agenda is meant to identify a limited number of themes based on scientific strengths, societal challenges and economic opportunities (ibid.), specifically focussing on themes where cooperation and coordination can provide added value (ibid. p. 27).

The elaboration of the new agenda was entrusted to the ‘knowledge coalition’ including of the main actors in the research system: VSNU, KNAW, NWO and TNO among others (see below). In the spring of 2015, a public consultation was held. The result was announced on the 27 November 2015 and consists of a catalogue of 140 research questions, grouped into five main themes:

- People, environment and economy
- Individual and Society
- Diseases and health
- Technology and society
- Building blocks of Life.

Each organisation is responsible for their own contribution to the implementation of the agenda but the government will monitor progress. Thus, the knowledge coalition is required to report to the ministry on progress. Specifically, OCW envisages that the Agenda will be influential in the universities’ profiling (i.e. specialisation), that NWO and the top sectors align their priorities with the Agenda, and that proposals that address the themes of the Agenda will be assessed positively. Finally, the Agenda is expected to be important for the award of the new NWO Gravitation Programme grants (ibid. pp. 27-28).

D.1.3.2 Agency-level

The ‘Knowledge Coalition’ (Kenniscoalitie) is made up of a number of organisations at the agency- and performer level, and play a central role in the National Science Agenda (see above) and the committee for large-scale infrastructure. The members include the associations for universities (VSNU) and universities of applied sciences, KNAW, NWO, the Confederation of Netherlands Industry and Employers (VNO-NCW), the Large Technological Institutions (TO2) and Royal Association MKB-Nederland.[118] NWO intends to use the coalition for broader collaboration, including joint lobbying for higher government investment in R&D (NWO, 2015a, p. 20).

D.1.3.3 Performer level:

The **Association of Universities in the Netherlands (VSNU)** has existed in its current form since 1985 and plays a number of roles. It represents the 14 Dutch research universities in talks with the government, is a forum for debate and also acts as employer’s organisation for the universities.[119] Each member university has a seat on the General Council, the governing body of VSNU, which decides on the organisations policies and budget. During the

[118] http://www.nwo.nl/en/about-nwo/what+does+nwo+do/influencing

[119] http://www.vsnu.nl/en_GB/about-vsnu.html (accessed 8 December 2015).

1990s, the association was responsible for organisation university evaluations and became one of the 'centres of control' (Meulen, 2007) in the Dutch system. Since 2000, this role has changed: VSNU develop the evaluation protocol in collaboration with KNAW and NWO but is no longer responsible for the implementation. Similarly, the eight University Medical Centres or organised through the Netherlands Federation of University Medical Centres (Nederlandse Federatie van Universitair Medische Centra) (NFU) and the Vereniging Hogescholen represents the 37 Dutch colleges.

In the institute sector, several new initiatives aim to improve coordination between them. Regarding scientific research institutes, NWO and KNAW are doing more to ensure that their institute portfolios are coherent and contribute to the national agenda, and ultimately abolish or create new institutes as needed. From 2017, institute evaluations of NWO institutes will relate to KNAW institutes and vice versa. Within NWO, the eight national institutes will be more closely aligned as part of a new non-profit association that will report directly to the new Executive Board at NWO. Encouraged by the minister for Economic Affairs (EZ), TNO and the applied research centres have come together in a federation of RTOs, TO2, to develop a joint strategic agenda for 2015-2018. As from 2018-2021, the TO2 members should all apply the same synchronous four-year strategy period.

D.1.4 Vertical coordination (steering)

D.1.4.1 General approach to steering

Following the corporatist tradition for consociational democracy (Lijphart, 1977), central political steering in the Dutch system has historically been relatively underdeveloped. Instead, the intermediary level (particularly NWO) has played a prominent role, and this has favoured process of consensus- and agenda building. Traditionally, the science ministry (OCW) has taken a 'hands off' approach to governance of the science sector. The OCW sets out the overall direction and does not see it as their role to flesh out the specific details of the policy. Intermediary organisations such as KNAW, NWO and TNO are not only expected to implement government policy but also "make (science) policy" – in the form of long-term strategic plans – which is (only) "partly based on national policy" (OCW, 2012, p. 8). Rather than a 'top-down' or 'bottom-up', this approach relies on a process of mediation and aggregation of interests (Dawson et al., 2009, p. 67).

Some see this 'aggregation' approach to be more suitable than top-down steering in the context of societal challenges and needs for broad coordination. However, it is also conducive to a high degree of institutional inertia that can be difficult for policy-makers and the ministry to change. In addition, there is an issue about the relationship between the agendas agreed at the intermediary level and the implementation by research performers ('anchoring') (van der Meulen & Rip, 1998).

D.1.4.2 Specific steering mechanisms

The government's R&D policy is expressed in regular white papers, published by OCW every 4-5 years. Following a 2006/7 OECD review of higher education in the Netherlands which drew attention to the reactive and short-term approach to decision-making within the OCW,

the first comprehensive, long-term strategy covering both higher education and science was published in 2007 (OCW, 2012). Further strategies were issued in 2011 and 2014. This suggests an increasingly pro-active approach to science policy from the OCW. For example, the latest white paper (OCW, 2014) has set in motion a major restructuring of the NWO and the creation of the National Research Agenda.

At the level of concrete programmes and schemes, the direct steering from the ministry has generally been limited. Direct initiatives by the government has taken the form of "temporary task forces", that is bodies within NWO that direct research in areas of strategic importance. Such task forces include genomics (2002), ICT (2005), Brain and Cognition (2009) as well as a long-standing task force on Advanced Chemical Technologies for Sustainability (ACTS). Such initiatives are added onto rather than replacing existing structures and this has led to a rather complex system with many layers of funding schemes, 'tasks forces' and temporary programmes (OCW, 2012, pp. 21-22).

Following a period with initiatives to strengthen prioritisation and move funding away from institutional grant funding towards politically defined aims, the government which took office in 2010 has reverted back to a 'hands-off' approach to R&I policy (Solberg, Larsen, Wiig, Aagaard, & Sivertsen, 2012, p. 32), at least in so far as the identification of substantive priority research areas is concerned. The government has made the explicit decision to move from "specific" to "generic" support for R&D and aims to let stakeholder demand, especially from industry, play a larger role in determining priorities for public research. The Top Sectors are important in this context.

The Top Sectors is probably the strongest instrument used by the current government and has led to a higher degree of alignment with common priorities by both research performers and intermediaries. By way of illustration, NWO's 2011 strategy originally outlined six societal challenges defined by the organisation itself but was subsequently revised to bring it in line with the nine top sectors. Since 2012, NWO has contributed more than a third (€225m) of its budget to top-sector related research, increasing to 44% (€275m) from 2015 onwards taken from across the NWO programmes and institutes. Applied research institutes are also expected to make substantial contributions to the top sectors (see below). This has led to concerns about the use of public R&D funding. Informed by the experience from the Finnish SHOK programmes, OECD reviewers warn of the risk of diverting resources from leading edge research at universities and institutes, not least in areas that might fall outside the top sectors, towards what could turn out to be relatively unambitious industrial research (OECD, 2014, pp. 230-34).

D.2 Steering and financing system of university research

D.2.1 University governance

D.2.1.1 Types of institutions

The higher education sector in the Netherlands consists of 14 research universities, 8 teaching hospitals (university medical centres) with some autonomy from the universities, and 41 'hogescholen', that is Universities of Applied Sciences (UAS). Although the UAS are beginning to build more research capacity (Melin et al., 2015, p. 15), the research universities are the main research performers and will be the focus in this section.

The 14 research universities differ with respect to their legal status and the scope of the subjects they cover. 11 universities are established under public law and employs their staff as public servants. The remaining three are denominational universities established under private law as associations (University of Amsterdam) or foundations (Nijmegen and Tilburg). Of the 14 universities, six are 'comprehensive' universities covering the whole spectrum of academic subjects. Seven are 'specialised' covering primarily natural sciences and engineering (TU Delft, Twente and TU Eindhoven), humanities (Maastricht, Rotterdam and Tilburg) or agriculture (Wageningen). The last of the 14 is the Open University which offers distance learning (Meza, 2012).

D.2.1.2 Roles:

According to the Dutch Act on Higher Education and Research of 1992[120], universities should teach, perform research and transfer knowledge to society. The latter of the three has been particularly emphasised in recent government policy under the headline of Valorisation ('valorisatie').

D.2.1.3 Governance:

Dutch universities have a a degree of autonomy concerning how they spend the government lump sum funding, internal organisation, staffing and property management, whereas student fees and programmes offered are more closely regulated by the government (Niekerk, 2013). The governance model for Dutch universities is dominated by New Public Management ideas of autonomy and accountability. In 1985, the government introduced the concept of 'steering from a distance', with the aim to reduce detailed regulation and instead make institutions accountable for results. This was known as the 'HOAK' approach. With the Modernising University Act (MUB) of 1997, the managerial principles were further enshrined.

Internally, university management was made more business-like. Previously, university governance had been based on representative model of co-management whereby university management, academic staff and students shared power. With the 1997 reform, the executive leadership was strengthened and the representative bodies reduced to a largely advisory role. According to the new management structure, the minister appoints the (external) members of the supervisory board to oversee the university executives and approve strategic plans, annual reports etc. The supervisory board, in turn, appoints the the members of the executive board, including the Rector. This basic structure was made mandatory, but universities were given some discretion to decide on other aspects of the organisational structure.

These reforms, coupled with a move towards more competitive and performance-based funding (see below), aimed to enable universities to act as 'Public entrepreneurs' that are more responsive to demands and incentives from the external environment. This more indirect form of steering was meant to allow for a more strategic policy in research, for example in terms of 'profiling' and specialisation. (Antonowicz & Jongbloed, 2015)

[120] 'Wet op het hoger onderwijs en wetenschappelijk onderzoek' (in Dutch) http://wetten.overheid.nl/BWBR0005682/geldigheidsdatum_18-01-2016 (Accessed January 2016)

D.2.2 Financing of universities

D.2.2.1 Size of the Sector (HERD)

The Higher Education sector accounts for a large share of R&D performed in the Netherlands. In 2012, Higher Education R&D (HERD) equalled 0.7% of GDP, up from 0.62% in 2000, and more than 30% of the Gross domestic expenditure on R&D (GERD). In comparison, the EU27 average was 23.7%. This should, however, be seen in the context of a relatively low (but increasing) business expenditure (BERD).

D.2.2.2 Overall composition of university income

Universities gain their income from four main budget streams: 1) a lump sum from the government based on formula (institutional grant), 2) funding from funding bodies NWO and KNAW, 3) third party funding, e.g. from EU grants and contract research, 4) student fees. Table 5 shows the funding streams for the 13 research universities (excl. the Open University).

Table 5: Funding streams by university, the Netherlands

	First-stream funding				Second-stream funding		Third-stream funding		Total
	Institutional funding		Tuition fees		NOW funds		Other		
	euros	%	euros	%	euros	%	euros	%	euros
Erasmus Universiteit Rotterdam	236.7	50.1	78.6	16.6	20.9	4.4	135.9	28.8	472.1
Radboud Universiteit Nijmegen	264.9	59.6	29.7	6.7	54.2	12.2	95.4	21.5	444.2
Rijksuniversiteit Groningen	325.9	62.1	47.0	9.0	40.7	7.8	110.9	21.1	524.5
Technische Universiteit Delft	333.9	65.2	35.1	6.9	33.1	6.5	110.2	21.5	512.3
Technische Universiteit Eindhoven	185.4	62.0	14.9	5.0	24.0	8.0	74.6	25.0	298.9
Universiteit Leiden	283.3	58.6	36.4	7.5	55.8	11.5	107.8	22.3	483.3
Universiteit Maastricht	194.6	63.4	26.6	8.7	16.5	5.4	69.3	22.6	307.0
Universiteit Twente	189.9	65.4	17.2	5.9	21.0	7.2	62.4	21.5	290.5
Universiteit Utrecht	445.8	61.9	50.3	7.0	69.2	9.6	154.4	21.5	719.7
Universiteit van Amsterdam	372.4	70.7	58.5	11.1	48.6	9.2	47.2	9.0	526.7
Universiteit van Tilburg	104.6	58.2	21.8	12.1	9.4	5.2	43.8	24.4	179.6
Vrije Universiteit Amsterdam	284.1	68.5	39.5	9.5	34.9	8.4	56.1	13.5	414.6
Wageningen Universiteit	163.1	58.5	17.0	6.1	22.0	7.9	76.6	27.5	278.7
Total (average)	*3384.6*	*(62.1)*	*472.6*	*(8.7)*	*450.3*	*(8.3)*	*1145.3*	*(21.0)*	*5452.2*

Note: The numbers are in millions of euros. Source: DUO Staat van Baten en Lasten 2007-2011 and NWO Annual Report 2011.

Source: (Dalen, Mehmood, Verstraten, & Wiel, 2014, p. 34)

D.2.2.3 Institutional grants for research and education

'First stream' or institutional funding for research and education is allocated according to criteria shown in Table 6 below.

