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SYSTEM EVALUIERUNG

Evaluation of Government Funding in RTDI from a Systems Perspective in Austria

Synthesis Report

Karl Aiginger, Rahel Falk, Andreas Reinstaller

August 2009

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Austrian Institute of Economic Research,
convelop cooperative knowledge design gmbh,
Austrian Institute for SME Research,
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Commissioned by the Federal Ministry for Transport, Innovation and Technology and the Federal Ministry of Economy, Family and Youth

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Karl Aiginger, Rahel Falk, Andreas Reinstaller

Reaching Out to the Future Needs Radical Change

Towards a New Policy for Innovation, Science and Technology in Austria

Synthesis Report

The Summary Report is based on nine special reports

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SYSTEM EVALUIERUNG

Evaluation of Government Funding in RTDI from a Systems Perspective in Austria

A project commissioned by

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bmvit

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Austria Investment Agency and Promotional Bank (AWS)
Austrian Research Promotion Agency (FFG)
Austrian Science Fund (FWF)

Evaluation of Government Funding in RTDI from a Systems Perspective in Austria

Overview of Special Reports

Report	***Work packages***	***Title***	***Authors***	***Institute***
1	WP 1	Framework Conditions	Jürgen Janger Michael Böheim Nadine Grieger	OeNB and WIFO
2	WP 2	Strategic Governance	Gabriele Gerhardter Markus Gruber Simon Pohn-Weidinger Gabriel Wagner	convelop
3	WP 3	Governance in RTDI – Relation between Ministries and Agencies	Sabine Mayer Iris Fischl Sascha Ruhland Sonja Sheikh	KMFA
4	WP 4	Tax Incentive Schemes for R&D	Rahel Falk	WIFO
5	WP 5	Direct Public Funding of RTDI	Sabine Mayer Iris Fischl Sascha Ruhland Sonja Sheikh	KMFA
6	WP 6, 7	Effects of Block Grants on Research Institutes and Universities	Michael Astor Ulf Glöckner Stephan Heinrich Georg Klose Daniel Riesenberg	prognos
7	WP 8, 9	Public RTDI Funding - The Users Perspective	Sabine Mayer Sonja Sheikh Jürgen Streicher	KMFA
8	WP 12	Coherence of the Instrument Mix	Rahel Falk	WIFO
9	WP 10, 11, 13	Intervention Logic – Interaction between Institutions and Actors	Michael Astor Stephan Heinrich Georg Klose	prognos
Synthesis Report		Reaching out to the Future needs Radical Change	Karl Aiginger Rahel Falk Andreas Reinstaller	WIFO

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Reaching Out to the Future Needs Radical Change

Towards a New Policy for Innovation, Science and Technology in Austria

Synthesis Report

Content:

Karl Aiginger, Rahel Falk, Andreas Reinstaller

Reaching out to the future needs radical change

Towards a New Policy for Innovation, Science and Technology in Austria

0. Executive Summary of the Final Report

(1) The Austrian Innovation System has by and large worked quite well in the past. Together with other favourable political and economic conditions, it helped Austria's income and productivity catch up with the most advanced countries by the nineteen seventies. It was instrumental in the following decades as Austria forged ahead relative to the average of the European Union. As a consequence Austria is now one of the top five countries in the EU as measured by income per capita and is ranked among the top ten industrialized countries worldwide.

Complacency is, however, the greatest danger to future prospects. Several strains are now noticeable in the Austrian Science and Technology System which make it necessary to increase innovation efforts, to boost efficiency and to foster radical changes in the innovation system. Challenges come from new global framework conditions (globalisation, EU enlargement, internationalisation of research; see *Jürgen Janger*). We are confronted with intensive competition both from neighbours and Asian countries. Radical change is urgent, specifically as a result of past success; a high-income country has to compete in sophisticated markets and products. Other countries are now moving into Austria's position as medium-tech specialists, deriving their competitive edge by adapting technologies imported from abroad and producing at somewhat lower labour costs. In addition, we see that higher innovation inputs in Austria have not been met by higher market shares and exports specifically in the highest quality segment of fast growing sophisticated industries. The number of firms innovating continuously remains small. Business research expenditure is highly concentrated on a small number of firms. Twice as much business research, as compared to the EU average, is financed by foreign resources in Austria, and multinational firms increasingly source research facilities and capacities at the low end of the spectrum from the globalising world. Maybe the largest challenge to the system stems from an internal weakness: the Austrian innovation system is only loosely interlinked with, and insufficiently supported by, the education system. The gap between human capital available and the demand of firms is increasing at least with respect to the highest education level. More generally and most importantly, innovation and education are separated too much at all levels.

