POLICY CASE STUDY

Case study on the policy mix for science-industry knowledge transfer in Austria

Contribution to the OECD TIP Knowledge Transfer and Policies project

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Abstract

The case study provides a comprehensive overview of the policy mix for science-industry knowledge transfer used in Austria. It addresses the current focus of policies for knowledge transfer and its main instruments as well as the development from the late 1990s on. The analysis also covers the main actors involved in the design of this policy mix at national level and the policy debate with respect to the future development of the policy mix for knowledge transfer, including a short discussion of impacts, synergies and trade-offs.

Executive Summary

Knowledge-based capital is the main driving force of competitiveness and long-term growth. Since the 1990s Austrian higher education institutions and public research institutions have built close linkages with the business sector, building upon each other's inputs into the innovation process. As a contribution to the OECD/TIP-project on Knowledge Transfer and Policy Impact, Austria carried out a case study on the policy mix for science-industry knowledge transfer, emphasising its recent development, its current focus and impact.

Science-industry linkages: From a weakness to a success story

In the 1990s, the low amount of interaction between science and business was identified as one of the critical deficits in the Austrian innovation system. Since then, policy makers have enhanced existing programmes and developed a number of complementary initiatives to increase the degree of interaction between academia and business. Programmes such as CDG, COMET, BRIDGE, COIN, AplusB, etc. vary in design and address specific needs of actors in the innovation system, and have played a major role in this catching-up process. In addition, the aims of the RTI Strategy of the Austrian Federal Government (devised in 2011) and its sub-strategies (such as the IP-, the Open Innovation strategy and a strategy to develop the Austrian life sciences and pharmaceutical sector) supported a culture of cooperation, altogether leading to beneficial dynamics. Nowadays, Austrian firms have the highest cooperation intensity with higher education institutions and research institutions in the EU-28 (measured by the share of companies with science-industry linkages as percentage of all innovative firms). Almost 25% of all innovative firms cooperated with universities/higher education institutions and research institutions in the period 2012-2014. According to the European Innovation Scoreboard (2017), Austria is besides Finland and Belgium one of the leading European countries with regards to industry-science linkages. Hence, Austria shows an even better performance in industry-science linkages than the Innovation Leader countries.

The high participation of firms in research and innovation is certainly also a result of the high expenditures for R&D. Austria's research quota (3.15% of GDP in 2016[1]) is the second-highest among the EU member states and according to the current programme of the Austrian Federal Government, public funding for research and innovation should continue to increase to 3.76%. In addition, the government commits itself to an RTI policy that supports science-industry knowledge transfer also strategically.

The main driving forces for success

Looking back on the development of the policy mix for knowledge transfer in the last 20 years, major changes have occurred. Examples regarding policy issues include the implementation of the Universities Act of 2002 in 2004, the re-organization of the national funding agencies (aws, FFG and FWF) in the period 2002-2004 and the set-up of the RTI Strategy by the government in 2011, which enforced the development of research and innovation in Austria.

[1] Meanwhile, by 2018 the research quota in Austria has reached 3.19%.

On the corporate side, the increase in the research premium[2] (from 2002 to 2018 it was raised from 3% to 14%) fostered the engagement of companies and complemented the numerous (direct) funding programmes following mainly a bottom-up approach.

The main driving forces for industry-science collaboration were discussed in 27 expert interviews with main stakeholders at the national level, i.e. with representatives from ministries responsible for RTI, funding agencies and the Austrian Council for Research and Technology Development. The results suggest that the portfolio of the policy mix for science-industry knowledge transfer in Austria is well balanced and that the last gap - the transfer of academic knowledge into goods and services by researchers themselves - was filled by the new programme "Spin-off Fellowships" just recently. According to the interviewees, already existing programmes, such as the CDG and COMET (both implemented as public-private-partnership-models) and other programmes targeted towards knowledge transfer such as COIN, BRIDGE, AplusB, ACR, etc. should be continued with sufficient funding while avoiding to overload these programmes with additional tasks.

The well-established approach of providing programmes with a bottom-up orientation was a major contributing factor to making science-industry cooperation in Austria that successful. Indeed, bottom-up approaches are also regarded as appropriate instruments in dealing with current topics and challenges like digitalization.

Concerning the further development of the national innovation ecosystem, the Austrian Council of Ministers[3] has recently proclaimed the strengthening of excellence in basic research and the increase of efficiency, impact and planning security in public STI-funding as important elements of the Austrian innovation policy. Consequently, these issues will also influence the further development of the policy mix for science-industry knowledge transfer.

[2] Research tax premium in accordance with Section 108c of the Austrian Income Tax Act

[3] https://www.bundeskanzleramt.gv.at/documents/131008/972899/25_63_mrv.pdf/2b02f3d8-09cd-45ee-b9f2-f3cfd8244990

1. Development of the policy mix

Knowledge-based capital is the main driving force of competitiveness and long-term growth. Policy makers in OECD countries have developed a number of instruments and regulations to promote the accumulation of knowledge-based capital. One prominent way of doing so is to support the interaction between the business sector and the research sector, i.e. to foster the knowledge transfer between knowledge producers and the users of this knowledge for commercial purposes. This report analyses knowledge transfer related policies from the policy mix perspective. A policy mix can be defined as "the set of policy rationales, arrangements and instruments implemented to deliver public action in specific policy domains as well as their interactions" (OECD, 2016). Central to the idea of a policy mix are the concepts of interaction between policy instruments and possible synergies or trade-offs that may arise due to their joint application in an economy.

Since the 1990s higher education institutions and public research institutions have built strong linkages with industry, building upon each other's inputs into the innovation process in Austria. The following chapter outlines the current focus and the relative importance of different policy instruments as well as the main factors that motivated the current policy mix. Looking back, strengthening knowledge transfer has been a major objective of the Austrian innovation policy, leading to great success as Austria is currently one of the leading countries among the EU member states with regard to industry-science collaboration.

1.1. Current focus of policies for knowledge transfer

Before 2000, the low interaction between science and industry was recognized as a strategic weakness of the Austrian innovation system (OECD, 2004). To boost cooperation between science and industry the federal government has supported the **development of a broad portfolio of instruments** ranging from strengthening application orientation basic research (CD-Labs, COMET, BRIDGE, etc.) to capacity building in applied research and innovation (AplusB, COIN, Innovation Voucher, etc.).

Figure 1 The main driving forces for the policy mix for knowledge transfer in Austria

Source: WPZ Research, own demonstration

Several factors can be regarded as the main components of the current policy mix. They can also be seen as the main drivers for collaborations between research institutions and business partners (figure 1).

Today Austria's policy mix for knowledge transfer offers **a well-diversified portfolio of funding programmes**. The majority of these programmes is based on a bottom-up-approach. There are also a few thematic and R&D-infrastructure-funding initiatives complementing the contemporary setting of knowledge transfer programmes.

Furthermore, this programme mix is strengthened via **several positive framework conditions:**

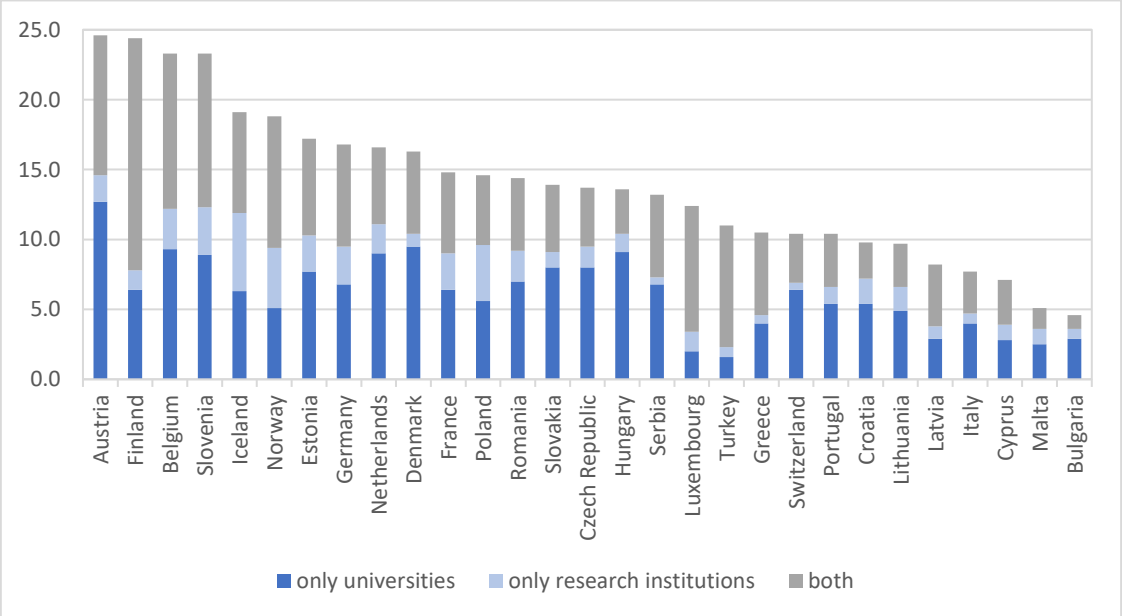
The **Universities Act of 2002** is an important foundation for the current policy mix. The autonomy of Austrian public universities has increased their openness towards collaborations with industry. Besides the universities, also public/non-university research institutions have provided a strong contribution to strengthen the scientific knowledge flow into business and industry.

An expansion of the **research tax premium** has also been an incentive for innovative companies to increase their STI-investments including the cooperation with scientific partners.

Many of these initiatives were also taken into account by the **RTI Strategy of 2011**, which has been affirmed by additional **sub-strategies** (such as the IP strategy, the OI strategy and a strategy to develop the Austrian life sciences and pharmaceutical sector).

Austria has become one of the leading nations in terms of collaboration between science and business. According to Eurostat, Austria is above average in businesses collaborating on innovation with higher education and research institutions. Almost 25% (24.6%) as a percentage of all firms with product or process innovation activities in Austria collaborated with universities and/or with public research institutions in 2012-14 (figure 2). Consequently, Austria shows an even better performance in industry-science linkages than the Innovation Leader countries.

Figure 2 Businesses collaborating on innovation with higher education and research institutions, 2012-14



Source: Eurostat, CIS 2014

In terms of public-private co-publications, Austria scores at the fifth place within the EU-28 in 2017 (which is an increase of 13.2% since 2010). Concerning private co-funding of public R&D expenditures - measured by all R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD), financed by the business sector, as percentage of GDP 2015 - Austria (0.046%) performs slightly below the EU-28 average (0.049%).

1.2. The last 20 years: Catching-up, milestones and new programmes

Within the last decades, RTI policy has changed Austria's research landscape considerably. An important starting point for the promotion of knowledge transfer was undoubtedly the **"technology billion"** ("*Technologiemilliarde für wissenschaftliche Forschung und technologische Innovation"*) in the second half of the 1990s. The funding was targeted mainly to the development of the institutionalized cooperative research not at least in response to the weakness of knowledge transfer at that time. As a result, the non-university research sector has been growing and played an important role in bridging the gap between industry and science. A further impetus was provided by **Austria's EU accession in 1995** which helped the Austrian policy makers to engage in policy learning from other countries and EU standards. The **EU Lisbon Agenda** made research and innovation a topic of high priority and induced the design of more ambitious innovation policies in Austria.