Table 6: Parameters for first stream funding for Dutch universities (2012)

Education	**Research**
Number of students and degrees (65%)	Number of degrees (15%)
Education provision (35%)	Number of PhD defences (20%)
	Research schools (5%)
	Research provision (60%)

Source: (Dalen et al., 2014, p. 35)

The Netherlands have used performance-based funding formulas for institutional grant funding since 1993. In the current model, about 27-32% of university block grants is performance-based, including approximately 37% of research funding and 27% of teaching funding (incl. performance agreements, see below) (De Boer et al., 2015).

The new National Research Agenda, issued in November 2015 (see above), was originally meant to be unrelated to research funding, similar to the Danish 'catalogues'. However, OCW has decided to re-direct 85m Euros per year to support universities' implementation of the research agenda. [121]

D.2.2.4 External funding

The reliance by universities on external funding from streams two and three have increased significantly over the last couple of decades. Funding from the second and third streams discussed above has more than doubled in the decade from 1999 to 2009 (Meza, 2012, p. 8). Among the largest increases have been in international funding, largely accounted for by grants from EU Framework programmes.

Private sector funding has also increased very significantly, from €112m in 1999 to €344m in 2009 (Meza, 2012). As a share of HERD, industry funded research in the Netherlands increased from 5.2% in 2001 – below the EU average – to 8.2%, well above the EU and OECD averages (OECD, 2014, p. 151). An important driver behind this development has been the decision by Dutch companies to outsource a larger part of their R&D to universities (Melin et al., 2015, pp. 149–150).

D.2.3 Assessment or performance reviews

Dutch universities are assessed according to the Standard Evaluation Protocol (SEP) as well as through recently introduced performance contracts. Only the latter have direct financial implications.

[121] *Nationale wetenschaps agenda: Vragen, verbindingen, vergezichten*. (2015). Available at: http://www.tweedekamer.nl/kamerstukken/detail?id=2015D46336.

D.2.3.1.1 The Standard Evaluation Protocol (SEP)

The SEP is the basis of a largely formative assessment of universities and research institutes. The focus of the evaluations includes the past results and future plans, and looks at both research and management aspects. The assessments under the protocol are unified in their *procedure* but leaves room for institutions define the substantive criteria according to the specific groups being assessed. The first protocols were developed by VSNU following the 1992 University Act. The SEP as used today, also cover NWO and KNAW institutes and was developed from 2000. It has seen three cycles so far: 2003-2009, 2009-2015 and 2015-2021.

Under the protocol, research at universities, university medical centres and scientific research institutes under NWO and KNAW have to be evaluated every six years. This includes a self-evaluation and an external review which includes a site-visit. In addition, a mid-term review can be organised after three years. The assessment is done at two levels at the level of the institute (e.g. faculty or school) and the level of the research group or programme. It is the responsibility of the University boards, NWO and KNAW to organise the evaluations, to define the level of aggregation of each research unit to be assessed, and to appoint the assessment committee. The SEP ensures a level of comparability across institutions, but the institutions may also choose to coordinate between themselves to carry out a joint national assessment of a given field.

Under the current SEP (2015-2021) (VSNU, NWO, & KNAW, 2015), research units are assessed according to three core criteria: 'Research quality', 'Relevance to society' and 'Viability', each judged on a four-point scale from 'unsatisfactory' to 'world leading/excellent' as shown in Table 7 below. The new SEP contained several adjustments compared to the previous period (VSNU, KNAW, & NWO, 2009). One significant change has been an increased focus on the *quality* of research. The previous protocol had 'Productivity' as one of four core criteria, but this had been criticised for assigning undue importance to the volume of publication output. With the new SEP, productivity is no longer an independent criterion, and it is hoped that this will alleviate some of the pressure on researchers to publish for the sake of publishing (OCW, 2014, pp. 74–75). A second change concerns the societal relevance of research. In line with the government's research policy white paper (OCW, 2011, p. 52), the new protocol contained a stronger emphasis on valorisation akin to the focus on 'impact' in the UK's Research Excellence Framework (Wouters, 2014).

The assessments are primarily formative in nature as they do not have any direct bearing on research funding. Still, they have implications for the reputation of the researchers involved and can be consequential in other ways if university management decides to take action on the basis of the results (ibid.). Reportedly, the original intent behind the protocols was to enhance the government's ability to steer research organisations and to set priorities for research. The protocols have not been an effective tool for this purpose but arguably works well on their own terms (Meulen, 2007, p. 201).

Table 7 Main assessment criteria and categories, SEP 2015-2021.

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading/ excellent	The research unit has been shown to be one of the few most influential research groups in the world in its particular field.	The research unit makes an outstanding contribution to society.	The research unit is excellently equipped for the future.
2	Very good	The research unit conducts very good, internationally recognised research.	The research unit makes a very good contribution to society.	The research unit is very well equipped for the future.
3	Good	The research unit conducts good research.	The research unit makes a good contribution to society.	The research unit makes responsible strategic decisions and is therefore well equipped for the future.
4	Unsatisfactory	The research unit does not achieve satisfactory results in its field.	The research unit does not make a satisfactory contribution to society.	The research unit is not adequately equipped for the future.

Source: (VSNU et al., 2015, p. 8)

D.2.3.2 Performance agreements

Performance contracts for universities were introduced in 2011/12. A different model – whereby collective agreements where concluded with the Universities of Applied Sciences (UAS) sector as a whole – had already been trialled between 2008 and 2011. It was seen as unsuccessful because agreements were insufficiently aligned with institutional strategies and failed to gain ownership from the UASs. Instead a new model based on collective and individual agreements was developed (OCW, 2011). In addition to improving education, the agreements aimed contribute to the development of research profiles and priority areas, as well as knowledge transfer. In December 2011, the university associations signed a general agreement with OCW (VSNU, 2011) to develop contracts between the universities and the ministry, including seven mandatory indicators[122]. The following year, the universities submitted 'profile' documents, including targets as well as strategic and operational plans. The university plans were evaluated and scored by the 'Higher Education and Research Review Committee' according to three criteria: the level of ambition, alignment with the national policy agenda (double weight), and feasibility.

Unlike the SEP evaluations, the performance contracts do affect funding. Under the current model, the 'performance budget' allocated on the basis of the contracts amounts to 7% of teaching funding for the universities. Of this 5% is 'conditional funding' paid out to all institution on condition that they enter into a performance contract with the ministry. While

[122] The seven mandatory indicators are: completion rate for Bachelor students, drop-out rate (after the first year of an institution's programmes), study switch in the first year, an excellence/quality indicator, teacher quality, educational intensity (i.e. number of face-to-face hours per week in the first year) and indirect costs (i.e. overheads) (VSNU, 2011, p. 15).

the full amount is paid *ex ante*, universities may lose part of their conditional funding in the next funding cycle if they do not meet the performance targets. A further 2% is 'selective' funding allocated on the basis of the quality of their contracts as assessed by the Review Committee. Although the majority of HE funding is still based on the formula funding, the introduction of the contracts does constitute a step towards more a performance-based funding system. The performance contracts provide a tool for the ministry to steer the universities to some degree and has also acted as a driver for internal change at the universities (De Boer et al., 2015, pp. 27–32).

The future of the performance agreements is somewhat uncertain. A mid-term review, carried out in 2014, was generally positive about the progress made, but the universities are reported to be against a continuation of the scheme beyond the current period (Jonkers & Zacharewicz, 2015, p. 69).

D.3 Steering and financing system of governmental research organisations

D.3.1 PRO types and roles

D.3.1.1 Main types of PROs [123]

The Government R&D Sector accounts for 10.7% of GERD in the Netherlands, down from 13.2% in 2004. At its current level, it is about average for comparable European countries. (OECD, 2014, p. 156). There are three main groups of institutes:

- Scientific research institutes, including the academically oriented institutes under NWO (8) and KNAW (16)
- Government laboratories, under various sector ministries (10+).
- The applied research institutes (RTOs) including the six members of the TO2 federation: the Netherlands Organisation for Applied Research (TNO), the four Large Technological Institutes (GTIs) and the Agricultural Research Services (DLO).

D.3.1.1.1 Scientific research institutes

The eight national NWO institutes cover different subject but overall have the following four tasks: Carrying out scientific research; managing national research infrastructures and Dutch participation in international facilities (e.g. CERN), providing facilities for researchers; and developing new technology (Steen, 2008, p. 7).

In addition to its functions as scientific association, advisory body and manager of research awards, the Royal Netherlands Academy of Arts and Sciences (KNAW) is the umbrella organisation for sixteen institutes, which fall into two main clusters: Humanities and social sciences (HSS) and life sciences (LS). KNAW allocates 90% of its budget to the institutes as part of their mission to promote the quality of scientific and scholarly work and its contribution to society. The institutes conduct research, maintain scientific collections and provide services to science and society in general (Steen 2008, p. 9). In addition to subject-

[123] This section is largely based on the OECD (2014) review of the Dutch Innovation System.

specific goals, KNAW aims for their institutes to play a leading role in defining national and international research agendas, cooperate with university research groups, promote knowledge transfer and to promote open access.[124]

Overall, the scientific research institutes under NWO and KNAW play an important role in the innovation system, complementing the universities by providing infrastructure and facilities as well as producing high-quality research in their own right. (OECD, 2014, p. 160) Politically, they have come to be seen as important policy instruments. According to the new government white paper, they should be "not only 'excellent' but [fulfil] a specific function within the National Science Agenda" (OCW 2014, p. 35).

D.3.1.1.2 Government labs

Several ministries have their own agencies or institutes that are either partly of fully dedicated to conducting research to support the departmental missions. This is a rather heterogeneous group and it is difficult to attach any shared characteristics. Table 8 below lists the most prominent government labs:

Table 8 Departmental research institutes, estimated R&D expenditure (estimated, approximation)

Ministry	**Institutes**	**Estimated R&D budget**
Ministry of Justice and Security	Netherlands Forensic Institute (NFI) and Research and Documentation Centre (WODC)	€ 20 million
Ministry of Education, Culture and Science (OCW)	A number of cultural institutes with a research function (the National Service for Cultural Heritage - RCE and the Netherlands Institute for Art History - RKD)	€ 10 million
Ministry of Infrastructure and the Environment (IM)	Netherlands Environmental Assessment Agency (PBL) and internal research institutions, including the Royal Netherlands Meteorological Institute (KNMI), Rijkwaterstaat centres of excellence and the Netherlands Institute for Transport Policy Analysis (KiM)	€ 50 million
Ministry of Economic Affairs, Agriculture and Innovation (EZ)	Netherlands Bureau for Economic Policy Analysis (CPB)	€ 13 million
The Ministry of Health, Welfare and Sport (VWS)	National Institute of Public Health (RIVM) and the Environment and the Netherlands Institute of Social Research (SCP)	€ 208.5 million
All ministries (total)		***€ 300 million***

Source: Adapted from Rathenau Institute: 'The Dutch Science System' website.[125]
Note: these figures are based on estimates of R&D activity and not the full institute budgets.

D.3.1.1.3 Research and Technology Organisations (RTOs)

The members of the federation of applied research institutes, TO2, are the largest groups of institutes in terms of turnover and staff (see Table 9 below). As described by in the government's 'Vision of Applied Research' (EZ, 2013), the role of the TO2 institutes is to serve the needs of government departments, find solutions for societal problems and strengthen innovativeness of businesses. The government 'vision' also calls on TO2 institutes

[124] https://www.knaw.nl/en/institutes (accessed January 2016).

[125] http://www.denederlandsewetenschap.nl/en/web-specials/the-dutch-science-system/organisations/ministerial-research-institutes.html (Accessed in January 2016).

to position themselves more sharply between public research and private enterprises, performing pre-competitive research without entering into competition with commercial knowledge providers.

Table 9 Core data for TO2 institutes

Institute	Founded in	Total turnover (2012, in millions)	Government contribution to knowledge development (2012, in millions)t	Workforce (2012)
MARIN	1929	42	5	323
TNO	1932	506	186	3409
NLR	1937	79	26	618
DLO	1938	343	162	2879
ECN	1955	76	23	502
Deltares	2008	111	12	768
Total		1157	414	8499

ECN excl. Nuclear Research & Consultancy Group

Source: (EZ, 2013)

D.3.1.2 Governance (appointments, management etc.)

The various institutes have different governance arrangements, depending on their legal status and roles. AWTI, among others, has raised concerns about the complexity of the innovation system and the lack of clarity it creates.

D.3.1.2.1 Scientific research institutes

The NWO institutes are independent legal entities, non-profit foundations under the umbrella of NWO, with their own managing boards. Under the new structure based on the Government's 2014 white paper and due to be rolled out in stages until 2019, the NWO institutes will all become part of a new single institutes' Foundation, a non-profit organisation that will be tasked with supporting functions for the institutes and also be the legal employer of institute staff. The institutes' foundation will report directly to the new executive board of the NWO.

KNAW also falls under the responsibility of OCW but the minister does not nominate or approve members for the Board. The Academy governed its members drawn from the scientific community. Leadership is provided by the Academy board and the Board of Management responsible for day-to-day management. One of two full time directors, the Director of Research responsible for the research institutes.[126] With a few exceptions (earmarked funding for the Rathenau Institute, NIDI, the Frisian Academy and a number of bi-lateral programmes), the board decides on the budget for the institutes. The institutes make up a rather heterogeneous group with varied provenance and missions. In recent years, KNAW has worked to develop a more coherent portfolio as well as better coordination with the NWO institutes and university research groups. An evaluation from 2014 criticised KNAW's steering of the institutes for being too 'top-down' to the detriment of scientific autonomy (Weerdesteyn et al., 2014).