A radical strategic shift in six dimensions

(2) We recommend a radical strategic shift in innovation policy in the following six respects:

From an **innovation policy in the narrow sense** to a **comprehensive innovation policy.** The latter is interlinked with education policy and includes improvements of the framework conditions (e.g. competition, international openness, mobility); while the former only concentrates on the measures and institutions directly involved in science and technology.

From an **imitation strategy** to a **frontrunner strategy**. In a frontrunner strategy firms and researchers strive for excellence and market dominance in niches and high quality segments, increasing market shares in sophisticated industries and technology fields, and in areas or missions of particular relevance to society.

From **fragmented public interventions** to **coordinated** and **consistent interventions derived from a vision** which specifies economic objectives, external and internal challenges and the type of (market or system) failures which call for public intervention.

From a **multitude of narrowly defined financial programmes** to a **flexible, dynamic policy defining broader tasks and priorities.** Some broad technology and research fields important for society (missions) should be defined top down in the vision, but clusters and centres of excellence will grow bottom up, and should be funded sufficiently so as to attain international leadership.

From a **blurred division of responsibilities** between and within ministries (and other "players") to **well defined responsibilities.** Ministries devise sub-strategies for their area of responsibility from the top-level vision, are coordinated on the government level by a high level commission and monitored by a Council for Science, Research and Innovation.

From managing public **intervention by bureaucratic procedures** to **modern public management techniques.** Goals are pursued either by internal competence centres in ministries or by delegation to outside agencies (agencification). Agencies are free to choose instruments and are controlled according to pre-defined output criteria, not by means of micro-interventions.

The report summarises about fifty recommendations for major or minor improvements of the Austrian System of Science, Research and Innovation which will enable a strategy shift and make the system fit for future requirements.

The reference point: an overarching vision

(3) The preconditions of a new innovation policy are i) a commonly shared belief that research, technology and innovation are crucial for the welfare, growth and competitiveness of the Austrian economy and ii) a consensus on the policy changes necessary to increase the effectiveness of Austria's innovation policy to its highest level. Therefore it is necessary to develop a general strategic "vision", which will define the mission and the goals of the Austrian System of Science, Technology and Innovation, including its relationship to the educational system, to societal and economic goals and the framework conditions needed for innovation.

We strongly recommend developing such a strategic "vision" at the highest level of government. It will serve as a reference point for all sub-strategies of ministries, regions, institutions and agencies and thus forms a blueprint for a new science, technology and innovation policy ("New STI"). The vision should be prepared by a team of national and international experts, but finalised and "owned" by the government. It should be put into legislation by parliament and monitored by a "Council of Research, Science and Technology" (see *convelop/Gerhardter*) as an external control. The "vision" has to define the mission and goals of the innovation system, its interaction with the education system, but also to other societal and economic goals. It is the base for all sub-strategies of ministries, regions, institutions and agencies.

Coordination and monitoring: reformed institutions

(4) Implementation of a New STI policy does not end with the creation of a vision but needs consistent coordination between the policy strands defining the new comprehensive innovation policy. We propose to set up a "high level coordination commission" which presses ahead with the implementation of the strategy with the ministries responsible for innovation and education as core members. The chair should rotate between the three ministries. The commission should meet about twice a year. The chancellor, the vice chancellor, and the minister of finance attend every second meeting. The government should be accountable to a new permanent "parliamentary committee for science and technology" (a merger of two existing committees; see *convelop/Gerhardter*). The parliamentary committee should also discuss an annual report of the "Council for Science, Research and Innovation" on the progress of the vision.