In the mid-1990s the **first funding programmes were launched** to strengthen the cooperation between industry and academia. In 1995, the Christian Doppler Association (CDG) was the first PPP-initiative that supported collaboration between industry and science via CD-Laboratories, followed by the Competence Centre Programme in 1998. In its initial phase, the competence centre programme consisted of three main funding lines (Kplus, Kind[4] and Knet). After the merger of Kind and Knet the programme was restructured and renamed as COMET. In addition, several thematic programmes were launched over the years, as for instance in the field of ICT, nanotechnology, energy, life sciences, etc., whose main instrument was also cooperative project funding. Some funding programmes were launched in order to meet special needs and challenges of individual players of the innovation system as well. COIN and Research Studios Austria (RSA) were introduced to prepare in particular SMEs, universities and universities of applied sciences for STI-cooperation. To encourage especially SMEs for short-term projects with innovative/scientific partners later on, a small grant programme the "Innovation Voucher" was set up.

The upgrade into a more dynamic innovation system has been accompanied by a **steady increase in R&D expenditures.** In 1998, the Austrian research quota reached 1.7% of GDP and was far below the OECD-average of 2.18%. Especially the performance of the corporate sector was below average and linkages between science and industry were rather weak. Between 2002-2004, only 10.4% of innovative companies cooperated with universities (see figure 5). To counteract this low share, the Austrian government decided to increase R&D expenditures significantly and set milestones for R&D-growth. Consequently, the milestones stipulated a research quota of **2.0% of GDP by 2002, 2.5% by 2005, 3.0% by 2010** and **3.76 by 2020**.

Major amendments also took place on the side of the funding agencies, to make research funding more targeted and sustainable.

[4] As a forerunner, the Austrian Science Fund (FWF) had previously promoted an action called "Thesis for the Economy" in 1997, which was intended as an incentive for high-quality science-industry projects. This idea was then adopted by the formerly TIG (now Austrian Research Promotion Agency - FFG) and used for the conception of the programme line "Kind".

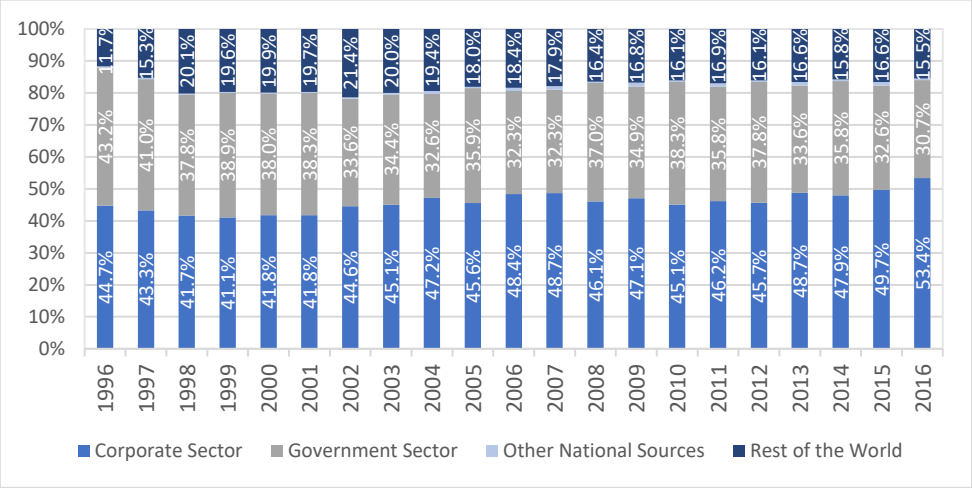
In 2002 the **Austria Wirtschaftsservice GmbH (aws)** was founded by merging existing institutions as the "*BÜRGES Förderungsbank*", the "*Finanzierungsgarantiegesellschaft*" and the "*Innovationsagentur*". Since then, the aws has been acting as the Austrian federal promotional bank, with an emphasis on funding highly technology-oriented firms and promoting start-ups and high growth firms via venture capital and professional business coaching (BMBWK, BMVIT and BMWA, 2003).

In 2004, the **Austrian Research Promotion Agency (FFG)** was set up by federal law (pursuant to the FFG Act) as a new agency, encompassing three already existing organisations, namely the "*Forschungsförderungsfonds für die gewerbliche Wirtschaft (FFF)*", the "*Technologie Impulse Gesellschaft (TIG)*", the "*Austrian Space Agency (ASA)*" and the "*Büro für internationale Forschungs- und Technologiekooperationen (BIT)*". The main target of the FFG is to provide research funding for companies and to promote activities in applied research.

At the same time, in 2004, also the funding for basic research was re-organised under the umbrella of the **Austrian Science Fund (FWF)**. From then on, the FWF was established as a separate legal entity under Austrian law, based on the Research and Technology Funding Act.

According to the **Federal Act on the Organisation of Universities and their Studies (Universities Act of 2002)**, the higher education sector underwent a significant change. Public universities became autonomous legal entities and were granted full autonomy. This facilitated the cooperation with industry (BMBWK, BMVIT and BMWA, 2005). Due to the Universities Act of 2002 the public universities were enforced to act more strategically. From then on universities had to define their research priorities, and to shape a specific research profile (BMBWK, BMVIT and BMWA, 2006). In addition to the core functions of teaching and research, the universities were required to implement a third pillar "knowledge transfer" through the performance agreements. Consequently, the number of research projects with the industry increased at many universities, creating a new dimension of knowledge-sharing (called "third mission"). Thus, the role of universities in the innovation system changed, since universities became more and more a key player with efforts to increase their impact on business and society (BMWF, BMVIT and BMWA, 2008).

Figure 3 R&D Expenditures of Austria by source of funding, 2002-2015



Source: OECD: Main Science and Technology Indicators (2018)

As shown in figure 3, the development towards a more open, well-funded innovation system has also had an impact on the R&D activities of companies. Both, R&D expenditures as well as the number of companies engaged in R&D increased from 2000 on, improving R&D intensity in nearly all business sectors. R&D expenditures increased not only in a few high-tech companies but also in the enterprises of the medium- and low-tech sectors. Driven by a new "culture of co-operation", Austrian firms and research institutions also showed strong efforts to become more international.

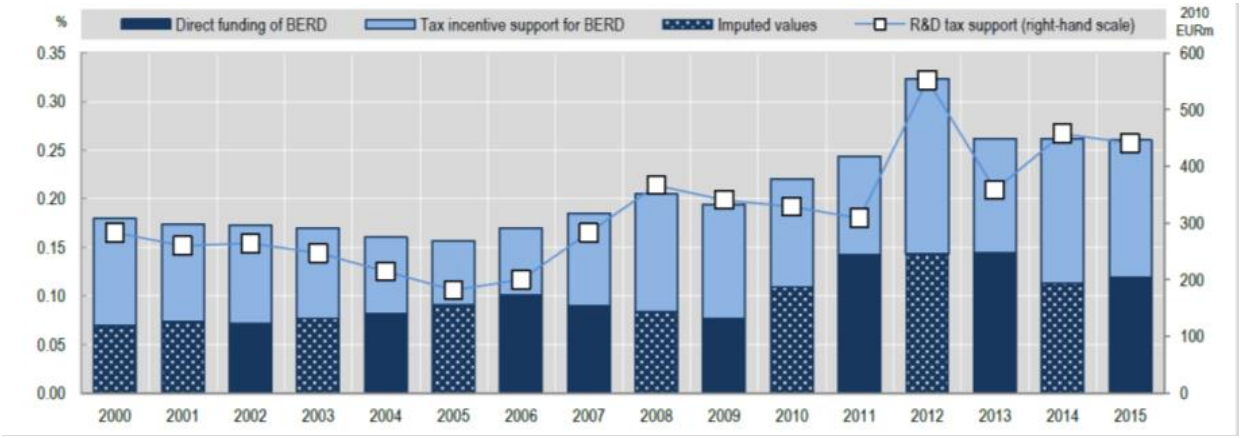
The global financial and economic crisis, which started in 2007/2008, led to a reduction in the growth rate of business financed R&D activities. Facing this challenge, the federal government decided to take over a leading role in R&D funding and helped to maintain the level of total R&D expenditures (BMWF, BMVIT and BMWFJ, 2013).

Public-sector expenditures have crucially supported Austria's catching up in research and innovation in general and during the global financial and economic crisis in particular. Thereby, the public sector has invested in R&D by way of direct funding (through a wide range of funding programmes) as well as having promoted business R&D by tax incentives (research premium).

Figure 4 below shows that indirect funding of R&D increased in the past few years, from 0.09% of GDP in 2007 to 0.14% in 2015. In 2015, the latest year for which OECD data is available, tax incentive support amounted to 0.14% and direct support amounted to 0.13% of GDP respectively. With regard to public R&D funding, Austria ranks 7th among all OECD countries in 2015.

A further increase in the research premium, from 10% to 12% (2016) and then to 14% (2018) has made the Austrian funding system more generous. Due to its design the **research tax premium** supports in-house research as well as contract research which also contributes to strengthen knowledge transfer. Evaluations of R&D tax incentives in Austria highlighted the importance of the research premium as a location factor and revealed also its complementary effect on direct research funding[5].

Figure 4 Direct funding of business R&D and tax incentives for R&D, Austria, 2000-2015



Source: OECD, R&D Tax Incentive Indicators (2018)

[5] See Falk (2009), and Ecker et al. (2017)

Another traditional instrument is the **cluster policy**. Indeed, clusters are an effective instrument of innovation policy to initiate and strengthen knowledge transfer especially with regards to regional SMEs. The way in which firms learn and innovate (i.e. the sources of learning, patterns of innovation development, sources of technology improvement), and the level of technological opportunities and entry barriers, differs across firm activities[6]. Clusters are strengthening the international competitiveness of Austrian companies, especially that of SMEs because they encourage firms to get linked with research institutions. Clusters also co-operate with other trans-regional clusters.

Austria was an "early mover" in cluster policy development. Activities started in the 1990s (1995: foundation of the Automotive Cluster Styria, 1998: foundation of the Automotive Cluster Upper Austria, from 2000 onwards other regions followed). Today there are more than 60 clusters and networks in Austria with more than 7,100 cluster members (73% SMEs) and about 815,000 employees. To promote these joint activities and goals, the Austrian cluster platform was launched by the Ministry of Economic Affairs in 2008.

According to the stakeholder-interviews, SMEs are generally not used to build bridges with research institutions. They should follow a step-by-step approach in building cooperations with universities or higher education institutions. Cluster collaborations provide a good starting point for SMEs to engage in knowledge transfer activities. From a cluster management view, SMEs often start to collaborate in the field of R&D by the way of a low-threshold cluster project (collaboration projects with low barriers to entry funding by regional programmes) in which companies initially cooperate with companies at a regional level.

In case of success, the companies are introduced to public and private research institutions, where they can benefit from funding via the Innovation Voucher. To increase innovation capacity, the next step would be a consortium with the goal to participate in programmes like BRIDGE or COIN, being linked with universities. After a company gathered experience in R&D collaborations and improved its innovation capabilities, it might be able to take part in the COMET Programme. It is supportive to SMEs if lead companies (which are usually large companies) assume a thematic leadership and act as consortium leader in COMET Centres, Modules or Projects. This helps SMEs to overcome barriers in establishing knowledge transfer activities at the research frontier.

In 2008 and 2009, the Austrian system of innovation underwent an overall assessment. As a result, the evaluation defined a broad range of recommendations concerning the further development of the Austrian science and technology system, such as working on a "Frontrunner strategy", following the principle of openness, non-exclusivity and the mobility between firms and institutions (Aiginger et al., 2009).