[126] https://www.knaw.nl/en/about-us/organisatie (Accessed January 2016).

Like the research universities, the NWO and KNAW institutes are assessed on the basis of the Standard Evaluation Protocol (SEP). This does not have any direct bearing on government funding.

D.3.1.2.2 Research and Technology Organisations (RTOs)

The responsibility for overseeing the Dutch RTOs move from OCW to EZ in 2011. Where OCW has a tradition of 'steering from a distance' (see above), the EZ tends to have a much more direct approach and has made it clear that TO2 institutes must contribute to the approach of the new enterprise policy and align their research more closely with the Top Sector and private sector needs.

D.3.2 Financing

Like in the university sector, direct institutional funding has gradually decreased, as research institutes increasingly rely on second and third 'stream' funding. Thus, institutes rely increasingly on making themselves relevant to Top Sector initiatives, to third party funders and procurers domestically and abroad. In the case of the applied research institutes (RTOs), some believe the level of funding for the development of basic capacity-building and knowledge development has become critically low.

D.3.2.1 Scientific research institutes

Scientific research institutes generally receive the majority of funding as direct subsidies.

Direct funding for NWO institutes has increased moderately over the past decade in absolute numbers, but their overall share of NWO's budget has decreased from 26% in 2001 to 22% a decade later, as universities receive a still larger portion. As of 2014, the institutes receive about 2/3 of their income from NWO, whereas the rest is derived from various other programmes and contracts. For illustration, the income of the Foundation for Fundamental Research on Matter (FOM), managing three of the eight NWO institutes, is shown in below.

Table 10: FOM income 2014

	Amount (k€)	**Share of income (%)**
NWO basic subsidy	74.874	65%
Government grants and subsidies	2.316	2%
Income from third parties	27.141	24%
Other income	10.322	9%
Total	114.653	100%

Source: FOM jaarboek 2014, p. 107.

The KNAW institutes have an annual budget of €129.2m (2014). 45% (58.4m) is lump sum funding from OCW. €12.4m was second stream funding from NWO and 25.9m was third stream project funding (Weerdesteyn et al., 2014, p. 22). The KNAW institutes have managed to almost double their R&D expenditure between 2011 and 2012, largely due to an increase in second and third stream funding. While direct government funding (first stream) increased from 75m to 94m during this period, second and third stream funding more than tripled from €14m to €48m (OECD, 2014, p. 159).

D.3.2.2 Government labs

The funding of government labs varies but they generally receive a large share of their income from their parent ministry.

D.3.2.3 Research and Technology Organisations (RTOs)

The applied research institutes derive their revenue from three sources: Direct government contribution to support the development of knowledge, government grants from national and EU programmes, and contract research performed for public and private clients. Table 11 below provides an overview.

Table 11: RTO funding, by source (2014)

	TNO	**GTI**	**DLO**
Direct government funding	32.5%	27.0%	39.7%
External grants and contract research	67.5%	73.0%	45.4%
of which public assignments	*16.5%*	-	*16.4%*
of which private	*43.9%*	-	*19.0%*
of which international (EU)	*7.1%*	-	*7.4%*
of which other	-	-	*2.6%*
Other	-	-	14.8%
Total	100.0%	100.0%	100.0%

Source: Adapted from data provided by the Rathenau institute [127]

D.3.2.3.1 Direct government funding

Until recently, direct government funding made up about a third of institute revenue on average across the TO2 institutes (see Table 9 above), but this is set to be cut to about 25% by 2016. Instead, institutes are meant to take the lead from industry demand articulated through the top sector initiative. The policy aims to induce RTOs to seek more collaboration

127 http://www.denederlandsewetenschap.nl/fileadmin/user_upload/rathenau/De_Nederlandse_Wetenschap/EN-tables_of_applied_research_institutes.xlsx (Accessed January 2016).

and co-funding from private sector sources, thereby enhancing the economic relevance of their research. Overall, this means that RTO funding will become more variable, depending on performance and impact, specifically the subsidies implemented through the TKI supplement funding. The amount of core funding is low by international standards and this has led to concerns about adverse effects on the independence and long-term development of the knowledge base within the institutes (Janssen & Hertog, 2015, p. 26; OECD, 2014, p. 164).

In addition to the general decrease in volume, direct government funding to TO2 institutes is increasingly subject to earmarking and steering from the government. For example, between 2007 and 2012, government funding for TNO, introducing two categories of direct funding: oriented basic funding from EZ known as 'knowledge as an asset' (€72m in 2012) – the majority of which are dedicated to specific themes – and targeted funding for 'policy and applied research' from EZ and other sector ministries (€120m) (OECD, 2014, p. 164).

D.3.2.3.2 External income

As shown above, external income is divided between public and private assignments, both domestic and international. Looking at the development over the last 10-15 years, several developments stand out.

Government contract research accounts for about 16.5% for both TNO and DLO. A trend, particularly pronounced in the case of the DLO institutes, has been the replacement of core funding with government contract research. While the value of DLO's research contracts with private companies has been relatively constant, the value of government contracts increased by more than 50% between 2004 and 2014, from €34m to €54m. During the same period direct funding from EZ to DLO decreased by €30m, from 161m to 131m.[128]

The share of industry funding for government research is still relatively high in the Netherlands: 11.3% in 2011 compared to an EU28 average of 8.1%, despite a decrease from more than 20% a decade earlier (OECD, 2014, p. 157). As one would expect, a large part of this industry funding goes to institutes of applied technology: in the decade from 2004 to 2014, income from industry contracts has been relatively stable, with TNO deriving some 45% of their income from the private sector (primarily large enterprises) and the DLO institutes typically between 15 and 20%. The period has, however, been marked by a significant internationalisation with a marked shift from domestic to foreign clients. In 2004, TNO earned €251m from private assignments, of which 62% came from domestic clients and 38% from international clients. By 2014, income from domestic clients had declined by €30m to €117m and income from international clients increased by €20m to €114m, thus practically a 50:50 ratio between domestic and foreign clients.[129]

Finally, EU funding has increased with the overall size of the Framework programmes. For both TNO and DLO, income from EU programmes has almost doubled between 2004 and 2014, in both absolute and relative terms.[130]

[128] See footnote 127.

[129] See footnote 127.

[130] See footnote 127.

D.4 Sources

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Appendix E Sweden

E.1 Coordination of national systems

E.1.1 Composition of the system

E.1.1.1 Distribution of responsibility for R&I policy-making

In terms of R&I policy-making, the Swedish system can be characterised as decentralised. The government outlines overall policies, most importantly in the R&I bills that typically are presented once every four years. The next R&I bill is expected in late 2016. The government also rules government agencies (*statliga myndigheter*) through annual appropriations directives (*regleringsbrev*) and ordinances (*regeringsuppdrag*). The overall missions, formats etc. of the government agencies are outlined in government regulations (*förordning*) specific for each agency and typically left unchanged for longer periods of time.

Swedish ministries are small and focused on policy development. The policies and the public administration are carried out by government agencies which possess considerable independence and are large in comparison with the ministries. The ministries are prohibited by law from interfering in the on-goings of the agencies. In the R&I field, the category "government agencies" includes not only sectoral agencies in e.g. the energy and enterprise sectors, but also the research councils. Almost all higher education institutions (HEIs) are government agencies as well, but for the sake of clarity our use of the term "government agency" does not include HEIs. Research institutes are not government agencies. The structure of the system implicates that government agencies in the R&I field have quite considerable room for policy development as well, and the ministry expects them to take on that role.

E.1.1.2 Distribution of R&D budget across sector ministries

All ten sector ministries in Sweden fund R&D, but for most of them it is a very marginal part of their spending. Prior to a minor reorganisation of the ministry structure in 2015, 82 percent of the government's planned R&D spending for 2015 was concentrated to two ministries, the Ministry of Education and Research (68 percent) and the Ministry of Enterprise (14 percent). These are still the two by far most important ministries in the R&I field. The third largest ministry in terms of R&D, the Ministry for Rural Affairs (five percent) has since then become part of the Ministry of Enterprise, while the energy domain and thereby significant R&D spending has been transferred from the Ministry of Enterprise to the Ministry of the Environment. The Ministry of Defence represented four percent of the government R&D spending in 2015.[131] This means that a ministry such as the Ministry of Health and Social Affairs, which in some other countries controls significant resources for R&D, has a very small R&D budget in Sweden.[132]

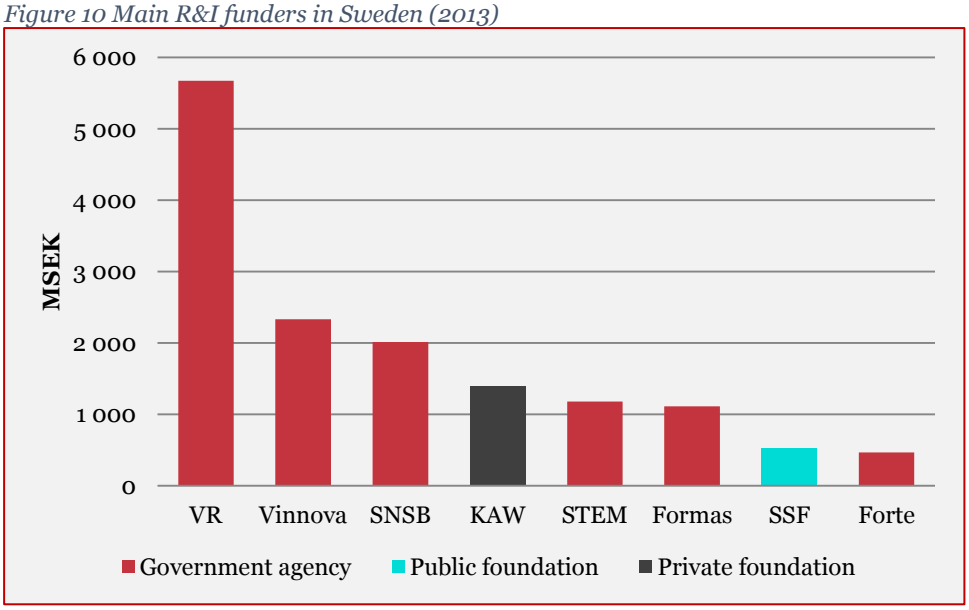
[131] Statistics Sweden (2015). Government budget appropriations or outlays for R&D 2015. UF 17 SM 1501

[132] After the reorganisation of the ministry structure in 2015, the official names of two of the mentioned ministries are the Ministry of Enterprise and Innovation and the Ministry of the Environment and Energy.

E.1.1.3 Main funding agencies

The structure of government agencies that fund R&I in Sweden dates back to 2001. Figure 10 shows the main agencies and foundations for R&I funding in Sweden are, in order of funding budget size.[133] The Swedish Research Council (VR) is the by far largest funder. VR is almost exclusively focused on basic research and funds all subject areas. Funding through VR has since its inception in 2001 grown considerably.[134] There are also two other research councils in Sweden, Formas and Forte[135], both funded in 2001. Formas funds research on the environment and in agricultural sciences and spatial planning, while Forte funds research in the fields of health, working life and welfare. The two councils are assigned to fund both basic and applied research within their respective fields, but have arguably put most of their emphasis on basic research, although they recently have put efforts into strengthening their funding to research motivated by needs. In 2001 also Vinnova was established. Vinnova funds needs-driven research and innovation, and during the last decade the agency has increased its focus on innovation rather than research. Two other government agencies have considerable R&D budgets as well: The Swedish National Space Board (SNSB) and the Swedish Energy Agency (STEM). The lion's share of SNSB's funding goes to technology development projects in companies, to a significant extent via the European Space Agency. STEM funds needs-motivated energy-related research of both basic and applied character.

Figure 10 Main R&I funders in Sweden (2013)



In the 1990s a number of so-called public research foundations were added to the system of funders. Based on capital from the state, the foundations were inaugurated to prevent politicians from exercising any control of the foundations' resources and strategies. The largest and arguably most important of these is the Swedish Foundation for Strategic

[133] Annual reports from the funders.

[134] Nilsson, Rolf and Staffan Håkansson (2011). Bilaga 2: Offentlig FoU-finansiering i Sverige 1981-2012. In Vinnova (2011). Utveckling av Sveriges kunskapsintensiva innovationssystem – Huvudrapport, Underlag till forsknings- & innovationsproposition. VP 2011:04

[135] Formas is officially named the Swedish Research Council Formas while Forte's official name is the Swedish Research Council for Health, Working life and Welfare.

Research (SSF), which funds mostly basic research in the natural sciences, engineering and medicine in order to strengthen Sweden's competitiveness. Another notable foundation is the Knowledge Foundation (KKS) which is the by far most important external funder to the university colleges and to universities established in the 1990s, despite only disseminating around 200MSEK annually. The Swedish RI system also benefits from a number of private foundations, of which the Knut and Alice Wallenberg Foundation (KAW) is the most important one.