Better governance: new role of ministries

(5) The change in strategy calls for a new and better defined role of the ministries in charge of innovation policy. They will devise sub-strategies from the overall vision to implement the vision in their respective areas of responsibility, focusing on the frontrunner position and on links with other policies. They decide which part of the sub-strategy has to be fulfilled "internally" (e.g. (i) linking the innovation system and the education system, (ii) improving the framework conditions), and which part has to be delegated to agencies or institutions. Each ministry should be responsible for the implementation of well defined parts of the new strategy. Their activities should be coordinated by the "high level coordination commission" on research and technology that defines also the goals and milestones for each ministry.

Better governance: increased autonomy of agencies

(6) We recommend increasing the autonomy of the agencies in a process of agencification (e.g. according to the concept of "earned autonomy"; see *Sabine Mayer*). This will require new governance procedures. At the administrative level we need to systematically build up competency to actually manage the agencies and to coordinate the intra-ministerial

processes of policy development. Processes should be implemented that coordinate policy development activities across departments in order to avoid overlaps and conflicting assignments to the agencies. Broad tasks should be delegated to the agencies instead of narrowly defined programmes and the delegated tasks should be monitored according to output goals whenever feasible. For these tasks actual goals and outcomes should be specified. With these in mind the agencies themselves should develop suitable support measures which fit into their overall portfolio. If actual programmes rather than tasks are still delegated, they should be much broader defined and undergo a strict need-based test. The strategic governance level should exercise its control functions via ex ante definition of targets and ex post evaluations of outcomes, and not via intermittent micro interventions. For this process to be efficient new and compatible reporting systems across ministries are needed, as well as within and across agencies.

Changing the track: Switch to a frontrunner strategy

(7) The New STI policy for Austria should be a frontrunner strategy. A frontrunner strategy aims at supporting Austrian firms to achieve and sustain economic leadership through product innovation and productivity growth in niche markets. This requires an increasing number of Austrian companies to build up a winning margin in technological and market competencies over their principal competitors. This can only be achieved through more and more ambitious research and development in the business sector, more and better qualified people, and leading edge scientific research. Education is the driver which enables change in firms and institutions.

Government commitment: ambitious goals for 2020

(8) We support the goals set by the Austrian government to increase research expenditures to 4% and expenditures for tertiary education institutions to 2% of GDP by 2020 (the two numbers should not be added up, since part of the second is included in the first). Europe is trailing the USA and Japan in research, and has set the 3%-of-GDP goal for 2010 without any chance of reaching it soon. Austria as a high-income country should be more ambitious. The Austrian government should take the necessary steps to make available sufficient financial means in the public budgets to finance the tax credit and direct support for R&D, to sufficiently finance university research, and to improve the quality of education and the number of graduates from higher education institutions. Economic growth and competitiveness of a country on the technological frontier according to the EU Commission is defined by (i) a high level of expenditure for innovation and education, (ii) their respective efficiency and (iii) intensive synergies between higher spending and higher efficiency. Since the 2% and the 4% of GDP are only input goals, complementary output goals would be necessary to track efficiency.

In face of crisis: keeping up dynamics

(9) Keeping the dynamics of research expenditures is absolutely necessary. Over the past 10 to 15 years Austrian policy placed high emphasis on this priority, but in these days it is very much contested. Private investment in research will be curtailed in the crisis and this will happen over-proportionally in multinational firms. Empirical evidence shows that research expenditures are highly pro-cyclical; and even more so in Austria. The elections and the deferrals in the budgeting process for 2009 have already delayed spending by public funds and institutions (e.g. FWF, FFG, AWS). Other sources are drying up as the crisis deepens, and public money will be scarce in the further course of the crisis and thereafter. It would, however, be extremely important to keep the dynamics of research expenditures, since this is essential for a frontrunner strategy and for competitiveness in a tough environment. The current expenditure path for the next year is definitely lower than planned and as necessary to arrive at the 3%-of-GDP target in 2010.