Based on these recommendations, a **national RTI Strategy** was set up in 2011 by the Austrian government with the objective to increase R&D expenditures to 3.76% of GDP by 2020. The RTI Strategy underpins the importance of knowledge transfer by the following goals:

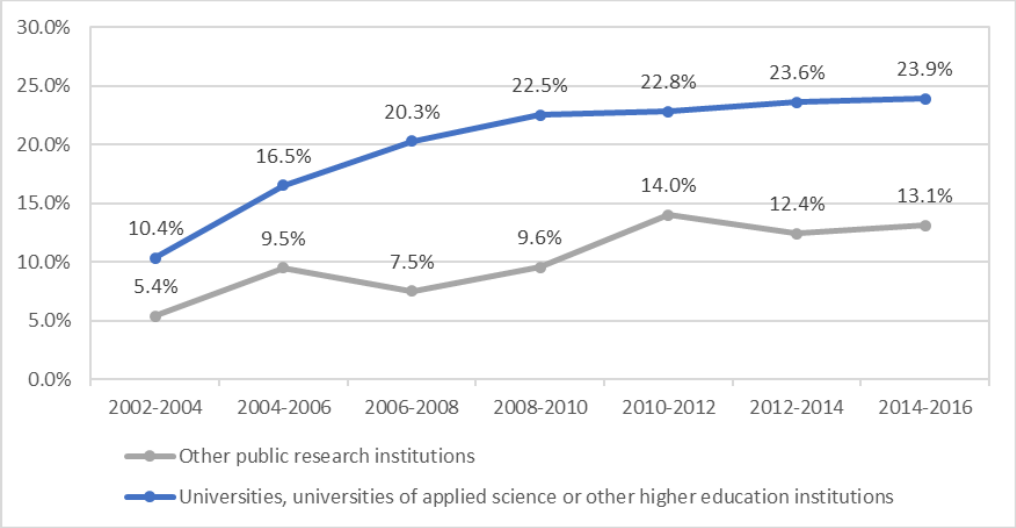
- To increase the cooperation intensity of Austrian enterprises and to strengthen strategically oriented collaboration between science and industry, paying attention to excellence and sustainability;
- To reduce barriers and obstacles especially for SMEs, that enterprises cooperate more with science/ research facilities;

[6] See Bekkers and Freitas (2008); for Austria see also Schartinger et al. (2002)

- To foster more enterprises towards technology leadership and top positions in innovation.

The strategic orientation to strengthen knowledge transfer was successful and led to increasing cooperations between innovative enterprises and scientific partners. According to CIS data 2016, 23.9% (1,877 enterprises) of innovative enterprises in Austria were collaborating with universities, universities of applied sciences or other higher education institutions; and 13.1% (1,031) had collaborations with other public research institutions (e.g. COMET Centres, AIT) in the period 2014-2016. Thus, both forms of cooperation have more than doubled since 2002 (see figure 5).

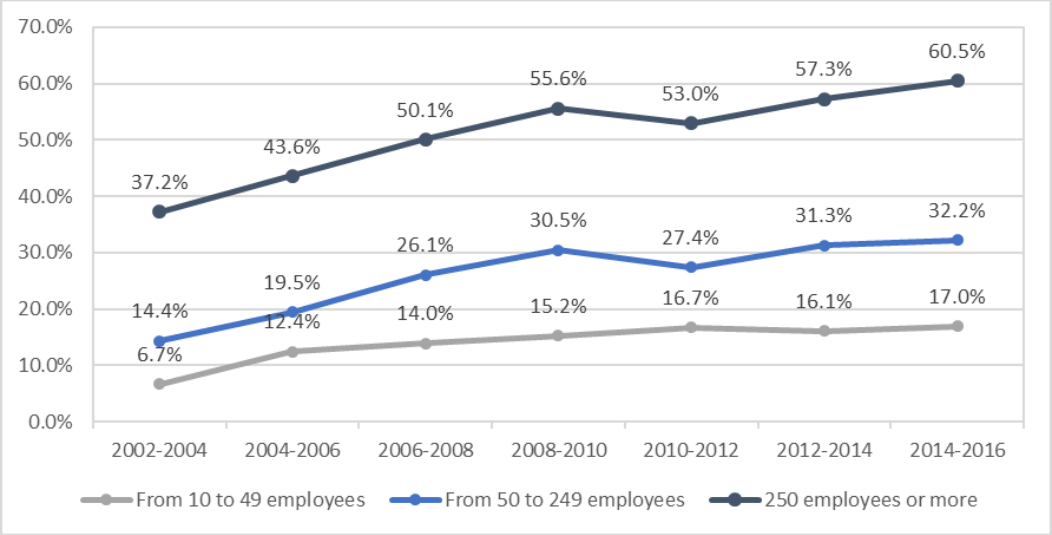
Figure 5 Product and/or process innovative enterprises co-operating with universities, universities of applied sciences, higher education institutions or other public research institutions, 2002-2016



Source: Statistics Austria: CIS 2004, 2006, 2008, 2010, 2012, 2014 and 2016 (data include multiple answers)

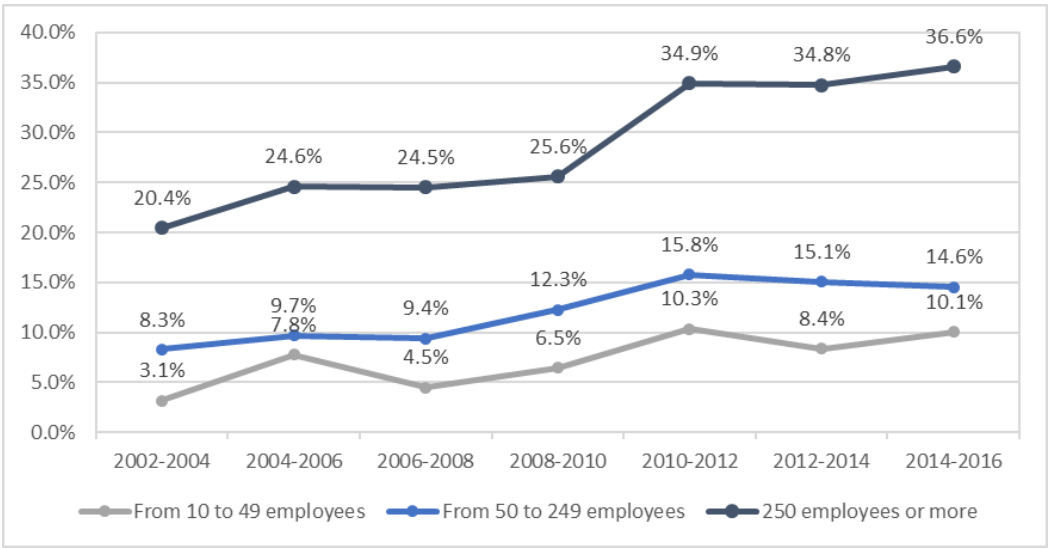
With regard to firm size, the Community Innovation Survey shows that 1,877 enterprises had cooperations with universities or other higher education institutions in 2016. With regards to knowledge transfer activities, large enterprises (i.e. with more than 250 employees) play a pivotal role in knowledge transfer since they are the most active segment within the business sector. More than 60% of large enterprises cooperate with higher education institutions (and more than 36% of large enterprises do so with public research institutions), whereas only 17% of enterprises with less than 50 employees cooperate with higher education institutions (see figure 6 and 7). This implies that in particularly large enterprises play a strong role in the development of industry-science linkages.

Figure 6 Product and/or process innovative enterprises co-operating with universities, universities of applied sciences and other higher education institutions according to firm size, 2002-2016



Source: Statistics Austria: CIS 2004, 2006, 2008, 2010, 2012, 2014 and 2016 (data include multiple answers)

Figure 7 Product and/or process innovative enterprises co-operating with public research institutions according to firm size, 2002-2016



Source: Statistics Austria: CIS 2004, 2006, 2008, 2010, 2012, 2014 and 2016 (data include multiple answers)

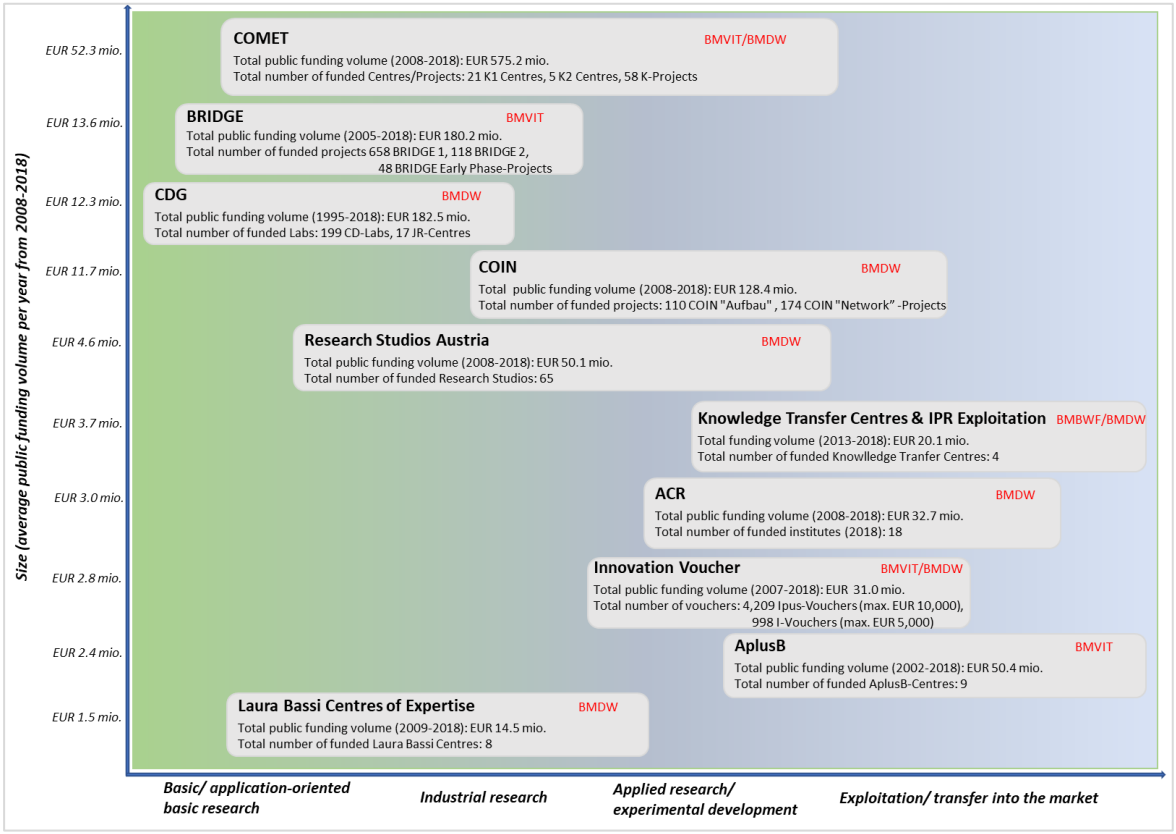
1.3. Different policy instruments promoting science-industry collaboration

Since the 1990s a broad set of instruments to promote science-industry collaboration has been developed, improving the mutual transfer of knowledge between science and industry. In particular, large and long-term programmes, such as COMET and CDG have played an essential role.

These programmes have been supplemented by further approaches and impulses, which focus on different levels of research and innovation, and therefore follow goals like the development of co-operative infrastructure, the building up of networks, etc. The programmes BRIDGE, COIN and Research Studios Austria belong to such programmes,

while AplusB and most recently the Knowledge Transfer Centres at universities specifically promote entrepreneurship and entrepreneurial thinking. Laura Bassi specifically targets the promotion of highly qualified women.