E.1.1.4 Main PROs/universities

Sweden has 16 universities, 14 university colleges, five colleges of art and 13 other organisations with accreditation to organise higher education.[136] The universities perform almost all R&D in the HEI sector, 94 percent in 2013, while the university colleges make up the remaining part.[137] In terms of higher education, the balance is however much more even between universities and university colleges. The colleges of art and the other accredited organisations are all very small also in terms of higher education.

The universities can be separated into three distinct groups: six broad universities with large R&D budgets and R&D activities in more or less all subject areas, six niched universities of which four have large R&D budgets, and finally four universities established in the 1990s or early 2000s which have limited resources for R&D. The six broad universities are, in order of R&D resources:

- Lund University
- Uppsala University
- University of Gothenburg
- Stockholm University
- Umeå University
- Linköping University

Niched universities with significant resources for R&D, in order of R&D resources:

- Karolinska Institute (medicine)
- Royal Institute of Technology (engineering and technology)
- Swedish University of Agricultural Sciences (natural, agricultural and veterinary sciences)
- Chalmers University of Technology (engineering and technology)

The Swedish sector of research institutes is small and insignificant in comparison with the institute sectors in most other countries. Most of the public research institute sector is organised in a common holding company, RISE Research Institutes of Sweden, which controls four groups of institutes:

- SP (technical R&D broadly)

[136] Swedish Higher Education Authority (2015). Fakta om högskolan: http://www.uka.se/fakta-om-hogskolan/universiteten-och-hogskolorna.html

[137] Statistics Sweden (2015). Research and development in Sweden 2013. An overview. UF16SM1501.

- Swedish ICT Research (ICT)
- Swerea (materials technology)
- Innventia (paper and pulp)

In addition there is a relatively large public research institute in the defence sector, Swedish Defence Research Agency (FOI). There are also around 30 private research institutes which together have a turnover around the same size as the public research institutes.[138]

E.1.2 Horizontal coordination

E.1.2.1 Ministry level

It is only relatively recently that decisions on R&I policy are shared between ministries. Until 2006 such decisions were concentrated to the Ministry of Education and Research, also decisions on budget items and government agencies formally placed under other ministries. The change was most likely made mainly to make the Ministry of Enterprise more involved in the policy area and thereby link R&I policy closer to industrial policy.

There is no formal organ or work group for coordinating R&I policy between ministries, which means that ministries collaborate directly with each other on single issues. For each issue all ministries with a stake in that issue must get the chance to give their opinions, which, given the cross-sectoral character of R&I matters, means that the coordination tends to be time-consuming and difficult to manoeuvre. As responsible for the state budget, the Ministry of Finance has a gate-keeper position; all ministries need to have acceptance from the Ministry of Finance before new investments can be made. Such negotiations take place on minister level. The current government has installed broad expert councils both for the research policy and the innovation policy areas, but these are only advisory and has not yet made any noticeable impact on government policy.

The degree to which coordination is needed ultimately depends on the degree to which policies change. If they do not change, interaction between ministries tends to slip back into a battle for financial resources. In that light, Sweden arguably has a limited need for a coordinating organ between ministries at the moment; one interviewee for this study described the relations between ministries as “almost irrational, the interaction between them is very low”. R&I policy has been more or less remained stable since 2010, when the first term in office ended for the previous liberal-conservative government, the only Swedish government in the 2000s with a more active R&I policy. Some argue that Swedish politicians usually lack ideas and engagement to change the R&I policy, or even that they for political reasons are afraid of being criticised by certain stakeholders. The limited size of the Ministry of Education and Research also implicates that more radical shifts in R&D policy keep a significant amount of the ministry’s staff busy with activities that lie outside their ordinary tasks. The interviewee quoted above bluntly stated, “It is incredibly difficult to push new things onto the ministry’s agenda; for practical reasons, the ministry’s work is essentially focused on getting things *off* the agenda”. The stable R&I policies may on the other hand also be because the politicians and the ministry are satisfied with the current situation. In any case, R&I policy has rarely been a prioritised field in Swedish politics.

[138] Statistics Sweden (2015). Research and development in Sweden 2013. An overview. UF16SM1501.

E.1.2.2 Agency-level

Through the government regulations to the agencies, the government orders the heads of the research funders that are government agencies (VR, Formas, Forte and Vinnova) to collaborate with each other, including developing common analyses, strategies and research programmes. The government typically also uses allocation letters to order the research funders to collaborate with each other. Examples include the orders in the mid-2000s to initiate common funding programmes for Centres of Excellences, and the initiative in 2008 to establish so-called Strategic Research Areas (SRA) which the agencies would collaborate in supporting. Since a few years the heads of almost all research funders of significance – government agencies as well as public research foundations – also have a common forum in a steering group for research policy activities at the Royal Swedish Academy of Engineering Sciences (IVA) and some funding through IVA to initiate policy-relevant studies.

The overall picture, however, is that most research funders rarely take initiatives on their own to collaborate or to coordinate their R&I funding activities in a deeper sense. Arguably, the main reason to this is found in the structure of the system. Swedish ministries, which take a monitoring position in relation to the government agencies, traditionally allow a certain amount of predatory behaviour among its agencies. Government agencies therefore tend to be suspicious towards close collaborations with other agencies, afraid of ending up swallowed. In the R&I field, the two largest agencies, VR and Vinnova, are located in each end of the R&I value chain, which arguably makes the ones in between, in particular Forte and Formas, act defensively when collaborations are discussed.

E.1.2.3 Performer level: alliances between universities and/or PROs (e.g. competence centres mentioned in spec, Finnish SHOK centres, UK Catapults)

On the performer level alliances or other types of collaborations between universities or between universities and research institutes are fairly widespread. The two large technical universities have had good links with research institutes for many decades, although mainly on the level of researchers. Since the mid-1990s universities have hosted collaborative research centres in which also companies and to some extent research institutes have participated. The format of such centres has gradually become institutionalised as a standard structure for collaboration and is generally regarded as a well-functioning way of organising collaborations. In 2008 the government launched the SRAs in which research environments at typically 2–3 universities collaborate with each other. More recently Strategic Innovation Areas (SIA) were introduced. SIAs are broad alliances between universities, research institutes, companies and possibly other stakeholders that are formed in a bottom-up process. SRAs did generally not impress on the evaluators in a recent evaluation[139], while it is yet unclear whether the SIA will fly or not – the bottom-up format and cross-sector approach is generally applauded, but SIAs have also been criticised for being too large and fuzzy and thereby difficult to coordinate.

During the last decade university management has overall taken a larger role in establishing strategic alliances with external actors. This also includes the establishment of formal

[139] Swedish Research Council (2015). Evaluation of the Strategic research area initiative 2010–2014. Stockholm: Vetenskapsrådet

partnerships, mostly with large corporations but some partnerships have been with research institutes. There are cases where research institutes and HEIs collaborate very closely, but the links are mostly at arm's length distance. Some Swedish HEIs have also been active and successful in attracting offices from Knowledge and Innovation Communities (KIC) with which they collaborate.

E.1.3 Vertical coordination (steering)

E.1.3.1 Steering mechanisms

While Sweden generally has a tradition of 'soft' steering, the R&I field is also characterised by a certain amount of hard steering. As mentioned above, Swedish ministries traditionally accept a certain degree of predatory behaviour among the government agencies, which includes some readiness to shift responsibilities from one agency to another. Extensive reorganisations are nevertheless rare, the system with R&I funding agencies has remained stable for 15 years. The previous government however reorganised the structure of agencies administering the higher education sector, after a number of years with friction between the Swedish Higher Education Authority and the Ministry of Education and Research. Some hard steering has also been seen with regard to HEIs where the previous government forced, or more or less forced, a couple of mergers to take place. However, in all political camps there is a general unwillingness to actively intervene in the structure of HEIs; any major reorganisation is bound to result in severe criticism from politicians and others at the affected local and regional levels, which may be politically challenging to handle.

The Ministry of Education and Research has made limited use of the budget to steer government agencies and HEIs, essentially because the R&I field during the last decade has been subject to consistent budget increases. Although almost all the increase has been channelled to specific purposes, almost no area has seen its resources decrease. The debate has rather concerned where the money shall be spent, a topic that continues in E.2.2 . The increase has mainly been used to create incentives for strategic priorities, collaborations and above all improved publication output at the level of HEIs. The creation of such incentives has also been a consistent focus of especially Vinnova, which since its inception has required co-funding from HEIs as well as external partners, but also from other external R&I funders.

It is evident that the HEI sector, and also the R&I funders, act proactively when new 'trends' emerge. For instance, the gradually growing interest that university managements since the mid-1990s have shown in external collaboration is not only the result of initiatives from the political side and the R&I funders. It is also an adaption to a changing context of the universities as well as an expression of beliefs represented by individuals in leading positions in the universities – largely, but not only, because external collaboration implicates more resources for R&D.[140] Overall, Swedish HEIs have shown a considerable readiness to adapt to incentives when there has been funding involved.

[140] Åström T. et al. (2015). Långsiktig utveckling av svenska lärosätens samverkan med det omgivande samhället. Effekter av forsknings- och innovationsfinansiärers insatser. VINNOVA Analysis VA 2015:03. Stockholm: VINNOVA

E.1.3.2 Levels

As mentioned, the ministries expect the R&I funders be active in policy development. In the annual appropriation directives and the ordinances to the government agencies, the ministries are typically only able to give overall directives, while the agencies develop the details. The ministries are also prohibited from interfering in the day-to-day on-goings in the agencies. As a consequence the agencies have considerable space for action. They have however turned out to be relatively shy in that respect; they typically make sure to anchor their plans at the ministry and appear afraid of 'causing a stir'. They are also relatively prone to turn to the ministry to solve conflicts with other agencies, and very careful not to make mistakes. Beside the above-mentioned competition between agencies, one reason to the defensive behaviour of the government agencies may be that the Director Generals are appointed on six-year terms and therefore are afraid to become unpopular among too many influential individuals and organisations. Since the ministry is relatively weak and often lacks a clear agenda for the R&I policy area, one may argue that the Swedish system for R&I policy has a steering problem.

As an effect there is usually no actor in Sweden that is both capable and willing to initiate major reforms. There has also been no actor willing to really engage in creating a deeper and more extensive and systematic knowledge-base as a foundation for potential reforms. For instance, the statistical information on the Swedish R&I system is overall underdeveloped. Deeper analyses that address the Swedish R&I system as a whole often have marginal impact, since there is usually no actor that feels particularly responsible for or wants to take the lead in developing policies based on the new information.

E.2 Steering and financing system of university and institute research

E.2.1 University governance

E.2.1.1 Different types of institutions and roles

Swedish higher education is provided by public HEIs or by so-called independent education providers accredited by the government. All universities and university colleges belong to the public sector, except Chalmers University of Technology and Jönköping University (a university college) which since 1994 are operated as independent foundations, and Stockholm School of Economics which is run by a private foundation. The provision of courses and programmes at Master or PhD levels is an exclusive right of universities and of those university colleges that have been granted entitlement in specific subject areas. All HEIs have institutional block grants for R&D and are allowed to apply for grants at the R&I funders, but in practice only the older universities (established in the 1970s or earlier) possess significant R&D resources.

The common mission for all HEIs is to "offer education based on an academic or artistic footing and proven experience." They are also required to "undertake development work, including research and artistic development". The third mission is to "co-operate with their

surrounding communities, provide information about their operations and also act to ensure that benefits are derived from the findings of their research".[141]

The basic laws and regulations are presented in the Higher Education Act (*Högskolelagen*) and the Higher Education Ordinance (*Högskoleförordningen*). These documents mainly set broad frames for the organisations and activities, and leave the HEIs with comparably extensive freedom to decide on their own organisations, allocation of resources and educations. The system is based on the principle of management by objectives.[142]

E.2.1.2 Governing bodies (academic elections vs. government appointments etc.) and their competencies and linkages

Since 1 January 2011 Swedish HEIs has more autonomy than previously in deciding on their internal organisation. The Higher Education Ordinance stipulates that all HEIs must have a vice-chancellor and a board, and regulates these two institutions. The board must consist of the vice-chancellor and 14 other board members. Three board members represent the students and are typically elected by the student population, and three board members must be appointed through academic elections. The government appoints the remaining eight board members and the vice-chancellor. The vice-chancellor is appointed for maximum six years following a public consultation with staff and students at the HEI in question. The other eight government-appointed board members have three-year terms and are proposed by a committee consisting of one government representative, the county governor and a student representative. These eight board members must have "good knowledge of the HEI in question" and are virtually always selected among external stakeholders, which leave the HEI boards with a majority of external representatives.[143]

Apart from the board and the vice-chancellor the HEIs are since 1 January 2011 free to decide on their own organisations. This has led many HEIs to remove some decision-making authority at faculty and department levels and to abolish academic elections at faculty and department levels. At many HEIs deans and heads of departments are instead appointed by the HEI managements. Most HEIs have entirely removed the department boards and handed over its decision-making authority to the head of department, and some HEIs have also entirely removed the (equivalent of) faculty level to let departments report directly to the vice-chancellor. The changes have been made to give HEI managements more space for action, mainly to allow more flexibility and more room for strategic priorities. However, there are four significant exceptions to this pattern: the four largest broad universities, Lund University, Uppsala University, University of Gothenburg and Stockholm University have all left their organisational structures including academic elections more or less unchanged.[144]

In January 2011 Swedish HEIs also received more freedom to appoint staff and on which categories of staff to use. Before the reform the HEIs were restricted to use five categories for its permanently employed teaching staff, while categories for staff employed to conduct

[141] Swedish Higher Education Authority (2015). Overall responsibility and regulations [regarding the Swedish HEI sector] http://english.uka.se/higher-education-system/overall-repsonsibility-and-regulations.html

[142] Swedish Higher Education Authority (2015). Overall responsibility and regulations [regarding the Swedish HEI sector] http://english.uka.se/higher-education-system/overall-repsonsibility-and-regulations.html

[143] The Swedish Higher Education Ordinance (Svensk författningssamling 1993:100)

[144] "Utvecklad ledning av universitet och högskolor" SOU 2015:92

research were unregulated. After the reform only two teaching staff categories remain: professor and lecturer. A third category, "employment for meriting", is legally regulated as well. The HEIs are free to decide on the qualification requirements, employment procedures etc. for each category it wants to use. This also applies for professors and lecturers, as long as the legal requirements of proven scientific and pedagogic skills (professor) or proven pedagogic skills and a PhD or the equivalent level of scientific skills (lecturer) are fulfilled. In other words, both professors and lecturers can be appointed without e.g. external peer-review processes.