A strong driver for more investment into R&D is necessary if the 4%-of-GDP goal is to be reached in the foreseeable future, especially considering the economic constraints in the crisis, since multinationals make a high financial contribution to R&D expenditures in Austria. Total investment in R&D must increase by approximately 8.2% between 2008 and 2020 (in nominal terms) to reach the target of 4% of GDP by 2020.

A new simple tax credit: broadening the base and shifting the level

(10) A frontrunner strategy needs a broader base: a larger number of innovating firms, more firms innovating regularly, more innovative business start-ups, intensified research activities of innovating firms, a larger number of firms locating research facilities in Austria, and more firms cooperating with research institutions. As a driving force for broadening and shifting the level we propose providing a single tax incentive, namely a volume-based tax credit of 12% on R&D expenditures as defined by the OECD's Frascati Manual, including contract R&D. This new tax credit facility should replace all existing schemes. The new scheme would set much better incentives for the vast majority of R&D active firms; it would involve lower compliance costs, and higher planning reliability. It would be simple, transparent and visible.

Deepening and changing the track: the role of direct support

(11) To increase the effectiveness of direct support we recommend (1) reducing the number of programmes (not the money spent) and to allow agencies more discretion in the choice of instruments; (2) defining output goals for agencies rather than input goals; (3) that thematic programmes do not define narrow sub-fields, but allow these to develop and cluster bottom up; (4) basic, open programmes to increase and promote the quality component, to enforce clustering and cooperation with universities, (5) science programmes to support thematic fields if defined in the vision, and to foster cooperation, competence centres, excellence programmes in a bottom up process, if the chance for excellence exists.

Given the overall goals of 4% and 2% of GDP, it is necessary to increase funds for direct support at a rate exceeding GDP growth by far.

We need to move away from a culture where support measures run forever to one where they can end in the wake of positive or negative evaluations. Evaluations should focus on outcomes (target achievements).

Direct and indirect support: building on complementarities

(12) Tax incentives are instrumental in broadening the innovation base which provides the basis for a frontrunner strategy (the "necessary" condition). It is equally or even more important to support the peaks of excellence (the "sufficient" condition). Coherence of the intervention system as a whole crucially depends on the complementary effects of both funding approaches. The mission of indirect support is to foster R&D in general and to make investments in research more attractive than investments in other activities. The mission of direct measures is to promote structural shifts and the deepening of innovation. On this account it should address firms with high innovation and knowledge intensity, innovation in services and innovative start-ups. By focussing on areas of high societal importance it is also instrumental in offering solutions to problems beyond the narrow sphere of the immediate beneficiaries of support. Direct support furthermore enables a learning process, provides information and a certain degree of consulting. It is therefore important for firms starting or upgrading innovation ("changing the track").

Direct and indirect funding instruments are no substitutes for one another – far from it. There is strong evidence that funding effects materialise only if companies make use of tax incentives and also rely on more challenging measures of direct support. This applies especially to successful introduction of true market novelties. In this sense both measures work complementary and complementarities should increase through the reforms.

Higher education: new funding rules and additional research money

(13) The quality of universities, universities of applied sciences and non-university research institutions is a crucial determinant of a frontrunner position. Quality is related to the financial means of higher education institutions and proper incentives. Currently these are not funded sufficiently to ensure a high quality of research or teaching. Incentives do not lead to excellence centres.

We therefore recommend increasing spending for tertiary education to the level recommended by the European Commission (2% of GDP). The current lack of tertiary graduates especially in the field of science and technology is an important bottleneck for industry and academia.

To increase the funding efficiency of tertiary institutions (i) expenditure for research and teaching should be separated, (ii) the funding of teaching at universities should be in line with the provisions applying to the universities of applied sciences, and (iii) additional research money (that should not reduce the funds for the Austrian Science Fund, FWF) should be allocated to universities on the basis of performance criteria. These criteria should also include research co-operations with firms.

Money should be distributed within universities in a more competitive manner (inter alia to persons, and specifically to young scientists, not to institutes). A new tenure track system based on international best practice should be envisaged and career steps in universities should depend on international experience and be under a competitive framework.