Figure 8 Selected funding programmes targeted towards knowledge transfer, according to size and activities funded



Note: 2018 includes preliminary data as of October 2018. AplusB funding volume: includes FFG funding until 2018, excludes aws funding from 2018 on. Data for ACR available since 2018.

Source: BMBWF, CDG, FFG; calculation and graphic demonstration by WPZ Research

As illustrated in figure 8, the selected funding programmes are targeting different types of research (from basic research to market transfer) and different design of public support and funding. Thus, depending on the programme, different goals, instruments and incentives apply. In the following section the major programmes of the Austrian policy mix targeted towards knowledge transfer, in particular towards science-industry collaboration, are characterized.

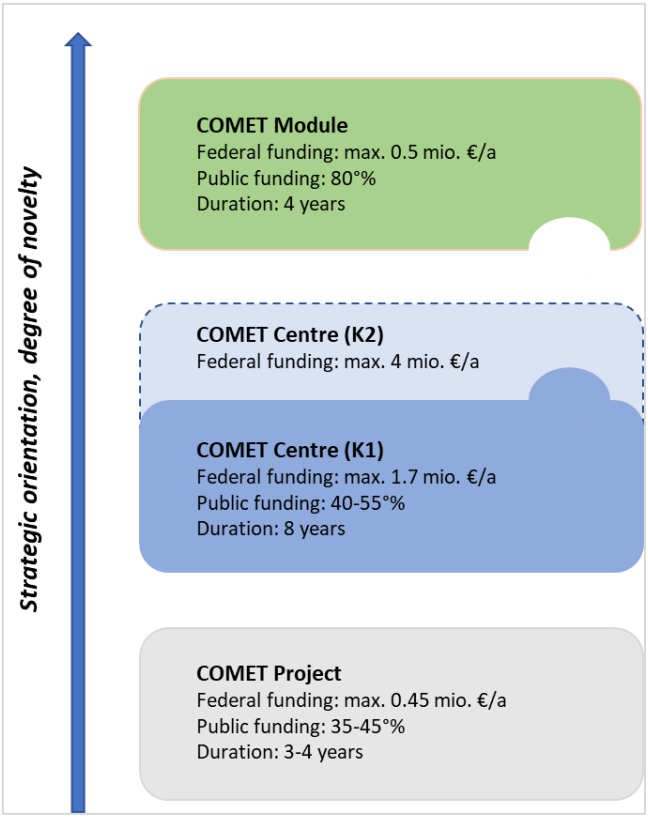
1.3.1. COMET Competence Centre Programme

With regard to role model countries such as Sweden or Australia, the idea of establishing competence centres at the interface of industry and academia was also implemented in Austria. The former, primary goal of the competence centres was to build up structures for cooperative research so that industry clusters may emerge from them one day.

Indeed, from 1998 until today, 45 centres and networks have been established targeted towards building up key research competencies by the way of cooperation between science and industry and creating a network of hubs, which offer high quality research in Austria.

In 2006, the programme was relaunched as COMET Competence Centre Programme[7] and **implemented with the existing portfolio of centres and networks** on a federal level. The Austrian federal provinces provide additional funding for COMET, also in order to strengthen individual regional objectives regarding technology policy. Since then, the goals of COMET have been to develop technological competences through long-term research cooperation between science and industry, to accelerate technology transfer and to trigger new research impulses. For that purpose, COMET follows a bottom-up approach and the competence centres are co-financed by the companies involved. In addition, the competence centres aim to reach ambitious goals, as for instance with regard to PhD-thesis, the development of prototypes, etc. The FFG is responsible for the management of the programme.

Figure 9 Overview on the COMET programme lines



Source: BMVIT and BMWFW (2016)

Over the years, several active centres have been transformed into new K1 Centres, others have developed new expertise or bundled existing competences, leading to the creation of new **K2 Centres**. K2 Centres are characterised by extremely ambitious research programmes, since they define new promising/emerging fields of research and differ from K1 Centres by carrying out research of particularly high risk. K2 Centres also aim to develop new competences by collaborating with international researchers of renown, scientific partners and companies in a joint strategically oriented research programme. In addition, structured career models offer high-potential researchers from Austria and abroad optimal development and career prospects.

In comparison, **K1 Centres** aim to develop competences through excellent cooperative research with a medium to long term perspective.

[7] https://www.ffg.at/programme/comet-competence-centers-excellent-technologies

They stimulate new research ideas in their fields of competence and thus, they contribute to initiating product, process and service innovations with a view to future relevant markets (for more details see figure 9).

However, as a result of the competitive funding model, a number of centres and networks have also ceased to receive support from COMET (BMVIT and BMWFW, 2016). In fact, COMET is recognised as one of the most successful technology policy initiatives in Austria. In 2017, the total volume of funding for COMET was almost EUR 44.8 million. By February 2018, 5 K2 Centres, 17 K1 Centres and 18 K Projects were on-going.

The COMET programme also was subject of two **impact analyses**. The results have played a key role in the recent revision of COMET, as well as the results of the TAFTIE Task Force[8] on Competence Centres. The impact analyses (e.g. Dinges et al., 2015) show that COMET Centres make a fundamental contribution to increasing the expertise and innovative output of the companies involved. The companies are well serviced. Equally, COMET has also helped to consolidate existing research areas and enhanced the corresponding expertise of the scientific partners (BMVIT and BMWFW, 2016). Competence centres play an important role in the qualification of human resources, as they take up new research topics and train highly qualified employees for companies.

In order to counter a tendency that COMET Centres increasingly act as R&D service providers for companies, rather than driving new strategic research, the COMET programme goals as well as the structure of the programme have been redefined. The existing programme lines K2 and K1 are being merged into one type of centre, at the same time a new "COMET Module" has been implemented as add-on activity for existing centres. COMET Module aims to establish promising/emerging fields of research and to promote high-risk research. For this purpose, COMET Modules are thematically defined research areas and focus on excellent research that may lead to new topics being beyond state-of-the-art. With regards to the further development of COMET, there are also strong efforts to increase the internationalisation of the centres as a sign of excellent cooperative research.

1.3.2. CDG - Christian Doppler Laboratories and Josef Ressel Centres

The **CDG (Christian Doppler Research Association)** was originally founded 1988 as a group instrument of the State owned industries (*Österreichische Industrieholding AG - ÖIAG)* with the major goal to establish research units (CD-Laboratories) to pursue basic research at a high level. The themes selected had to be of an innovative impact and of medium to long-term benefit for the companies of the group; financing was provided by the group management.

In the beginning 1990s the crisis of the State owned industries made funding of CD-Laboratories more difficult - lastly resulting in a reorganisation of the model as the first PPP for research collaboration in Austria. Consequently, the restructuring of ÖIAG from an industrial group to an investment and privatisation agency in 1993 also brought about a reform of the CDG, opening the association to all Austrian companies in demand for high-level- and application-oriented basic research. In 1995, the CDG was placed under the responsibility of the Federal Ministry of Economic Affairs (now BMDW). The CDG was restructured and given a new financing basis in the form of a PPP-model for research cooperation between science and industry.

[8] The Task Force of TAFTIE (The European Network of Innovation Agencies) concerning the further development of competence centre programmes was active between 2014-2016.

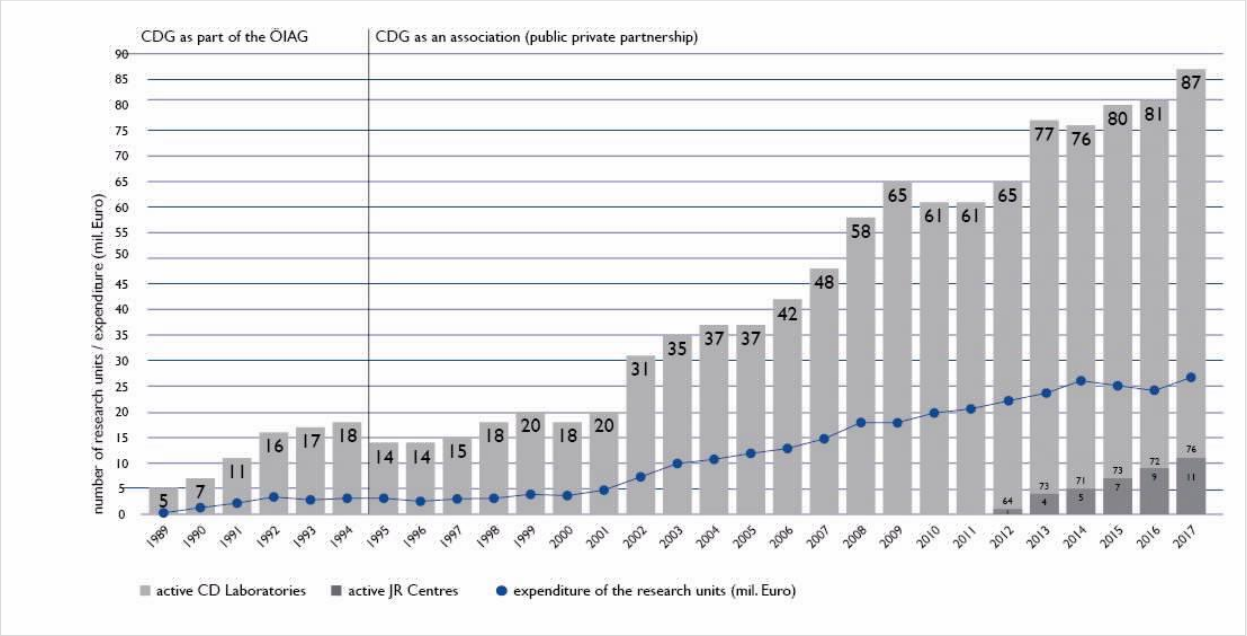
General features and characteristics of the CDG and the CDG-funding programme for **CD-Laboratories** (bottom-up orientation, rigorous scientific quality, 30% free resources for basic research) have not been changed since 1995, but only flexible adapted, due to practical and regulatory demands. Based on several positive evaluations, the CDG appears as a widely accepted and stable element in promoting research and innovation in Austria.

CD-Labs consist of research groups (5-15 people) and are led by a laboratory head. They are directly embedded within a hosting university, or non-university research institution and are established for a maximum of 7 years. This period is sectioned into 2, 3 and 2 years, entering the subsequent period only after passing a scientific evaluation. An annual budget of up to EUR 700,000 (EUR 110,000 minimum) per CD-Lab is financed by PPP-funding, split almost equally between commercial partners (about 50%) and public grants (about 50%).

In 2012, the CDG started the management of an additional funding programme for Josef Ressel Centres. JR-Centres are exclusively established at universities of applied sciences. They basically correspond to the structure and objectives of the CD-Laboratories, with the difference to focus on application-oriented research. Their maximum duration is 5 years (2 plus 3-year phase) with an annual budget of up to EUR 400,000 (EUR 80,000 minimum).

A continuous growth of CDG-funded active research units underlines the successful development of the CDG (see figure 10). In June 2018, 90 active CDG-funded research units (80 CD-Labs, 10 JR-Centres) were supported by public funding and 162 CDG-member-companies. Over the years, more than 200 research units have been supported via the CDG.

Figure 10 Development of the Christian Doppler Research Association



Source: CDG (date 01/2018)

The CDG has passed three evaluations very successfully and can be regarded as best practice instrument for promoting science-industry knowledge transfer in Austria. The recent evaluation of the CD-Labs and JR-Centres (Alt et al., 2016) again shows a very positive picture.

The funding model of the CDG is perceived as flexible and adaptable with regard to market demand and the practical needs of the participating partners.

Long-term funding and intense cooperation in applied-oriented basic research has proven to build up strong research units and highly qualified researchers.