E.2.1.3 Priority-setting at institutional level (strategies)

Swedish HEIs have gradually developed their abilities to set their own priorities. This movement has occurred as a result of incentives consistently being introduced by the government and the research funders. Most large HEIs have also organised extensive evaluations of themselves which have given valuable information to the HEI leaders on which strategic priorities to make. However, one may argue that most HEIs are still relatively defensive in their internal priority-setting, for two main reasons. First, in most HEIs only small amounts of R&D funding tend to be channelled to strategic priorities, whereas the large bulk of funding goes to the regular activities. The Royal Institute of Technology is a notable exception by allocating around one fourth of the institutional block grant to prioritised broad areas. Second, in most large universities strategic decisions are not made by the vice-chancellor or the deans (even if these are the main architects behind the strategies), but by boards at these levels, which particularly in cases where academically elected faculty boards still exist, implicate considerable organisational friction against more radical changes. Most HEIs with significant resources for R&D also allocate a certain amount of funding to the vice-chancellor and the deans to enable them to make their own priorities, but that funding is relatively insignificant and tends to be used mostly to co-fund projects from external funders. HEIs frequently argue that the demands to co-fund external projects have grown significantly during the 2000s and thereby consumed resources that the HEIs could have used to make priorities entirely on their own.[145]

E.2.2 Financing of universities

E.2.2.1 Institutional Block grants: no-strings attached vs. performance-based

Around 45 percent of the HEI funding for R&D consists of institutional block grants.[146] For the moment the block grants are entirely distributed in proportions 'like the year before', or in other words without any particular demand on performance. Between 2009 and 2015 a part of the block grant was distributed through a performance-based component based on number of publications and amount of external research funding. Between 2009 and 2013 the share was around 10 percent. For 2014 the share increased to 20 percent, while in 2015

[145] "Utvecklad ledning av universitet och högskolor" SOU 2015:92 and Confederation of Swedish Enterprise (2013). Från departement till doktorand: På vilka grunder fördelas de direkta statsanslagen för forskning? Stockholm.

[146] Statistics Sweden (2015). Research and development in Sweden 2013. An overview. UF16SM1501. Statistics Sweden presents data according to OECD standard to allow for international comparisons. In Sweden institutional block grants are usually calculated according to standards developed by the Swedish Higher Education Authority, adapted to domestic needs. In the latter calculations the institutional block grants represent a slightly larger share than in our data, mainly because they include more funding to PhD educations.

the proportions from 2014 were kept.[147] The way the model was constructed resulted in very marginal redistribution between HEIs from one year to another.[148] The performance-based component was introduced in the research bill 2008 and has, despite the very marginal redistribution, had a considerable impact on most HEIs. The main reason behind the impact is that HEIs felt pressured to introduce internal performance-based systems for allocating R&D resources, often modelled similar to the ministry model, or other incentive structures to increase productivity in R&D. The performance-based model has thus probably led the heads of many HEI departments to put pressure on some of the staff to spend more time on scientific publishing, and it has probably had some impact on recruitment criteria as well. These, and not redistribution, were the effects the ministry intended to create.[149] At the time of writing this report, a new performance-based model is being developed, a task led by VR. The government intends to base the model on nationwide evaluations. The introduction is planned to 2018 and the model shall distribute 20 percent of the institutional block grants. In 2015 VR presented a proposed model for the evaluations, which has received considerable criticism from HEIs.

E.2.2.2 Competitive funding

Since more than half of R&D funding to Swedish HEIs come from external sources, competitive funding is a critical source of income for all HEIs. Most of this funding comes from sources that typically use peer-review in their grant processes. As Figure 11 shows, in 2013 almost 30 percent of the total external funding to Swedish HEIs was channelled through one of the three research councils. Another 22 percent came from "other government agencies", a category that includes e.g. Vinnova and STEM, 21 percent from non-profit organisations and the HEIs' own funds (the latter is a small category), eight percent from the European Union and five percent from the public research foundations. All these are categories in which funding is mostly or entirely awarded through peer-review processes.

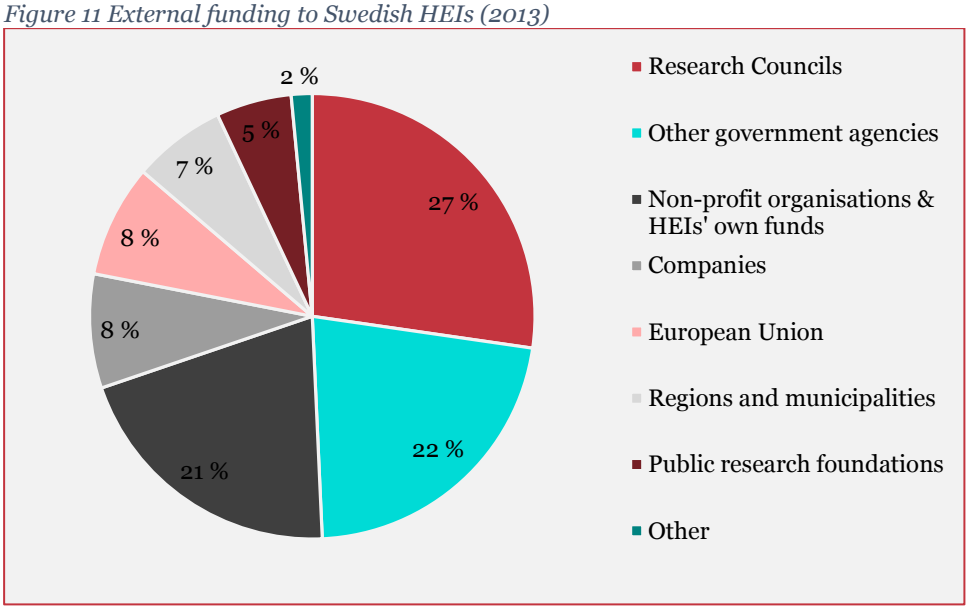
Most of the competitive funding is awarded through projects that last three to four years at the most. Given that HEIs find institutional block grants insufficient to fund a significant amount of research time for most of its permanent staff that are not professors, the competitive funding system has been criticised for giving too little room for innovative high-risk projects. In the research bill 2004 the government tried to correct that 'system failure' by introducing Centre of Excellence (CoE) schemes run by the research councils (allegedly against the will of VR) but more recently those schemes have to some extent been replaced by initiatives directed to individual 'elite' researchers. Also SSF used to run CoE schemes but have shifted towards individual grants. Another aspect of the high degree of competitive funding is that it disempowers HEI managements at all levels; researchers that attract external usually see it as 'their own', which makes strategic management difficult.

[147] The socialdemocratic-green government had intended to remove the model for 2015, but its budget lost in the parliamentary vote to the budget proposed by the liberal-conservative opposition, which wanted to keep the model. The government therefore decided to stick with the proportions from the year before.

[148] Swedish Higher Education Authority (2015). Forskningsresurser baserade på prestation: Tilldelning och omfördelning av basanslag till forskning och utbildning på forskarnivå baserat på indikatorer 2009 – 2014. Rapport 2015:15.

[149] Confederation of Swedish Enterprise (2013). Från departement till doktorand: På vilka grunder fördelas de direkta statsanslagen för forskning? Stockholm.

Figure 11 External funding to Swedish HEIs (2013)



E.2.2.3 Teaching funding

The teaching funding in Sweden is based on institutional block grants from the government. There are no student fees and virtually no external funding exists. The teaching funding is completely separated from the research funding; the HEIs must not mix the two accounts. Since the mid-1990s the teaching funding consists of two components: one for each student that is admitted to an education, and one for each student that graduates. Each HEI has a maximum level of funding that must not be exceeded. The funding levels differ between subject areas; the medical field receives much more per student than the humanities do, etc. Although the HEIs are free to shift teaching funding from one subject area to another, and thereby increase funding to students in one area at the expense of another, more or less all HEIs (Chalmers University of Technology is an exception, but all its students on the other hand qualify as engineers) apply the same funding levels as the government for all educations in a particular subject area – arguably because any change would result in severe criticism from the student organisations and from teachers (and financial controllers) in the disadvantaged educations.

The system is repeatedly criticised for eroding quality in teaching, as the graduation component makes many teachers feel pressured to let most students pass. The situation is also affected by the fact that some HEIs (or departments) apply the system for each course and not, which arguably is what the ministry intended, per education programme. The balance between the components has changed throughout the years, and it also differs between subject areas. In the humanities and social sciences the graduation component is currently around 65 percent of the admittance component, while in areas such as medicine and teaching studies, the graduate component is around 20 percent larger than the admittance part.

Defenders of the model point at the problem that comes with having no economic incentive for graduation: before the model was introduced, HEIs tended to admit a lot of students who took a long time to finish their studies, and many dropped out. Other alternative models

seem not to have been seriously considered, and since the mid-1990s there has been no government interest in a new model. Some HEIs argue that the institutional block grants for teaching and R&D should not be separated, to give more room for strategic priorities and more efficient use of resources. The ministry has however shown no intentions to do such a change, probably mostly because the ministry must report to the parliament how much resources that are used for higher education and how much that is used for R&D.

E.2.2.4 Third stream funding, industry income

While other funding has increased, industry funding to HEIs has been more or less stable for a long time. The share of industry funding has thus decreased over time. In 2013 it represented around eight percent of the total external funding. However, collaboration between HEIs and companies has gradually deepened and there are many examples of very close links between companies and HEIs. The existence of unusually many large and R&D intensive corporations in Sweden is undoubtedly a beneficial factor – Sweden has one of the highest shares of R&D of the GDP in the world (3.3 percent in 2013) and the business sector represented 69 percent of that share.[150] During the last two decades many HEIs have become considerably better at collaborating with industry, and also industry has improved its collaboration skills. The significant increase of PhDs in industry from the 1990s and onwards has been vital to the improved relations. In addition, HEI managements have at least during the last decade worked strategically to increase and deepen collaboration. Some HEIs such as Chalmers University of Technology have long traditions of relatively deep collaboration with industry also at management level.[151]

E.3 PROs

A mere four percent of the Swedish R&D is carried out outside the business and the HEI sectors. Although most of this is carried out by research institutes, the institutes yet represented only 2.4 percent of the Swedish R&D expenses in 2013, or 0.08 percent of GDP. Around half of the R&D was carried out by the public research institutes presented in E.1.1.4 and the other half by private institutes. The largest sources of income for the public research institute sector are national defence authorities, base funding from the government and commissions from civil government agencies, while the private institutes to a greater extent rely on civil government agencies and companies.[152]

Although still very small in absolute figures, the government funding to the research institute sector has relative terms increased quite considerably during the last decade. As late as 2005 the research institute sector received less than 100 MSEK in government base funding, which equalled less than 1/15 of the government base funding to Lund University the same year. Since then the government has gradually increased funding to the research institute sector to around 600 MSEK in 2013. The research institutes, both the public and the private, are also able to compete for funding from public R&I funders and from the European Framework Programmes.