The budget of the Austrian Science Fund should be partly used to finance thematic programmes (if defined by the vision). Research infrastructure should be supported e.g. by increasing the overhead costs covered in FWF projects from 20% to 50% (case and performance dependant).

Block grants to non-university research institutions should depend on the existence of a mission and well-defined milestones for academic research and infrastructure.

A career path from apprenticeship to the universities of applied sciences should be developed, marketed and promoted by organisational instruments and financial support.

R&D cooperation between university and industry should be stimulated since radical innovations often arise from academic research and scientific discoveries.

Guiding principles of a new policy: non-exclusivity, learning and mobility

(14) The new strategy should be built on the principles of openness, non-exclusivity and mobility between firms and institutions. Openness for change and drawing knowledge from external sources should be overarching principles in education. Funding and policy decisions should be less influenced by the weight of interested parties, insider knowledge, and *entropy* (defined as the system's non-permeability of the system to information from external sources; see *convelop/Gerhardter*). The system should be open for experiments (e.g. *pilot calls*; see *Sabine Mayer*), and a culture moving from programme based to task based intervention should be established which would make it easier to end programmes. Continuous assessment and external evaluations (by international teams) should ensure that if the economic environment changes the system changes with it. The insiders and users of the current system are not overly critical of it as it is. They complain about administrative costs, but emphasize that they are guided well within the system, probably because direct funding did not dramatically affect their decisions. In comparison the new strategy allows new techniques to be learned, provides information and control and helps with planning. The strategy has to be implemented top down, information has to be gathered bottom up.

Regional, national, European: coordination and agenda setting on all levels

(15) The Austrian research promotion policy should be redesigned and anchored within a multi-level system between the European Union, the federal and regional level. Deficits in coordination and specifically in agenda setting as well as the problem of cross-policies should be tackled. Demand for action exists specifically at the interface to the European level: while

reflux of funds is working excellently (Austrian firms and institutions get more money back than government pays), there is no strategic, active co-design of the STI policy in the European Commission by Austrian authorities.

At the federal level we recommend the integration of further policies like educational, health, and environmental policies.

At the regional level a reorganisation of the one-way communication from the federal level is required. A two-way exchange of information and combined learning as well as possible support from cross-region activities should characterise the new system.

The case for radical change: a task beyond policy borders

(16) Change is necessary, not because the Science, Research and Innovation System in the narrow sense has not worked, but because of new challenges and the new position of Austria as a high-income country. A successful innovation policy for a frontrunner has to be much more comprehensive and needs to interlink with other policies. The system should react to external as well as internal challenges, and to economic as well as societal trends. The changes needed are not minor changes. They need the attention of the top political level and an overhaul of current management and monitoring techniques; they rely on human capital, and build on the quality of the education system.

In addition, we now enter into a critical period in which firms, specifically multinational ones, will reduce research expenditures because of the crisis. At the same time, competitiveness of firms will depend even more on education and innovation in the crisis and thereafter, so that switching from an imitation strategy to a frontrunner position is absolutely necessary.

1. Introduction and Outline

The objective of this study is to analyse whether the Austrian funding system in the fields of research, technology and innovation is "overall healthy" and whether it fits current and future requirements. The underlying assumption of this evaluation is that the overall effects of public intervention cannot be assessed by simply adding up the effects of individual interventions, but accrue through their interplay ("system evaluation"). The project proposes recommendations for major and minor policy change to improve the performance of the innovation system.

The system evaluation did not start from scratch. There are numerous and excellent studies on the performance of the Austrian innovation system. Chapter 2 summarizes the key results of the previous evaluations and adds more recent evidence on the overall efficiency and relative position of the national innovation system. It elaborates on the industry structure and economic dynamics in Austria and discusses the major strengths and weaknesses of policy domains which influence innovation, but which currently remain outside a narrowly defined innovation policy. It further analyses the framework conditions for research and development (summarising one of the special reports).