The historical track of the CDG model is a success story also because of its thematically broadening from material sciences towards a wide range of research fields, mostly related to natural sciences and engineering.

The main and most functional features of the CDG-model are:

- CDG is often a nucleus of research collaboration especially for research intensive companies and technological market leaders.
- In questions of front-end research scientists and companies work closely together, creating a mutual benefit.
- A long-term partnership (up to 7 years) enables strategic co-operations.
- Selection and funding of CD-Labs is based on peer review evaluation.
- More freedom for academic research is granted via the CDG-model than in other funding instruments because 30% of overall CD-Laboratory budget must be allocated to independent basic research.
- CD-Labs are opening possibilities for both - mainstream and niche demand for companies, according to the market, which is particularly apt for a small economy like Austria.

1.3.3. BRIDGE

BRIDGE[9] is an initiative with the goal to enforce the link between basic and applied research, also focusing on industrial exploitation. Furthermore, BRIDGE aims to increase the collaboration between science and industrial partners as well as to enhance the mobility of young researchers into industry.

Since 2004/2005 the BRIDGE initiative has followed a bottom-up approach. It funds projects in the field of application-oriented basic research without thematic restrictions. It started as a joint initiative of the Austrian Science Fund (FWF) and the Austrian Research Promotion Agency (FFG) with two programmes: the Translational Research Programme administered by the FWF, and the "*Brückenschlagprogramm*" administered by the FFG. The latter aimed to promote small science-industry consortia, and offered two funding lines: BRIDGE 1 and BRIDGE 2. The scope of BRIDGE 2 was to fund more application-oriented projects and thus to increase the willingness of the industrial partners to taking part in the programme. In 2010, BRIDGE 2 was cancelled because the overlap with other programmes of the policy mix to strengthen knowledge transfer between industry and science was too large. Since 2013, the FFG is solely responsible for the management of BRIDGE and the "Translational Research" Programme was replaced by "BRIDGE Early Phase", designed to build consortia with at least one industry partner involved.

With reference to the stakeholder-interviews it is regarded as a strength of BRIDGE that small consortia can be formed quite easily with just a single project/topic. These BRIDGE-projects predominantly show a character of basic research, that is also why precursors for BRIDGE are FWF projects as well as projects from thematic programmes. In 2017, the total funding volume was almost EUR 11.7 million for 47 BRIDGE projects.

[9] https://www.ffg.at/programme/bridge

A recent evaluation (Kaufmann et al., 2018) shows that BRIDGE still contributes to closing the funding gap between basic and applied research in Austria. Even if there are some marginal overlaps with other funding schemes, following a bottom-up approach, BRIDGE differs from other instruments, such as COMET and CDG, especially in a smaller size and structure. The financial input of max. 20% of the project costs required from the company partner is quite low compared with other programmes. Therefore, the BRIDGE funding instruments are highly appreciated in the research community. Nonetheless, to continue the success of the programme, the evaluation recommends merging the programme lines BRIDGE 1 and BRIDGE Early Phase. The reason for that is that the distinction between these two lines is not clear enough.

1.3.4. COIN Cooperation & Innovation

The objective of the COIN Cooperation & Innovation programme[10] is to promote knowledge transfer by a better and broader transition of knowledge into innovation. Since 2008, COIN has consisted of two funding lines: the COIN "Network" and the COIN "Aufbau" (capacity building) line. Both funding lines emerged from existing programmes. Coin "Aufbau" emerged from the programmes FHplus and prokis, which aimed to enforce universities of applied sciences and non-university research institutions in Austria to engage more in knowledge transfer. In addition, COIN "Network" focuses on networking, encompassing the programmes protecNETplus (having been targeted towards technology transfer), CIR-CE (targeted towards cross-border cooperation) and REGplus (targeted towards regional development by the way of promoting collaborations).[11]

Today the two COIN funding lines can be characterised as follows:

- The COIN "Network" funding line encourages technology transfer within entrepreneurial cooperation schemes, thus raising the level of innovation within businesses and strengthening their cooperation capacities. It focuses on output-oriented cooperation projects to develop and improve innovative products and processes.
- The focus of the COIN "Aufbau" (capacity building) funding line is on building RDI competence and infrastructure at universities of applied sciences and research institutes. COIN "Aufbau" aims at strengthening providers of applied research who are core partners for enterprises in terms of RDI, and increasing the cooperation between applied sciences and companies, especially SMEs.

In 2017, 16 projects were funded with a total volume of EUR 6.1 million. The development of COIN is perceived very positively in the research community. In fact, COIN enables researchers to build up research infrastructure and to enforce especially universities of applied sciences to expand research activities. According to the interviews with stakeholders, in the context of universities of applied sciences, COIN is also seen as a preparation to apply for a Josef Ressel Centre later on.

1.3.5. Research Studios Austria (RSA)

The Research Studios Austria (RSA) programme[12] was launched in 2008. Its objective is to promote the application and implementation of results from pre-industrial research, thus strengthening collaboration between science and industry. For that purpose, Research Studios Austria are small and flexible research units which are usually affiliated to existing institutions. In particular for non-university research institutions,

[10] https://www.ffg.at/programme/coin-cooperation-innovation

[11] See Warta and Geyer (2011)

[12] https://www.ffg.at/programme/research-studios-austria

like the Austrian Institute of Technology or Joanneum Research, but also for universities the RSA programme is interesting to strengthen knowledge transfer.

Research Studios may be established alone or in collaboration with a partner with the aim to translate research results into marketable products and services in a short period of time. The topics addressed have to fulfil several criteria as they:

- Can be converted into marketable products and services in a short period of time,
- Are of importance for the Austrian economy,
- Have the potential to find broad application and
- Enable transition from basic research to application if the companies alone do not have sufficient relevant research expertise and capacity.

In 2017, the funding volume of the RSA programme was almost EUR 10.4 million, promoting 11 new Research Studios in the fields of "Information and Communication Technology for Industry 4.0", "Energy and Environmental Technology" and "Biotechnology". **Since its start in 2008, 54 RSA have been funded**, of which two spin-offs which are still operating today.

1.3.6. AplusB-Centres

The promotion of academic spin-offs has a long tradition in Austria although the topic gained momentum in recent years through the Austrian entrepreneurship strategy "Start-up Country" ("*Gründerland-Strategie*"). Since 2001, the AplusB (Academia plus Business)-Programme[13] has played a central role in the policy mix of knowledge transfer as it has supported innovative, technology-oriented spin-offs from the academic sector. Administered by the FFG until 2017, seven AplusB-Centres were established in which start-ups have been qualified, consulted and coached in order to have optimal start-up conditions. A total of 829 projects were supervised through the AplusB-Programme of which 710 founded a business. Over 3,000 high-quality jobs were created in the new companies.

A recent evaluation of the AplusB-Programme (Ploder et al., 2015) shows that since its inception, the AplusB-Programme has made a significant contribution to raise awareness in the community; the programme has contributed to increase the number of academic start-ups, and that participation in various competitions has raised the recognition of the AplusB-Programme significantly, even at the international level. Nonetheless, it was also evident that there is need for better coordination and planning across national and regional levels, improved profiling and image development for the programme and definition of interfaces with private incubators. That was also the reason why there was a change in administration and profile in 2017.

Now, the AplusB-Programme is administered by the Austria Wirtschaftsservice (aws), renamed as "**aws AplusB Scale-up**"[14]. Based on a call for tenders, incubators are selected to take up the role of an innovation mediator for a duration of five years with the main objective to identify FTI-based start-ups with high growth potential in the academic environment.

Furthermore, the objective of AplusB Scale-up is to mobilize potential founders and to accompany the start-up processes through qualification and individual support. Due to these goals, it is assumed that through the various risk financing instruments of the aws the support for start-ups may be improved in the future.

[13] https://www.ffg.at/programme/aplusb-academia-plus-business

[14] https://www.aws.at/foerderungen/aws-aplusb-scale-up/

1.3.7. Laura Bassi Centres of Expertise

Laura Bassi Centres of Expertise (LBC)[15] are cooperative research centres that facilitate interdisciplinary and/or trans-disciplinary research under the leadership of highly-qualified female scientists. They were designed as a one-off initiative with the scope to stimulate knowledge transfer based on research experience (excellence) and to make the research achievements of highly qualified women visible. Hence, the initiative was launched in 2008, encouraging especially women to apply for the position of research director. By doing so, the Laura Bassi Centres of Expertise are targeted towards the following objectives:

- Research programme with high scientific quality
- Joint research management by partners from science and industry
- Creation of a wide range of career options for female scientists in collaborative research

Total budget (2009-2017) of the programme was EUR 25.5 million. The Centres were designed for a duration of 7 years, each centre having a maximum budget of EUR 320,000 per year.

In 2009, eight Laura Bassi Centres Research Centres were established in the areas of medicine, life sciences, and IT in Austria. From the beginning, the programme was also special as it was regarded as a learning initiative, and therefore the programme was accompanied by monitoring carried out by external experts. The scope was that other funding instruments should also benefit from the experience made in the Laura Bassi programme. Finally, the monitoring report (Heckl and Dörflinger, 2014) confirmed the success of the Laura Bassi Centres of Expertise and made recommendations which elements could be considered also in other funding programmes, whether in the design of new programmes or in the adaption of existing programme structures. This includes the explicit consideration of the topics of management, leadership and personnel development, the explicit consideration and promotion of interdisciplinarity, the selection process (using future potential analysis and focusing on gender) as well as accompanying measures.

In 2013, the continuation of all eight existing Laura Bassi Centres of Expertise was recommended by international peers. At that time, eight female heads of research and around 87 researchers worked in the centres. The programme expired in 2018. As a consequence, some centres continue their work in another way, such as for instance in the thematic research context of a new CD-Lab or a new Research Studio.

1.3.8. Knowledge Transfer Centres and IPR Exploitation

To promote networking among higher education institutions and other main actors in the national innovation system with regard to knowledge transfer, in 2013, the Federal Ministry of Science, Research and Economy (now BMBWF and BMDW) launched a further funding programme: the **Knowledge Transfer Centres and IPR Exploitation**[16] (a follow-up of the former programme called uni:invent). Its primary goal is to fund the commercialisation of research results at universities with a wide range of different partners that go beyond the partnerships already established between science and industry (as for instance via COMET, CD-Laboratories).

[15] https://www.ffg.at/programme/laura-bassi-centres-expertise

[16] https://www.aws.at/foerderungen/aws-wissenstransferzentren-und-ipr-verwertung-modul-1a-regionale-wissenstransferzentren/

Therefore, comprehensive, long-term support services should be built up/provided at universities which also promote spin-offs.

From 2013 to 2018, three regional Knowledge Transfer Centres (East, South and West) and one thematic Knowledge Transfer Centre in the field of Life Sciences have been established. By doing so, all universities in Austria participate at least in one of these Knowledge Transfer Centres via commitment to the performance agreement. Altogether, the funding volume was around EUR 20.1 million for the period from 2013 to 2018. From a policy view the Knowledge Transfer Centres-Programme fits well in the strategy to strengthen knowledge transfer in the higher education sector. In this vein, the recent evaluation (Jud et al., 2017) also shows that many strategic and operational objectives of the programme could be met, since the focus was to strengthen the research community by connecting IP and technology transfer managers from different universities and research institutions. In addition, there was special emphasis of the Knowledge Transfer Centres on promoting collaboration with industry, as for instance through events, information campaigns, etc., and there was some extra money provided for projects that include approaches from humanities, social sciences and cultural studies, and arts in the way of knowledge transfer as well.