[150] Statistics Sweden (2015). Research and development in Sweden 2013. An overview. UF16SM1501

[151] Åström T. et al. (2015). Långsiktig utveckling av svenska lärosätens samverkan med det omgivande samhället. Effekter av forsknings- och innovationsfinansiärers insatser. VINNOVA Analysis VA 2015:03. Stockholm: VINNOVA

[152] Statistics Sweden (2015). Research and development in Sweden 2013. An overview. UF16SM1501

Appendix F United Kingdom

List of abbreviations

AHRC – Arts and Humanities Research Council

BBSRC –Biotechnology and Biological Sciences Research Council

BIS – Department for Business, Innovation and Skills

CST – Council for Science and Technology

CUC - Committee of University Chairs

DEFRA – Department for Environment Food and Rural Affairs

DEL – Department for Employment and Learning (Northern Ireland)

DFID – Department for International Development

EPSRC – Engineering and Physical Sciences Research Council

ESRC – Economic and Social Research Council

GCSA – Government Chief Scientific Advisor

HEFCE – Higher Education Funding Council for England

HEFCW – Higher Education Funding Council for Wales

HESA – Higher Education Statistics Agency

GO-Science – Government Office for Science

MoD – Ministry of Defence

MRC – Medical Research Council

NERC – Natural Environment Research Council

NHS – National Health Service

NPL – National Physical Laboratory

ONS – Office for National Statistics

PSRE – Public Sector Research Establishments

QR – Quality-related funding

RAE – Research Assessment Exercise

RCUK - Research Councils UK

REF – Research Excellence Framework

RSE – Research Selectivity Exercise

RUK – Research UK

SFC – Scottish Funding Council

STFC – Science and Technology Facilities Council

UUK – Universities UK

F.1 Coordination of national systems

F.1.1 Introduction

The UK science system is largely centralised, but some powers have been transferred to the devolved governments of the Wales, Northern Ireland and Scotland. Thus, responsibility for institutional HEI funding lies with four separate funding councils whereas the seven research councils operate UK-wide. (Cunningham, 2015, p. 1)

Compared to other European countries, UK gross domestic expenditure on R&D (GERD) is relatively modest at 1.63% of GDP compared to an EU28 average of 2.02% (ibid.). Public expenditure on R&D 10.6bn in 2013 (see below). If estimated contributions to EU R&D programmes are included, the UK government R&D expenditure has been relatively stable over the past decade, between £10bn and £11bn in constant 2013 prices. Relative to national GDP, however, government R&D expenditure has fallen since 2002.

Table 12 UK government net expenditure on R&D by department (2013)

	Spend 2013 (£m)	**Spend 2013 (%)**
Research councils	**3,366**	**31.8%**
of which Engineering and Physical Sciences (EPSRC)	*870*	
of which Medical (MRC)	*790*	
of which Science and Technology Facilities (STFC)	*502*	
of which Biotechnology and Biological Sciences (BBSRC)	*489*	
of which Natural Environment (NERC)	*393*	
of which Economic and Social (ESRC)	*194*	
of which Arts and Humanities (AHRC)	*92*	
Higher Education Funding Councils (HEFCs)	**2,297**	**21.7%**
of which England (HEFCE)	*1,803*	
Civil Departments	**2,653**	**25.1%**
of which Business Innovation and Skills (BIS)	*981*	
of which Health (DH including NHS)	*952*	

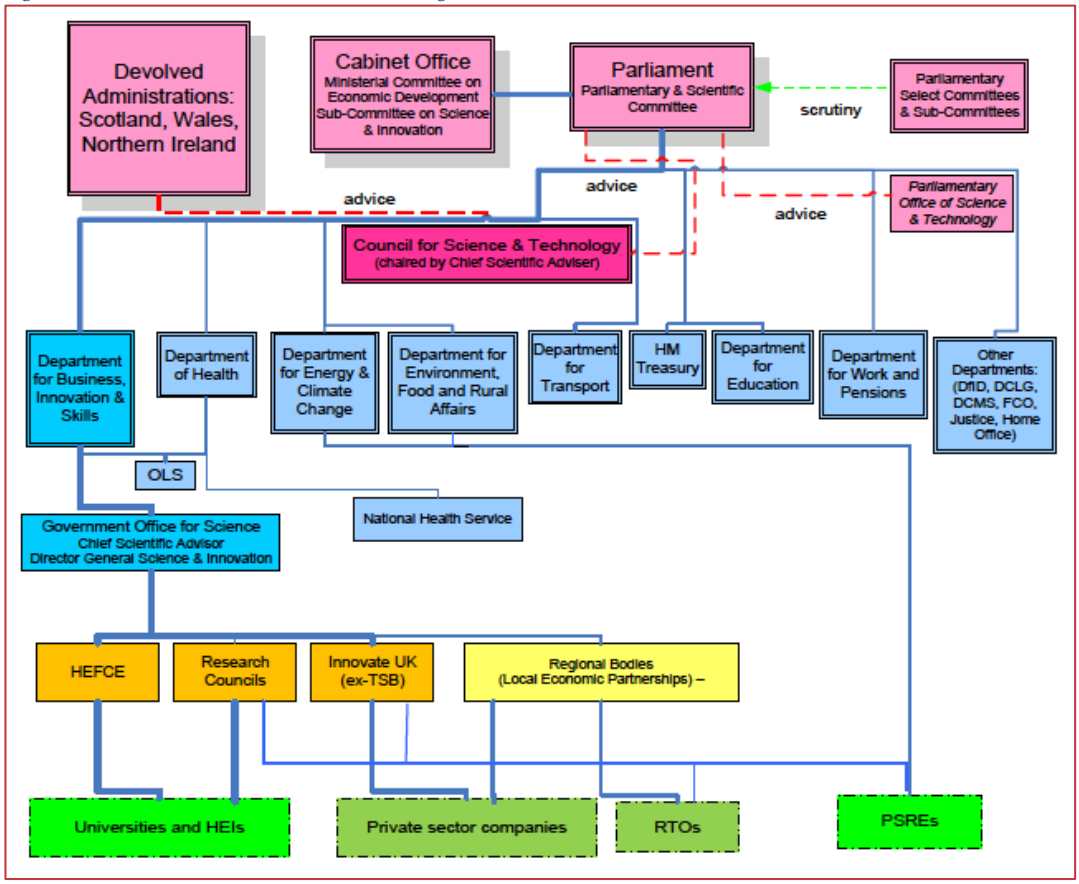
	Spend 2013 (£m)	Spend 2013 (%)
of which International Development (DFID)	*262*	
of which Environment, Food and Rural Affairs (DEFRA)	*138*	
Ministry of Defence	**1,516**	**14.3%**
Indicative UK contributions to EU R&D expenditure	**756**	**7.1%**
Grand Total	**10,588**	**100%**

Source: Adapted from the Office for National Statistics (ONS, 2015a, fig. 4)

F.1.2 Composition of the system

The UK government currently has 24 ministerial departments, 22 non-ministerial departments as well as more than 350 agencies and other public bodies. **Error! Reference source not found. Error! Reference source not found.** provides an overview of the structure of the UK research and innovation system, including the most important actors.

Figure 12: UK research and innovation system



Source: (Cunningham, 2015, p. 6)

F.1.2.1 Distribution of responsibility and budget for R&I policy-making between ministries

The responsibility for science and innovation is brought together in a single ministerial department, the Department for Business Innovation and Skills (BIS). BIS plays the lead

executive role in research issues, and maintains the national research strategy as well as being the major source of funds for research in the public sector. The science and research budget allocation accounts for about half of UK government expenditure on R&D (see Table 12 above) and includes institutional (QR) funding through the Higher Education Funding Councils (HEFCs), competitive project funding through the research councils, as well as funding for the UK Space Agency, the National Academies and other programmes such as the Newton Fund (BIS, 2010, 2014a).

Outside of the science budget proper, about 25% of government R&D expenditure is spent by civil departments, distributed as shown in Table 13 below. The departmental expenditure indicated for BIS is largely for 'technology research', that is, funding for the innovation agency, Innovate UK. Combined with the science and research budget, this means that BIS oversees some 60% of total government R&D expenditure, or 80% of domestic government expenditure on civil R&D (excl. EU and defence spending). Apart from BIS, the largest spend is found in the Department of Health, primarily for the National Health Service (NHS). In addition, the Department for International Development (DFID) and the Department for Environment Food and Rural Affairs (DEFRA), have significant R&D budgets, primarily for 'policy research'.

Table 13 UK government net expenditure on R&D by primary purpose (2013), selected civil departments

£ million	General Research	Govt. Services	Policy Research	Technology Research	Total R&D
Business, Innovation and Skills (BIS)	110		10	707	**827**
Health (DH including NHS)	916	7	29	-	**925**
International Development (DFID)	-	-	262	-	**262**
Scottish Government (SG)	73	5	53	33	**164**
Environment, Food and Rural (DEFRA)	3	45	90	-	**138**
Culture, Media and Sport (DCMS)	59	4	15	2	**79**
Transport (DfT)	-	1	8	34	**43**
Energy and Climate Change (DECC)	18	8	7	11	**44**
Other Departments	14	29	87	13	**142**

Source: Adapted from the Office for National Statistics (ONS, 2015a, fig. 7)
Note: Includes only expenditure attributable to a primary purpose.

F.1.2.2 Funding bodies and agencies

The United Kingdom has a dual funding system. The first component is institutional funding distributed via the Higher Education Funding Councils, the largest of which is the English funding council, HEFCE. The majority is quality-related (QR) funding distributed as block grants to universities to support research infrastructure and ground-breaking research. The allocation is based on the national research assessment, REF (see section 2 on Higher Education below). The second stream of public funding is managed by the seven research councils and is primarily given for project research on a competitive basis. In addition, Innovate UK (formerly the Technology Strategy Board, TSB), the UK's innovation agency, provides co-financing for industrial research in companies. These bodies are all set up as

'executive non-departmental public bodies' and sponsored by BIS. Whereas the research councils have a UK-wide remit, institutional funding allocated by the funding councils are subject to devolved governments in Scotland, Wales and Northern Ireland.

In addition to government funding, the UK has a strong private non-profit (PNP) sector. In 2013, the sector provided £1,362m, primarily for health and medical research (ONS, 2015b). For the Wellcome Trust alone, grant funding and direct charitable expenditure (£886m in 2014/15)[153] is comparable in size to the budget of the Medical Research Council.

F.1.2.3 Research performers: Main universities and PROs

The bulk of publically funded research in the UK is carried out by Higher Education Institutions (HEIs) as shown in Table 14 below. The association Universities UK currently have 133 members, ranging from relatively research-intensive universities – incl. the 26 members of the 'Russell Group' – to teaching universities, many of which were 'Polytechnics' prior to 1992. Government intramural R&D (GOVERD) includes research performed by government departments and agencies as well as by the research councils (e.g. large research infrastructures).

Table 14 UK Expenditure on R&D by performing sector, 2013.

	£ million	% of GERD	EU28 average (% of GERD)
Higher Education Expenditure on R&D (HERD)	7,628	26.4%	23.2%
Government intramural expenditure on R&D (GOVERD)	2,281	7.9%	12.2%
Total Gross domestic Expenditure on R&D (GERD)	28,875	100%	

Sources: Adapted from Office for National Statistics (ONS, 2015b) and Cunningham (2015).

F.1.3 Horizontal coordination

F.1.3.1 Cabinet and ministry level

BIS has the main executive responsibility for R&D policy within the government and several advisory bodies support cross-government coordination. Government Chief Scientific Advisor (GCSA) advises the Prime Minister and Cabinet, on aspects of science, engineering and technology and to ensure that effective systems are in place within government for managing and using science. GCSA is supported by the Government Office for Science (GO-Science), hosted by BIS. The GCSA also chairs the network of departmental Chief Scientific Advisors which meets weekly and works on cross-cutting policy issues relating to science and engineering (GO-Science, 2015).

The main coordinating body for science and technology policy is the Council for Science and Technology (CST).[154] The Council's role is to provide high-level advice to the prime minister on "strategic science and technology policy issues which cut across the responsibilities of government departments" (CST, 2012). It will respond to requests for advice from the Prime Minister but may also suggest topics on their own initiative. CST's members, appointed by

[153] http://www.wellcome.ac.uk/About-us/Publications/Annual-Report-and-Financial-Statements/ (Accessed January 2016).

[154] https://www.gov.uk/government/organisations/council-for-science-and-technology/about (Accessed January 2016).

the Prime Minister, are prominent figures drawn from across industry, the financial sector, research councils and government and is co-chaired by an independent chair and the GCSA. It is supported by a secretariat within the Government Office for Science (Schwaag Serger, Wise, & Arnold, 2015).

F.1.3.2 Agency-level

As it stands, the seven research councils are separate non-departmental public bodies each reporting to parliament. The umbrella organisation Research Councils UK (RCUK) provides a forum for the councils to work together on The research councils work together on certain issues, ranging from administrative support functions to policy strategy, through Research Councils UK (RCUK). This umbrella organisation is not a legal entity and has very limited budget and staff.

Table 15 Planned Research Council spend on priority programmes (2011/12-2014/15)

£ million	AHRC	BBSRC	EPSRC	ESRC	MRC	NERC	STFC	TOTAL
Digital economy	12		106	11				129
Energy		51	439	13		20	17	540
Global Food Security		416		8	10	15		440
Global Uncertainties	10	4	64	35	15	4	3	120
Lifelong Health and Wellbeing	2	48	23	40	83			196
Living with Environmental Change	7	54	54	39	100	305	3	562

Source: BIS (2010).

Anecdotal evidence suggests that these programmes aren't always genuinely cross-disciplinary. As is evident from the budget breakdown, each programme in usually dominated by a single council which takes the lead and contributes the bulk of the funding. In addition, each council often undertakes 'their' part more or less separately from the others.