1.3.9. Innovation Voucher

The Innovation Voucher[17] is a funding instrument designed to help small and medium-sized enterprises in Austria to start ongoing research and innovation activities. It is designed to encourage SMEs to cooperate with research institutes as the voucher enables enterprises to enlist the services of research institutions and to pay for these services to a maximum value of EUR 10,000. By doing so, it should make it easier for small and medium-sized companies to overcome inhibition thresholds regarding cooperation with research institutions. The programme is administered by the FFG.

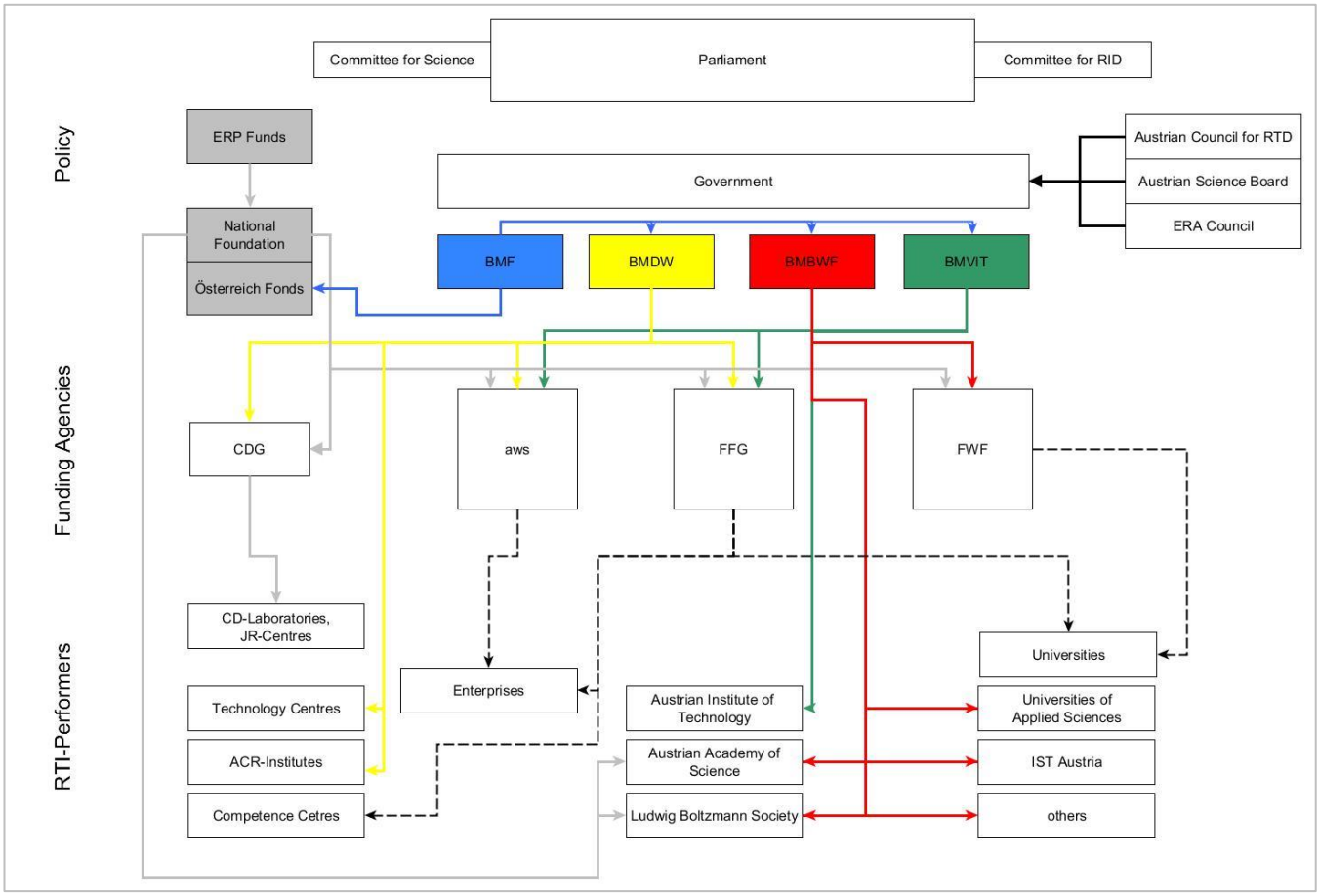
The recent evaluation (Jud et al., 2017) shows that the Innovation Voucher promotes mainly small and not regularly innovating firms. Nearly 70% of companies that use the Innovation Voucher are newcomers to research funding. In addition to companies that are hardly or not experienced in research funding, the Innovation Voucher is also used by companies that are experienced in research funding. In fact, the benefit to these companies to use the Innovation Voucher is, for instance to be able to carry out experiments with new ideas and new cooperation partners, which otherwise would not have been carried out.

[17] https://www.ffg.at/programme/innovationsscheck

2. Governance of the policy mix

With the differentiation of the research funding system, the coordination between ministries, agencies and initiatives has become more important over the years. Primarily, top-down decisions are made for structural changes in the policy mix, while topics within many funding programmes are expected to arise from bottom-up.

Figure 11Governance of the Austrian RTI system



Source: Figure adapted from Schuch und Testa (2018)

The following chapter briefly describes the main actors and funding agencies at the national level, as well as the main institutions of the research system. As figure 11 shows, we will focus on three layers.

2.1. Main actors involved in the design of the policy mix at national level

In Austria, policy on research and innovation is relatively centralised at national level, as regional RTI policies mainly focus on direct funding of applied R&D to enhance science-industry relations, technology transfer and innovation support measures for regional economies (Schuch and Testa, 2018). In the Austrian parliament two committees - the committee for Research, Innovation and Digitalisation (RID), and the Committee for Science -, are concerned with relevant STI policy issues. Within the **federal government**, three ministries are mainly responsible for the federal STI policies and the respective budgets. These ministries are financing and defining the tasks of agencies and public research institutions.

The Federal Government

The **Federal Ministry of Finance (BMF)** plays a key role in the STI-Governance, since all major funding decisions for direct R&D funding programmes must be approved by the BMF. Therefore, the BMF interacts closely with all ministries. Furthermore, the BMF is solely in charge of designing the research tax premium. Besides the BMF, particularly three ministries have a strong focus and budget concerning STI policy issues (including knowledge transfer) within their remits. The **Federal Ministry of Education, Science and Research (BMBWF)** is responsible for the public financing and the policy issues of HEI (universities, universities of applied sciences, private universities) including the promotion of basic research via FWF. The **Federal Ministry for Digital and Economic Affairs (BMDW)** supports innovative Austrian companies, start-ups, industry-science linkages and knowledge transfer between academia and business by means of various funding programmes and initiatives. The **Federal Ministry for Transport, Innovation and Technology (BMVIT)** supports collaborative research as well as thematic programmes in areas like energy, ICT, industrial production technologies, transport or space. The BMVIT has an additional focus on investments in research infrastructures (recently, as for instance additional funds are provided through the "Broadband initiative"[18]).

The federal government is accompanied **by three advisory councils**: the Austrian Council for Research and Technological Development, the Austrian Science Council, and the ERA Council Forum Austria. Following a decision by the Austrian Council of Ministers in August 2018[19], the three councils will be merged in the forthcoming years. The goal is to set up a new advisory body of the Federal Government, according to international status quo, which will also have competence in economics.

In order to increase cooperation between the RTI ministries and to shape the relevant governance structures more efficiently, the **RTI Task Force** has been created in 2011. The objective of the RTI Task Force is to coordinate the implementation of the RTI Strategy at the administrative level, under the leadership of the Federal Chancellery (BKA) in collaboration with representatives of the Federal Ministry of Finance (BMF), the Federal Ministry for Transport, Innovation and Technology (BMVIT), the Federal Ministry for Digital and Economic Affairs (BMDW), and the Federal Ministry of Education, Science and Research (BMBWF).

Ministries and agencies are cooperating in working groups to strengthen the exchange of relevant STI issues. By doing so, one working group was also set up on the topic research, technology and start-ups with a focus on knowledge transfer.[20]

With regard to funding agencies and programmes, representatives of RTI-relevant ministries, agencies and councils are usually engaged in advisory boards of the funding programmes/initiatives, to support the joint development of programmes. Indeed, it's regarded as strength by many interview partners on the governance side that strong efforts are made to balance the funding portfolio by the way which needs are addressed and thus, how programmes are designed.

[18] https://www.ffg.at/Breitband/breitband-austria-2020

[19] https://www.bundeskanzleramt.gv.at/documents/131008/972899/25_63_mrv.pdf/2b02f3d8-09cd-45ee-b9f2-f3cfd8244990

[20] BMWFW-10.070/0031-IM/a/2016

Public Funding Agencies

The previously described funding programmes for STI-cooperation are managed by four funding agencies.

The **Austrian Research Promotion Agency (FFG)** is the national agency for funding applied research and experimental development. Using a targeted combination of funding instruments, which includes both direct support for stand-alone projects in experimental research (through general funding programmes) and industrially oriented structural programmes, cooperation between science and industry is to be strengthened and developed further. In order to achieve a "critical mass" of research in strategically-important fields for the future, also internationally, special emphasis has been placed on specific, thematically-oriented programmes. Some programmes are carried out together with agencies in the federal states, who can benefit from the FFG research funding expertise at regional level. In 2017, the FFG approved in total 3,775 projects with a funding volume of EUR 562.5 million; considering the budget for the national Broadband Initiative, the total funding was EUR 685.4 million (FFG, 2018).

The **Austria Wirtschaftsservice GmbH (aws)** is the federal development bank. The aws particularly supports the transition of technological and social innovations in economic growth and enterprise creation. Activities and instruments are purposely designed to prioritise small and medium-sized enterprises and start-ups. In 2017, the aws approved a total of 5,482 funding applications, mainly for credits and guarantees, with an overall financing volume of EUR 1,145.4 million (aws, 2018).

Both funding agencies aws and FFG were evaluated recently. The evaluation (Bührer et al., 2017) shows that both agencies implemented numerous processes and structures to guarantee a high level of professionalism and service orientation. Further identified optimization potential is currently being discussed.

With regard to the development of Austria's scientific research systems, the **Austrian Science Fund (FWF)** is the central funding agency for basic research. The most important instrument of the FWF is the support for researchers through stand-alone projects. Through targeted projects the FWF also provides financial support for Austrian research centres, to help them compete in the international marketplace for leading researchers and the best ideas. In 2017, 642 projects received funding from the FWF, amounting to a total of EUR 217.3 million. The approval rate of 24.7% testifies the competitive nature of the funding programmes (FWF, 2018).

In contrast to the "classical" funding agencies, which have been established under federal law, the **Christian Doppler Research Association (CDG)** has been set-up as a non-profit association, with a specific and exclusive focus on the funding programmes for CD-Labs and JR-Centres. CDG-member companies participate in the CDG by funding one or several CD-Labs and/or JR-Centres. As a PPP-model the CDG collects and transmits the public (50%) and private funding (50%) directly to the CDG-funded research units. Thus, the CDG is acting also as a public funding agency. The interests of all CDG-partners (business, science, federal ministry) is ensured via quarterly participation within the management board and the scientific board of the CDG. In 2017 a total of 87 CDG-research units (76 CD-Laboratories, 11 JR-Centres) were supported by EUR 26.2 mio. PPP-funding via the CDG.

2.2. The RTI-Performers of the research system

According to the current figures of Statistics Austria, presumably EUR 12.3 billion will be spent on R&D in 2018. In comparison to 2017, the total sum of Austrian R&D expenditure will increase by 5.6% and hence reach 3.19% of the gross domestic product (GDP). The largest part of total R&D expenditure 2018 will be financed by Austrian businesses (approx. 49.5%). The public sector will contribute 34.1%; 15.8% will be

financed from abroad. The funds from abroad originate predominantly from foreign enterprises whose affiliates in Austria perform R&D and also include receipts from EU research programmes.

In the following the main characteristics of enterprises performing R&D in Austria, the higher education sector as well as the main public research institutions will be briefly described.

The business enterprise sector

Manufacturing drives the technological evolution of an economy to a degree far exceeding its relative size in the economy. Most R&D and innovation in Austria is carried out by the manufacturing sector - often in close cooperation with the service sector. This above-average innovation is propagated to the extent that manufacturing drives the growth of productivity in Austria.

Within the EU, Austria is one of those countries with a relatively high share of manufacturing in value added (18.7%) compared with the UK (10.1%) or the Netherlands (12.2%) in 2017[21].

Several Austrian companies are market leaders in specific technological niches. To maintain and strengthen their competitiveness, many of these companies actively participate in numerous research collaborations with academia and research institutions.

In Austria especially the medium-tech industry is relatively R&D-intensive. There was a technological shift within manufacturing in the last decades, which is characterised by a strong increase in medium-tech industries and a comparatively small share of the high-tech segment. Since 1990, manufacturing in Austria has also undergone a successful process of internationalisation which can be seen as an expression of its competitiveness. The driving force behind the long-term success of the business enterprise sector is the ongoing transformation of innovations into marketable products and services. Empirical analyses of the Community Innovation Survey 2014 show that Austria has a good position among the EU member states, especially when it comes to the performance of the Austrian SME sector. The share of innovating firms in Austria is significantly above the average for the EU-28, with a high innovator ratio in all industries.

Universities/higher education institutions

The Austrian higher education system consists of 22 public universities (thereof 15 research universities), 21 universities of applied sciences, 13 private universities and 14 university colleges of teacher education. Almost 80% of all students are enrolled in public universities. Beside the two basic functions teaching (education) and research, higher education institutions have put special emphasis on the "third mission" including knowledge transfer and active commercialisation of knowledge via patents, licenses, and spin-offs. Especially, technical universities play a key role in science-business cooperation. This is also confirmed by a recent study by Büsel et al. (2017), who analysed the co-publications of Austrian research institutions and the top 100 companies in Austria. The results show that the Vienna University of Technology, the Graz University of Technology and the University of Graz dominate the output of industry-science co-publications.

With the **Universities Act 2002** coming into force on 1 January 2004, national STI-Policy has provided **a legal framework for universities to become "entrepreneurial universities"**. However, technical universities had already started to commercialise their knowledge in the 1990s by establishing technology transfer facilities, whereas other

[21]https://www.oecd-ilibrary.org/economics/value-added-by-activity/indicator/english_a8b2bd2b-en

Austrian universities followed then by the UG 2002 in order to institutionalise their knowledge and transfer activities. In addition to boost knowledge transfer, projects and targets for cooperation with industry and to exploit research results are defined in the performance agreements and the Austrian universities receive therefore systematic funding. Additionally, the Federal Ministry of Science, Research and Economy (now BMBWF) has created guidelines on how to use property rights and exploit knowledge in the right way. In 2010, a **national contact point (NCP) for IP**[22] was designated, whose task is the coordination of measures regarding knowledge transfer between public research organisations and the private sector, including tackling trans-national issues. The NCP also focuses on legal issues, as for instance on the development of model contracts like R&D Cooperation Agreements, Patent Licensing Agreements, Sales and Purchase Agreements regarding IP, etc.[23]

Non-university/public research institutions

Due to increased funding of application-based research (business-oriented research) in the past 20 years, also non-university research institutes have shown an expansion[24]. Some of them (like the Austrian Institute of Technology) were re-organized; some, as for instance the competence centres[25] within the framework of COMET, were set up. Many participate in the wide range of programmes targeted towards cooperative research. Besides the universities also many non-university/public research institutions participate in the wide range of programmes targeted towards cooperative research.

The **Institute of Science and Technology Austria (IST Austria)** and the **Austrian Academy of Sciences (OeAW)** engage primarily in basic research. Some CD-Labs are embedded within OeAW-institutes.

The **OeAW** is Austria's central non-university research and science institution, founded in 1847. Its statutory mission is to "promote science in every way". Today the OeAW has over 770 members and 1,600 employees dedicated to innovative basic research, interdisciplinary exchange of knowledge and the dissemination of new insights. The OeAW operates 28 research institutes in the field of innovative basic research in the Arts and Humanities and the Social and Natural Sciences; internationally highly recognized are for instance the institutes for Life Sciences, in particular the Research Center for Molecular Medicine (CeMM), the Institute of Molecular Biotechnology Pioneering (IMBA), and the Gregor Mendel Institute of Molecular Plant Biology (GMI).

IST Austria is a young international institute dedicated to basic research and graduate education in the natural and mathematical sciences, located in Klosterneuburg on the outskirts of Vienna. Established jointly by the federal government of Austria and the provincial government of Lower Austria, the Institute was inaugurated in 2009 and will grow to about 90 research groups by 2026.

The **Austrian Institute of Technology (AIT)** is Austria's largest non-university research facility, mainly engaged in applied research and thus dedicated to topics of the future, such as energy, mobility, the security of critical infrastructure, health and the environment as well as innovation and sustainability research. AIT has about 1,300 employees, and its shares are held by the Federal Ministry for Transport, Innovation and Technology (50.5%) and the Federation of Austrian Industries (49.5%). Unlike

[22] https://www.bmdw.gv.at/Innovation/Initiativen/Seiten/NCP-IP.aspx

[23] https://www.ipag.at/

[24] See BMWF, BMVIT and BMWFJ (2010)

[25] K2 and K1 Centres are set up as independent legal entities and therefore, they are statistically treated as firms. Nonetheless, the COMET Centres belong to the non-university public sector as they perform cooperative research.

universities, the R&D activities of AIT range from taking up emerging technologies, first proof of concepts, applied research to transferring emerging technologies into specific applications up to demonstrators and prototyping. This is mainly done by cooperation with companies or other research institutions.

Joanneum Research (JR), with 450 employees, is also an important provider of innovation and technology with a focus on applied research in areas such as material analysis, health, information and communication technologies, robotics, etc.

The **Austrian Cooperative Research (ACR)** is a network of cooperative research institutes. Via ACR more than 800 employees offer services mainly for small and medium-sized companies (75% of the ACR-clients are SMEs). ACR-institutes are organised as associations or non-profit limited companies with a focus on applied research and technology development. Founded in 1954, the ACR only supports research institutes which fulfil the following criteria: i) non-profit, ii) no basic funding, iii) at least 60% of the activities are provided to SMEs and at least 50% of turnover is performance-based.

The **Ludwig Boltzmann Gesellschaft (LBG)** is also a publicly funded research institution with a thematic focus on medicine, life sciences, social sciences and cultural sciences. Currently, the LBG is running 18 institutes together with academic and implementing partners, thereby also testing new forms of collaboration between science and non-scientific actors like companies, the public sector and civil society.

3. Current trends

Strengthening knowledge transfer has been a clear research policy goal in Austria over the last 20 years. Various successful funding instruments have been developed further and new initiatives have been launched. In the following section, some of the recent developments and newly established funding instruments as well as the motivation behind them will be presented.

3.1. Latest roadmaps, strategies and policy instruments introduced to promote knowledge transfer

In 2015, the Austrian Federal Ministry of Education, Science and Research laid out a comprehensive **university development plan**. It is a strategic policy document designed to create more reliability and transparency in higher education, particularly regarding universities. It outlines which study programmes are offered and where the demand for study places should be steered to in the future. In the current planning period from 2019 to 2024, a major objective is to intensify knowledge transfer.

Universities are an integral element of the entrepreneurship ecosystem. Activities, such as setting incentives to attract new talents, looking for new ways of collaboration and using research infrastructures in cooperation with enterprises have become increasingly important. Thus, new initiatives and programmes have been launched to support entrepreneurship and to provide an appropriate infrastructure for exploiting research results.

The programme **Spin-off Fellowships.**[26] was launched by the Federal Ministry of Education, Science and Research in 2017 and promotes start-up activities of researchers. The objective is to motivate researchers working at academic research institutions to develop research results into a business idea. The programme provides fellowships for

[26] https://www.ffg.at/spin-off-initiative

up to 18 months with a maximum of EUR 500,000 to enable researchers to focus on the exploitation of their research results and to consider a spin-off to be an attractive career option.

The total budget of the Fellowship programme amounts to approximately EUR 15 million until 2019, the funds are administered by the FFG. The design of the programme follows international best practice examples (primarily the idea of the Pioneer Fellowship at the ETH Zurich) [27]. Spin-off Fellowships are also intended as an entry to the AplusB programme, which primarily focuses on the support of start-ups.

Another way to promote entrepreneurship in academia while strengthening collaboration with industry is to provide an adequate interface and therefore to establish an incubator close to excellent research. In 2017 a science and tech based incubator was set up at IST Austria, called the IST Cube. **IST Cube**[28] is funded by the JumpStart programme (administered by the aws) under the responsibility of the Federal Ministry for Digital and Economic Affairs. The main goal of the IST Cube is to direct its researchers towards entrepreneurship. In addition, the IST Cube acts as an investment platform.

Recently, the topic of IPR has attracted increasing attention. The Austrian government set up an **Intellectual Property strategy (IP strategy)** in 2017. Since then, the **Austrian Patent Office** has become an important player in the community. In June 2017, the **IP Hub[29] online platform** was created as a one-stop-shop for intellectual property rights. With currently more than 70 services, the platform is the central entry point for consultancy and funding. In addition, provisional patent applications were introduced, which entitle interested parties to secure their IP at a crucial stage of development at the Patent Office, even if not all formal requirements have been met. “Fast Track” is a new, customer-oriented service in the brand area: in case protection is provided, trademark registration is possible in about ten days. In addition, a new service called “PreCheck” provides a legally justifiable assessment for applicants. Altogether, the measures improve the handling of IP-issues.

New funding instruments designed to foster knowledge transfer are also promoted by the BMVIT. Indeed, the BMVIT has recently invested large sums in specific research facilities to develop individual projects in cooperation with industry. The largest example in terms of funding volume is **SILICON AUSTRIA LABS (SAL**)[30]. The objective of SAL is to build up a research facility, bringing together industry and science for Electronic Based Systems with a long-term perspective which is unique in Europe. Similarly, albeit smaller in size, the BMVIT invests in “Zentrum am Berg”[31], a research centre which works on the topic “safety and risk in tunneling”. The highly specialized infrastructure is regarded as big asset for the Montan University Leoben in starting cooperation with (international) industrial partners.

[27] See also Ecker and Gassler (2016)

[28] https://ist-cube.com/

[29] https://www.patentamt.at/ip-hub/

[30] https://www.feei.at/forschung-entwicklung/silicon-austria

[31] https://www.ffg.at/programme/zentrum-am-berg

3.2. Policy debates with respect to future development of the policy mix for knowledge transfer

Austria has **considerably catched-up since the 1990s** by a substantial increase of public R&D expenditure and private funding of R&D[32] as well. In 2016, the Austrian Court of Auditors analysed the research funding system in Austria and concluded that the research **funding landscape in Austria is highly complex**. Indeed, a large number of actors at the federal and state levels are involved in the promotion of R&D, and there is a big variety of funding programmes, which makes the system complex (except for experienced participants). This critique by the Austrian Court of Auditors caused the main actors like the government, advisory councils and agencies to work towards a better coordination of the instruments.