The research councils are likely to experience major changes in the coming years. Organisationally, the government has announced its intention to create a much stronger coordination between the research councils (HM Treasury, 2015, p. 48):

> *The government is taking forward the recommendations of Paul Nurse's independent review and, subject to legislation, will introduce a new body – Research UK – which will work across the seven Research Councils. This will take the lead in shaping and driving a strategic approach to science funding, ensuring a focus on the big challenges and opportunities for UK research. The government will also look to integrate Innovate UK into Research UK in order to strengthen collaboration between the research base and the commercialisation of discoveries in the business*

community. Innovate UK will retain its clear business focus and separate funding stream.

At the time of writing, the details of any future reforms are not yet known but the position in the Nurse review (Nurse, 2015b) is that the coordination should be much stronger but that the reforms should stop short of a whole sale merger of the research councils. The idea of a merger was also contemplated in the 2014 triennial review of the research councils which concluded that "reducing the number of Research Councils would only be likely to unlock limited savings, would risk significant damage to the research communities affected and is likely to involve large transition costs." (BIS, 2014b, p. 73).

Organisational reforms of the other side of the dual support system, the institutional QR funding currently managed by HEFCE, also seem likely. In the government Green Paper published in November 2015, the section "Reducing complexity bureaucracy in research funding" outlined several options for options for maintaining the dual support system without HEFCE: institutional QR funding could be placed under the new Research UK (RUK) alongside the research councils, or it could be placed in a separate body but coordinate closely with RUK (BIS, 2015, p. 71). It has also been suggested that it be managed directly by BIS. The responses from the consultation and the government response is expected to be published in the Spring of 2016.

A new 1.5bn 'Global Challenge Fund' has also been announced in the Government's Autumn Statement (HM Treasury, 2015, p. 48). The new fund would be funded through the Development aid budget but research councils should also make contributions.

F.1.3.3 Performer level:

Some coordination is provided through the association Universities UK (UUK), which has 133 members. UUK provides a forum for joint policy advocacy and also supports universities in their primary aims of teaching and research (UUK, 2013). A narrower group of 24 universities was first set up in 1994 to serve the interest of the leading research-intensive institutions (Russell Group, 2014).

F.1.4 Vertical coordination (steering)

F.1.4.1 General approach to steering

The 'Haldane principle' in a cornerstone in UK science policy discourse, endorsed by policy-makers and researchers alike. Based on a 1918 committee report on the 'Machinery of Government', it is generally taken to mean that decisions on individual research proposals should be taken by researchers themselves through peer review (e.g. BIS, 2014b, p. 7). Accordingly, within the science and research budget – administered through the research councils and the funding councils – the government does not directly prioritise specific areas of research but instead provides horizontal support to keep a high level of performance. In recent years, this has been increasingly coupled with objectives to make the science base more responsive to socio-economic needs. Separate from this, thematic and sectoral research is supported through departmental R&D (see above) (Simmonds, Montes, Sharp, Rentel, & Wain, 2014).

F.1.4.2 Specific steering mechanisms

The Haldane principle would prescribe a rather hands-off approach to steering the funding and research councils. Nevertheless, these intermediary organisations are under increasing scrutiny. Starting in 2011/2012, the Cabinet Office has carried out triennial reviews of non-departmental bodies, including the research councils and the CST. The purpose of the reviews is test the continued need for the body to exist and to ensure compliance with good governance practices. The result of these reviews were generally positive but pointed out a "need for an improved performance management framework for each Research Council" (BIS, 2014b, p. 93).

In the ongoing discussions of a reorganisation of the research support system (see above), the Nurse review highlighted the benefits of establishing a more direct line of communication between the proposed organisation, Research UK, and government (Nurse, 2015a). This could imply a more direct government steering of the agencies.

F.2 Steering and financing system of university research

F.2.1 University governance

F.2.1.1 Types of institutions

UK universities are a very diverse group of institutions with different histories that can be difficult to classify unambiguously (Tight, 2011). Universities include the two 'ancient' universities Oxford and Cambridge, the federal universities in London and Wales, 'civic' universities founded on either side of the year 1900, a group of universities founded in the mid-20th Century, and finally the 'post-1992' universities. Cunningham (2015, p. 2), counts 165 Higher Education Institutions (HEIs) in the UK in 2013, 115 of which had status as universities when the federal Universities of London and Wales are counted only once each.

Legislative changes has contributed to this diversity, notable the Further and Higher Education Act 1992,[155] which extended university status to the 35 former polytechnics and merged the funding bodies serving the two formerly distinct groups of institutions. In 2012, the criteria for obtaining university status were further modified: Institutions that are accredited to award taught degrees were now only required to have 1,000 full-time students (down from 4,000) to be able to apply for university status. This allowed ten relatively small and specialised institutions to become universities and arguably lowered the threshold for future entrants into the higher education market.

Private universities are currently a very small part of the UK HEI landscape but this may change in the future as the government has signalled its intention to look at ways to strengthen the private university sector.

F.2.1.2 Roles:

All universities teach, carry out research and engage in knowledge transfer but the balance between these activities vary significantly between institutions. The Russell Group includes

[155] http://www.legislation.gov.uk/ukpga/1992/13/contents (Accessed January 2016).

the most research intensive universities. The 'post-1992' universities – some affiliates of the 'Million+' not-for-profit think tank[156] – tend to focus on teaching but many have developed ambitious research strategies as well, not least in the context of the Research Excellence Framework (REF). Other universities are more business-oriented, such as the members of the 'University Alliance'.[157]

F.2.1.3 Governance:

UK universities autonomous organisations established in a variety of legal forms, largely dependent on their historical origins, for example by royal charters (chartered corporations) or by Act of Parliament. Common for all institutions is that they have charitable status.

Since the 1980s, universities in the UK has evolved in direction of a more corporate model of governance in keeping with ideas of New Public Management (NPM). Typically, the Vice-chancellor (or Principal) is the chief executive officer who provides strategic and managerial leadership and represents the university externally. The Chancellor is largely a symbolic figure who might support fundraising and perform ceremonial functions.[158]

The Vice Chancellor is overseen by a university board, the governing body of the university, usually with a majority of external members. The Committee of University Chairs (CUC) has issued a voluntary 'Code of Governance' to the work in university governing bodies (CUC, 2014).

F.2.2 Financing of universities

F.2.2.1 Overall composition of university income

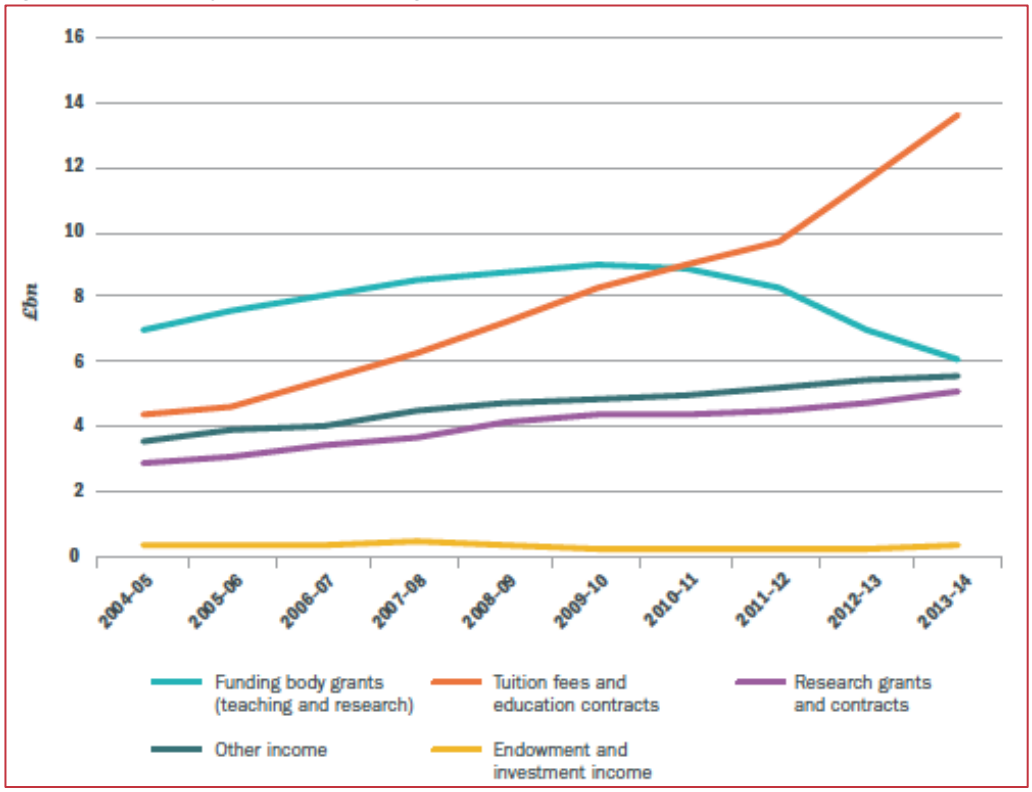
Compared to most other European countries, UK universities receive relatively little institutional funding. Within the last decade funding body grants have decreased in size whereas tuition fees, which were first introduced in 1998, and education contracts have become the single most important source of income.

[156] http://www.millionplus.ac.uk/ (Accessed January 2016).

[157] http://www.unialliance.ac.uk/ (Accessed January 2016)

[158] http://www.universitiesuk.ac.uk/linksforstudents/Pages/Anoverviewofthehighereducationsector.aspx (Accessed January 2016).

Figure 13: Income of UK universities by source, 2004-05 to 2013-14



Source: (UUK, 2015, p. 34, based on data from HESA Finance record)

F.2.2.2 Institutional grants for research

Institutional funding for research in is performance-based, primarily so-called 'Quality-Related' (QR) funding distributed by the funding Councils. 2015/16 is the first year in which the QR funding is allocated on the basis of the 2014 Research Excellence Framework (REF), replacing the preceding Research Assessment Exercise (RAE 2008) (HEFCE, 2015). The REF is discussed below.

F.2.2.3 Teaching funding

Unlike research funding, institutional funding for teaching is formula-based, primarily related to student numbers. Policy changes affect both the amount and method with which funding for teaching is allocated. Firstly, the institutional funding paid directly to institutions have been reduced dramatically and replaced by an increase in student fees, partly backed by government loans. In 2015, teaching grants in England have been reduced to less than 25% of their 2011 level from £4.3bn to £1bn (De Boer et al., 2015, p. 111). Student fees, which did not exist prior to 1998, accounted for 24.1% of UK university income in 2004/5, almost doubling to 44.5%, £13.7bn (UUK, 2015, p. 34).

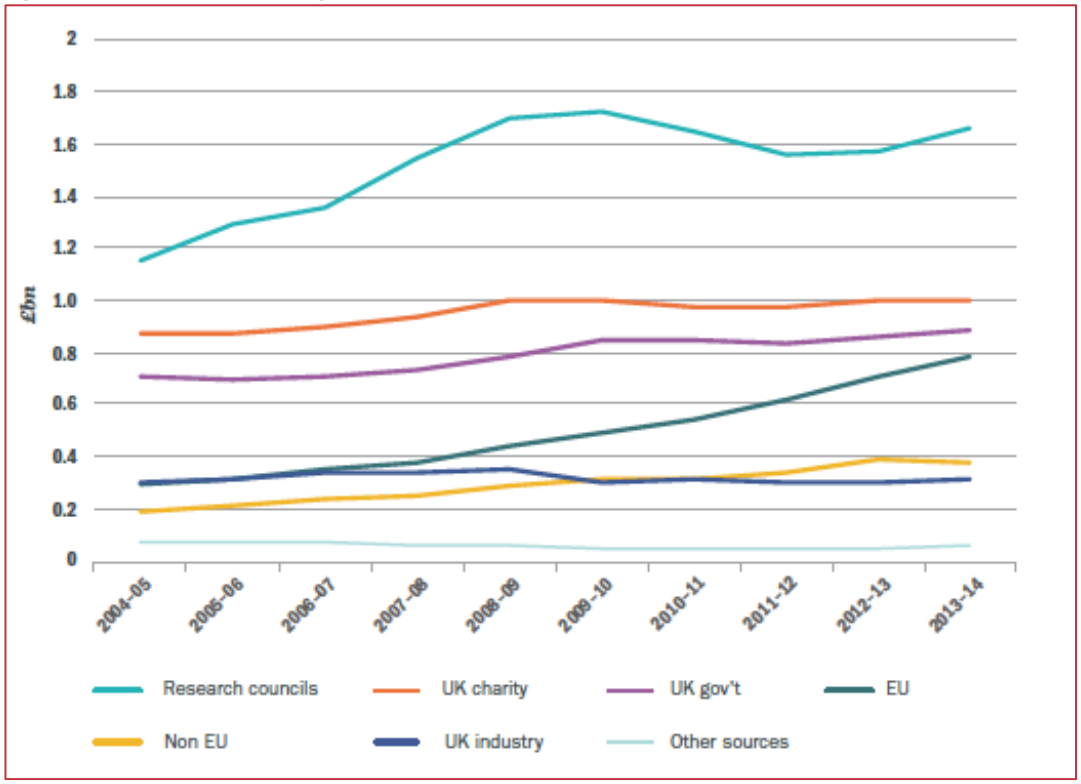
Secondly, there are advanced considerations of introducing an assessment framework for teaching equivalent to the REF, the Teaching Excellence Framework (TEF). One argument for a TEF is the perceived lack of incentive for universities to improve teaching standards. It is argued that REF has had the effect of drawing resources away from teaching, for which funding is 'automatic' towards research were funding is conditional on quality. By

introducing a TEF, it is hoped that these two university missions will receive more equal attention within universities. A related argument concerns transparency and choice. In a higher education market where students pay high fees, they should be able to see what they get for their money and choose the best value for money, thereby pushing universities to compete for their business (BIS, 2015).