In 2017, the Austrian Council for Research and Technology Development noted that the output of the Austrian innovation system does not adequately reflect the high volume of R&D expenditure. **The impact of research has to be raised**. Despite the high public expenditure, Austria has not succeeded in closing the gap to the leading innovation economies and is still considered a "Strong Innovator", not an "Innovation Leader", according to the European Innovation Scoreboard. From the council point of view the 3.76% research quota target, defined by the national RTI Strategy will not be met until 2020.

To develop a new national RTI Strategy 2030, the Austrian innovation policy is assessed by the OECD. The current **OECD-review on the innovation policy in Austria** shall provide recommendations for the development of a new STI-Strategy.

The Austrian Council for Research and Technology Development has already made some recommendations which will be recognised in the RTI Strategy 2030. Among these, a main goal is to promote top research in Austria and to strengthen knowledge transfer between basic and applied research, industry and society to a greater extent (RFTE, 2018a). The Federal Government is currently **drafting a law for research funding** [*Forschungsfinanzierungsgesetz*][33], which defines clear criteria for the financing of funding agencies and research institutions. The implementation will be subject to annual monitoring. In order to enhance the reliability of financial planning, 3- to 4-year contracts with the respective funding agencies and research institutions will be concluded.

[32] According to the global estimate 2018 of Statistics Austria, 65.4% of R&D expenditures are financed by the business enterprise sector (domestic and foreign enterprises). Thus, Austria is currently among those (few) countries that will almost meet the EU objective of 1/3 to 2/3 ratio between public and private R&D funding. See also BMWFW, BMVIT and BMDW (2018).

[33] https://www.bundeskanzleramt.gv.at/documents/131008/972899/25_63_mrv.pdf/2b02f3d8-09cd-45ee-b9f2-f3cfd8244990

4. Impact, Synergies and Trade-offs

Austria is a leading country in industry-science collaboration today. This has also been supported by the implementation of various funding programmes for STI-collaboration over time. At the government level, the design of this policy mix has been an interactive process, with constant feedback loops and mutual learning of all actors involved, and with a high sensitivity to contexts and changes over time.

The **policy mix for science-industry knowledge transfer** in Austria also **reflects the country's institutional and structural characteristics**. The Austrian innovation policy in the context of knowledge transfer has favoured a bottom-up approach based on several instruments. This is primarily due to the highly diversified research landscape, where thematic focuses are present but rather small in comparison to larger economies. Austria is also a country with a relatively high share in manufacturing. The manufacturing companies are active in a wide range of markets and activities, with some of them being highly innovative and successful in specific technological niches, sometimes even as world market leaders.

Fostering cooperation between industry and science has always been regarded **as a long-term policy target of the Austrian STI-policy**. Over the last three decades, cooperation between universities and companies has fundamentally improved due to a broad set of interventions and initiatives (such as COMET, CDG, BRIDGE, COIN, RSA, etc.) and improved framework conditions (e.g. Universities Act of 2002). The set-up of the Austrian policy mix for knowledge transfer has followed no specific masterplan so far. Many initiatives have been implemented as a response to specific shortcomings, identified by policymakers/ministries over the years.

With regards to knowledge transfer between science and industry the Austrian STI-Policy offers a **broad and diversified set of funding programmes**. Structural differences between different programmes and initiatives can be characterized by:

- Type of Research (ranging from application-oriented basic research through to experimental development and transfer into the market),
- Duration of cooperation (long-term partnerships like K2 Centres and CD-Labs versus short-term projects like Innovation Voucher and COIN Network),
- Requested input from the participating partners (i.e. a higher share of private funding/input of resources could be a barrier for smaller companies and less experienced researchers),
- Governance and set-up of partnerships (large consortia like COMET K2 Centres vs. smaller focused partnerships like CD-Labs)

Table 1 provides an overview of the main funding programmes in the field of industry-science cooperation according to their characteristics.

Due to similar objectives (cooperation and knowledge transfer) some overlaps between several funding programmes (i.e. COMET, CDG, BRIDGE) seem to be inevitable. So far, the **Austrian Policy Mix with regard to the funding programmes for knowledge transfer/science-industry cooperation** is predominantly **characterized by a diversified structural setting** in terms of duration, funding requirements and governance. Even programmes with a similar focus on research, for instance CD-Labs and COMET, which are both striving for scientific excellence, differ considerably in terms of structure and design and thus address different needs. COMET focuses on the long-term development of internationally visible research networks, while the CDG aims at strengthening research excellence through the establishment of compact, 7-year research collaborations alongside the current scientific demand of individual company partners.

Programmes with low entry barriers are regarded as opportunity to gain experience in STI-cooperation. Sometimes these programmes can provide a good starting point and motivation for the scale up of competences and a further participation in more demanding long-term STI-cooperations. For instance, BRIDGE is considered to be a good precursor for CD-Laboratories, COIN for JR-Centres, and the Spin-off Fellowships for the AplusB Programme.

At regional level, cluster initiatives and the "Innovation Voucher" support SMEs (with little or no experience in STI-cooperation) to get in touch with research institutions.

Overall, the current policy mix in Austria is suitable to **cover a wide range of different needs and demands** of STI-actors in science and business. This was also clearly confirmed in the stakeholder interviews. From the point of view of the interviewed stakeholders, the Spin-off Fellowship Programme closed the last funding gap within a well-balanced programme mix for knowledge transfer.

Additionally, **coordination mechanisms**, like the Task Force at the federal level and specific stakeholder advisory boards at an agency- or programme level were established to raise advantages and to reduce redundancies between the respective funding programmes/initiatives.

To improve the further development of the policy mix, also programme evaluations focus more and more on the systemic position of a programme within the national STI-portfolio.

Table 1 : Main characteristics of selected programmes targeted towards promoting knowledge transfer

Programme		Duration (in years)	Total Budget/ Project Volume	Partners/ Consortium (SP = scientific partner, CP = company partner)	Public Funding	Funding from SP and CP	Additional Information
COMET Competence Centre Programme	**COMET Module**	4	not specified	≥ 1 SP + ≥ 3 CP	80% ≤ EUR 0.5 mio. p.a. federal funding + ≤ EUR 0.25 mio. p.a. provincial funding	SP ≥ 5% CP ≥ 15%	SP-funding: ≥ 5% (≤ 100% in kind) CP-funding: ≥ 15% (in cash/in kind)
	K1 Centre	8	not specified	≥ 1 SP + ≥ 5 CP	40-55% ≤ EUR 1.7 mio. p.a. federal funding + ≤ EUR 0.85 mio. p.a. provincial funding	SP ≥ 5% CP ≥ 40%	SP-funding: ≥ 5% (≤ 100% in kind) CP-funding: ≥ 40% (≥ 50% in cash)
	K2 Centre	8	not specified		40-55% ≤ EUR 4 mio. p.a. federal funding + ≤ EUR 2 mio. p.a. provincial funding		
	COMET Project	3-4	not specified	≥ 1 SP + ≥ 3 CP	35-45% ≤ EUR 0.45 mio. p.a. federal funding + ≤ EUR 0.225 mio. p.a. provincial funding	SP ≥ 5% CP ≥ 45%	SP-funding: ≥ 5% (≤ 100% in kind) CP-funding: ≥ 45% (≥ 50% in cash)
CDG	**CD-Laboratories**	7	EUR 110.000 - 700.000 p.a. (30% scientific freedom for basic research)	1 SP + ≥ 1 CP	Public funding rate for the SP depends on the type of CP LE: 50% SME: 60%	CP = 40-50%	SP: hosting CD-Lab within existing infrastructure CP-co-funding: 40-50% (100% in cash)
	JR-Centres	5	EUR 80.000 - 400.000 p.a.	1 SP + ≥ 1 CP	Public funding rate for the SP depends on the type of CP LE: 50% SME: 60%	CP = 40-50%	SP: hosting JR-Centre within existing infrastructure CP-co-funding: (40-50%; 100% in cash)
BRIDGE		1-3	not specified	≥ 1 SP + 1 CP	Public funding rate for the SP depends on the type of CP SE: ≤ 80% ME: ≤ 70% LE: ≤ 60%	CP ≤ 20%	CP-funding: in kind (uncovered costs in cash)

Programme		Duration (in years)	Total Budget/ Project Volume	Partners/ Consortium (SP = Scientific Partner, CP = Company Partner)	Public Funding	Funding from SP and CP	Additional Information
COIN Cooperation & Innovation	**COIN Network**	1-3	≥. EUR 100,000	≥ 4 CP (incl. ≥3 SMEs)	≤ EUR 500,000/ project Funding rate for participating partner depends on the type of CP (or SP): SE; research institution: ≤ 60% ME: ≤. 50% LE: ≤ 35%	SP, CP: 40-65%	
	COIN Aufbau	2-5	≥ EUR 200,000	-	≤ 70% ≤ EUR 2 mio./ project	SP: ≥ 30%	
Research Studios Austria		4	≥ EUR 400,000	≤ 3 partners (SP and/or CP)	≤ EUR 1.3 mio./ project Funding rate for participating partner depends on the type of CP (or SP): Research institution: ≤ 70% SE: ≤ 60% ME: ≤. 50% LE: ≤ 35%	SP, CP: 30-65%	
AplusB-Centres	**AplusB-Programme**	10	not specified	≥ 1 SP	≤ 30%	SP: ≥ 15%	additional funding by regional authorities main objective: start-up support
	aws AplusB Scale-up	5	not specified	-	70% ≤ EUR 4 mio./ project	30%	
Laura Bassi Centres of Expertise		7	not specified	≥ 1 SP + ≥ 1 CP	≤ 60% ≤. EUR 320,000 p.a.	SP: ≥ 5% CP: ≥ 35%	SP-funding: ≥ 5%; (100% in kind) CP-funding: ≥ 35% (≤ 50% in cash)
Innovation Voucher		1	≥ EUR 12,500	-	80% ≤ EUR 10,000	20%	
Spin-off Fellowships		1.5	EUR 100,000 - 500,000	-	100%	0%	main objective: start-up support

Note: SE = Small Enterprise; ME = Medium Enterprise; LE=Large Enterprise; SP = Scientific Partner (according to the programme SP can be universities, UAS, PRI such as AIT, JR, ACR etc.)

Source: aws, CDG, FFG

5. Implications

Based on desk research and 27 stakeholder-interviews (incl. responsible experts from RTI-ministries, funding agencies, the Austrian Council for Research and Technology Development) within the scope of this case study, the results suggest that the portfolio of the **policy mix for science-industry knowledge transfer in Austria is well balanced**. Within the value-chain of knowledge transfer, the new programme "Spin-off Fellowships" has filled the last gap (direct transfer of academic knowledge into goods and services by researchers) just recently. According to the interviewees, **existing programmes targeted towards knowledge transfer,** such as CDG, COMET, COIN, BRIDGE, AplusB, ACR, etc., **should be continued with sufficient funding while avoiding to overload these programmes with additional tasks.**

The well-established approach of providing programmes with a **bottom-up orientation within many funding programmes has been a major success factor for the strengthening of science-industry cooperation in Austria that successful**. Furthermore, a bottom-up approach seems to be an appropriate instrument in dealing with many current challenges like digitalization.

Concerning the further development of the national innovation ecosystem, the Austrian Council of Ministers has recently proclaimed the strengthening of excellence in basic research, the increase of efficiency, impact and planning security in public STI-funding as important components. Consequently, these issues will also influence the further development of the current policy mix for science-industry knowledge transfer.

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