F.2.2.4 External funding

As shown in Figure 14, research funding from EU and other international sources have increased significantly whereas research council funding is slightly below its 2009/10 level. Industry funding for UK universities remains at a relatively low level.

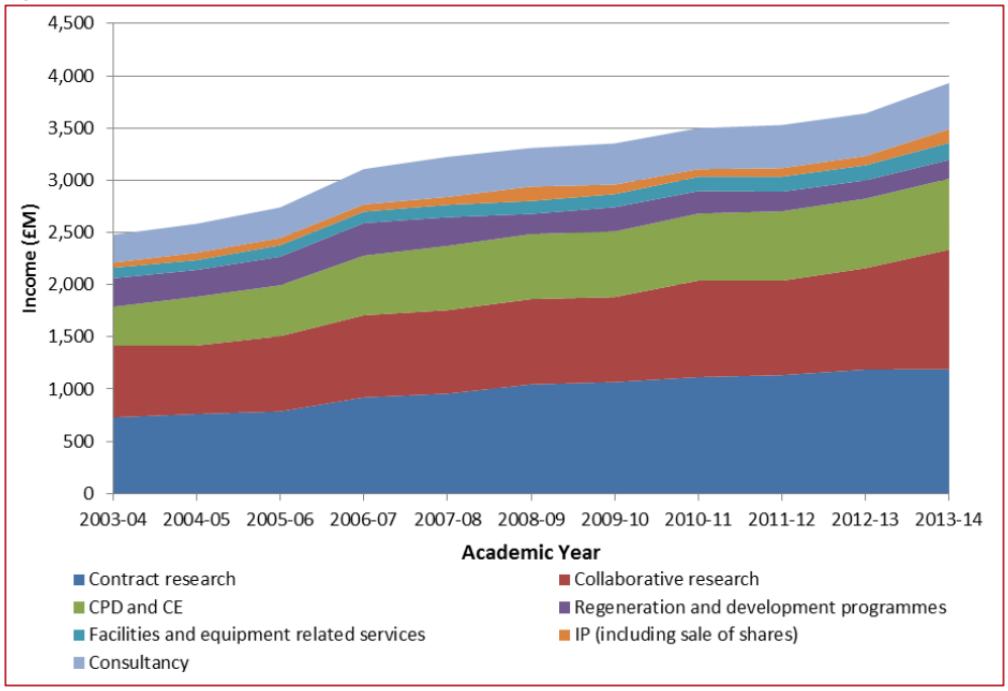
Figure 14: Research income by source 2004-05 to 2013-14 (real terms)



Source: (UUK, 2015, p. 35, based on HESA Finance record and BIS GDP deflators series, March 2015)

With direct government funding decreasing, the universities have a strong incentive to look for funding from external sources. For example, new strategies are being developed to attract funding from philanthropists and other non-governmental sources (Pearce, Blinco, Brooks, Trainor, & Williams, 2012). The annual Higher education-business and community interaction (HE-BCI) survey reveal a steady increase in a number of income streams over the last decade, including contract research, collaborative research, consultancy and Continued Professional Development (CPD) courses (see Figure 15).

Figure 15: Selected HE-BCI income streams, 2003-2014 (real terms)



Source: (HESA, 2015, p. 6)

F.2.3 Assessment or performance reviews

F.2.3.1 Scottish Outcome contracts

Performance contracts at the level of individual institutions do not exist in England but have been used in Scotland since 2011 to access the return of the Scottish Government's investment in higher education would be. Annual 'Outcome contracts' are concluded between the 19 individual HEIs and the Scottish Funding Council (SFC) and outline a three-year commitment. This cycle that has now reached its fourth iteration. Evidence is that the HEIs have been engaged in the process. The first years of the contracts were mostly forward-looking but the targets set in earlier rounds of contracts can now be evaluated. The majority of institutional funding for Scottish Universities is still based on formula and institutions can win or lose a maximum of 1% of their funding on the basis of the contracts (De Boer et al., 2015, p. 117).

F.2.3.2 Research assessment

Across the UK, a national research assessment exercise is carried out jointly by the four Higher Education Funding Councils for England (HEFCE), Wales (HEFCW), Northern Ireland (DEL) and Scotland (SFC) every 6-7 years. Its current incarnation is called the Research Excellence Framework (REF)[159] but its origins can be traced back to the 1980s when a first Research Selectivity Exercise (RSE) in 1986. The stated purposes of the exercise are:[160]

- Inform the allocation of institutional grants for research by the four funding councils.

[159] http://www.ref.ac.uk/ (Accessed 19 December 2015).

[160] http://www.ref.ac.uk/about/ (Accessed 19 December 2015).

- Provide accountability for public investment in research
- Provide reputational benchmarks for the institutions and the public

Another aim appears to have been the (continued) concentration of funding among a smaller number of institutions to avoid spreading limited resources too thinly (e.g. Hicks, 2012).

The RSE allocated only a minor part of institutional research funding but since the Research Assessment Exercise (RAE) in 1992, the bulk of institutional research funding from the funding councils have been allocated according to the results of the exercise. For England, the amount allocated through this mechanism is currently about £1.6bn per year. The REF is the largest exercise of its kind in the world and is unique in determining the quasi-totality of institutional research funding. While the allocation has generally been stable from one exercise to the next (Barker, 2007), the 2014 REF saw a couple of dramatic changes with the University of Manchester losing some 13% of funding and University College London (UCL) gaining a similar amount.

The method used to evaluate research quality relies heavily on peer review of research output, carried out by a number of disciplinary panels. The potential of using bibliometric data in the assessment was first explored in the 1980s and it has been a recurring theme since (Otley, 2010). Proponents of adopting metrics argue that it could arrive at the same results for a fraction of the effort and costs.[161] So far, the majority view appears to be that metrics may complement but not replace peer review. A pilot exercise carried out by HEFCE in 2009 concluded that bibliometrics was "[in]sufficiently robust at this stage" but that it could be used to inform peer review (HEFCE, 2009). Bibliometric data was supplied to panels in the REF (2014) but it is unclear exactly how the panels have used the data.

The assessment criteria have changed somewhat. The latest addition is research 'impact', included among the criteria for quality-related funding for the first time in the REF in 2014. Case studies were submitted to demonstrate impact, understood as "any social, economic or cultural impact or benefit beyond academia that has taken place during the assessment period, and was underpinned by excellent research produced by the submitting institution within a given timeframe" (HEFCE, SFC, HEFCW, & DELNI, 2011, p. 1). The weighing between assessment criteria is as shown in Table 16.

Table 16: Research Excellence Framework (2014), assessment criteria and weight

Criterion	Submission	Weight
Research output	Up to four outputs per researcher	65%
Environment	Environment data and template	15%
Impact	Impact template and case studies	20%

Source: Adapted from (De Boer et al., 2015, p. 113; HEFCE et al., 2011)

Discussions have now turned to the next started about the next exercise. Several consultations (BIS, 2015) and reviews[162] are under way to gather evidence and look at potential improvements or alternatives. One prominent aspect of the discussion is centred

[161] One well-known proponent of this view is Patrick Dunleavy from the London School of Economics: http://blogs.lse.ac.uk/impactofsocialsciences/2011/06/10/ref-alternative-harzing-google-scholar/ (Accessed 29 January 2016).

[162] https://www.gov.uk/government/news/government-launches-review-to-improve-university-research-funding (Accessed 29 January 2016).

around the 'cost of the REF'. A study by Technopolis estimated the total cost at £246m, the vast majority (£232m) of which borne by the universities (Farla & Simmonds, 2015).

F.3 Steering and financing system of governmental research organisations

F.3.1 PRO role and governance

In the UK, the non-university public research landscape is composed of around 100 research institutes (Simmonds et al., 2014). Approximately one-third of these institutes are affiliated with Research Councils (see above), the rest is affiliated Government Departments. Research Councils and Government Departments also sponsor partly or directly the institutes. Together, these two types of research organisations are called Public Sector Research Establishments (PSREs). Although the public research in the UK is dominated by universities, the non-university public research institutes fulfil important roles in research that universities do not carry out. The PSREs are positioned between academic and scientific research on the one hand and industrial research on the other. They cover a wide range of scientific disciplines and provide key scientific and technical inputs to public policy and government decision making. Most focus their effort on providing a range of evaluation, testing, emergency response and consultancy services to government, industry and the general public.

Having a special "parent body" (Research Councils or Government Departments) means that PRSEs help to fulfil their parents' missions and they have clear responsibility for their work and investment.

The PSREs in the UK can be classified as follows[163]:

- PSREs affiliated with Government Departments
  - Cultural Institutions (funded by the Department of Culture), comprising galleries, museums, arts and heritage organisations
  - NHS Regions, which consists of research activities of all NHS Trusts
  - Other departmental research bodies
- PSREs affiliated with Research Councils – Research Councils, as a general rule, do not carry out research themselves. For this purpose, some of the Research Councils have established their own research institutes or special research units.

The variety of PSREs is very large as the institutes are different in size (employment and turnover), legal status and governance structures.

The PSREs sector in the UK have undergone significant changes in the last two decades, aiming, as in other European countries, at increasing efficiency of their activities, improving the responsiveness to social and economic issues and at reflecting budgetary constraints. Since the mid 1980s, they were scrutinised repeatedly to determine whether they should remain public bodies. As a consequence, many of the PSREs were turned into "arm's length" executive agencies, with an increasing part of its work financed by contracts outside the

[163] Based on Warwick Economics & Development (2014) 7th Survey of Knowledge Transfer Activities in Public Sector Research Establishments (PSREs) and Research Councils: a report submitted to the Department for Business, Innovation and Skills

government. In the 1990s, some of these were privatised. There have also been a number of mergers and a higher involvement of the private sector. The UK experience may suggest that it is not appropriate to privatise those PSREs whose mission is largely public in nature, i.e., whose services and facilities mainly serve unique needs of the government. These changes meant that the importance of the PSREs sector has been relatively diminished at the expense of the university sector.

The PSREs are governed by their parent organisations (Research Councils or Government Departments). Some of them are now executive agencies, some remain departmental bodies and some are government-owned companies. Other PSREs operate under the so-called Government Owned – Contractor Operated model, which means that a public body retains the "ownership" of the organisation but they contract out the administration. This is an example of the National Physical Laboratory (NPL)[164] that was operated from 1995 to 2015 by an external company and returned back to the Department for Business, Innovation and Skills on 1 January 2015.

Other examples of PSREs include Tate Galleries[165], Food and Environment Research Agency (FERA Science Ltd.)[166] and the British Geological Survey.[167]

F.3.2 Financing

F.3.2.1 Institutional block grants

There is no single approach to institutional funding of the PSREs. The PSREs may either be owned by the parent Research Council or the Government Department[168], receiving the great majority of their income from that source, or they may have a more distant relationship, being treated as "centres of excellence" and receiving a block grant representing only a minority of their overall research funding.

However, some aspects of the setting of institutional funding of the PSREs turn out to be negative factors in their future development. The institutes are often tightly bound by the parent decisions, and they lack the freedom to adopt their own decisions in a number of operational issues, such as marketing, advertising, internal organisation etc.[169] Additionally, there are often too many layers of administration, generous pension contributions etc., which generates high overhead costs. It can be difficult for public sector organisations to gain the capital funding they need for the future development due to Treasury rules and complicated decision-making processes.

F.3.2.2 Competitive public funding

Similarly, to universities, PSREs can apply for a wide variety of competitive research funding from a number of sources. This can include funding from Research Councils and from the

[164] Official website: http://www.npl.co.uk/

[165] Official website: http://www.tate.org.uk/

[166] Official website: http://fera.co.uk/

[167] Official website: http://www.bgs.ac.uk/

[168] More information on the status of PSREs is available online at: http://www.parliament.uk/documents/commons-committees/science-technology/130516walportpsres.pdf

[169] Maxwell-Jackson, Q. (2011) Getting Better Value from Public Sector Research Establishments

National Academies (Royal Society, British Academy, Royal Academy of Engineering and Academy of Medical Sciences). The Research Councils fund specific projects that may typically last for three years. These grants are normally awarded on a competitive basis. The funding awarded depends on the estimated cost of undertaking the project. Research organisations usually have to calculate the full economic cost of the proposed project. Government departments, non-departmental government bodies, local authorities and the NHS also represent funding sources.

F.3.2.3 Third-party funding

The funding bodies may include charities, the European Commission and industrial and commercial organisations in the UK and overseas. This is mostly in the form of grants and contracts for specific research projects. Science and Technology Facilities Council (STFC)[170] and its affiliated research institutes are examples of successful participators in the EU framework programmes. Third-party research funding may be awarded by way of a research contract under which the funding body can obtain rights to use the results of the research.

[170] Official website: http://www.stfc.ac.uk/

F.4 References

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