In chapter 3 we outline the main results of the other eight special reports. Since the special reports were written by researchers from different scientific fields, in different institutions and from different countries, the individual reports present a broad variety of methods and rich results. These were brought together through effective project management and continuous dialogue. With the help of the commissioning ministries, the stakeholders and the experts, the team arrived, in principle, at a common understanding of the Austrian innovation system and the recommendations were shared by all partners of the evaluation team. Different emphases remain and they were by intention not eliminated in the specific reports. In this section of the Summary Report we concentrate on the main analytical results of the special studies and the broad policy lines, but not on specific recommendations.

Chapter 4 presents the major and minor recommendations. They are based on the results of studies available previous to this evaluation, on new results from international benchmarking, some recent empirical observations and above all on the nine special reports. The summary report was prepared by the team of the lead institution (WIFO). It was intensively discussed and the results are therefore in general shared by the other team members. Despite an overall feeling that the innovation system in the narrow sense by and large has been working quite well and is accepted by its users, a need for change was nevertheless identified. We recommend such an agenda because any system can be improved. We point out options for change to reflect new economic and technological challenges, while bearing in mind that innovation is becoming ever-more important for growth, competitiveness and employment and that innovation policy is closely intertwined with other policy fields.

The key messages are summarized in the Executive Summary, and we entitle it "Reaching out to the future needs radical change: Towards a New Policy for Innovation, Science and Technology in Austria". This title should signal the need for change, in particular with regard to the current economic development.

Throughout the report, the word "innovation" is generally used as an umbrella term for science, technology, research, development (and innovation) ("S-T-I-R-D"). It spans the wide area from basic to applied research and technological development and even encompasses non-technical and societal innovations. If necessary we specify which part of S-T-I-R-D is referred to. We come up with a strong plea for a comprehensive innovation policy which pays much closer attention to the framework conditions for innovation, and in particular, to various aspects related to human resources.

The System Evaluation was jointly commissioned by the Federal Ministries of Transport, Innovation and Technology (BMVIT) and Economics, Family and Youth (BMWFJ)[1]. It was carried out by a working group from four institutions: KMU FORSCHUNG AUSTRIA, prognos, convelop and WIFO (lead). Twenty researchers in total authored nine in-depth reports assessing Austrian government funding in Science, Research, Technological Development and Innovation from a systems perspective. Other colleagues provided research assistance, revised manuscripts, and actively participated in numerous discussions and workshops. Ten international experts provided valuable advice and last but not least the clients themselves and a wider circle of policy makers, ministries and other stakeholders were very much involved in the process of ongoing feedback.

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[1] Due to some internal re-organisations the Ministry is split in the meantime, the domain of Economics is now administered under the same roof as Family and Youth agendas.

2. Existing Evidence on the Austrian Innovation System

2.1 Overview on past studies and recommendations (Andreas Reinstaller – WIFO)

Influenced by the goals set out in the Lisbon Agenda of the European Union, enhancing growth through more innovation has become a priority for Austrian policy makers in recent years. This has led to some important changes in the Austrian Innovation System that have been analysed by a large number of national and international studies. The aim of this section of the report is to give a concise overview on the principal findings and recommendations of previous studies and assessments of the Austrian Innovation System.

Austrian performance in productivity growth and innovation

The OECD has repeatedly assessed Austria's growth and employment performance as good and above average. In the years proceeding the economic crisis of the year 2009 Austria's real GDP growth has exceeded the Euro area average. However, Austria's performance has fallen behind that of other advanced OECD countries such as the Nordic countries. At the same time the unemployment rate was one of the lowest in the European Union and until the middle of the year 2008 inflation was moderate. Austria is therefore considered to be one of the most economically advanced countries in the OECD (*OECD 2005a, OECD 2007a*). In a number of studies it has been argued that this position was achieved with relatively low R&D spending by raising productivity while at the same time preserving a relatively high employment rate (see *OECD 2007a* and *Aiginger et al. 2006*). This catching-up strategy was implemented by

- modernising the country´s industrial structure which in the post-war period was dominated by large state-owned enterprises in heavy industries, and
- by raising productivity largely through capital accumulation and improving the skill level of the workforce while keeping wage levels lower than in Austria's main export market Germany. The improvement of the skill level of the workforce was achieved mostly through the improvement and expansion of secondary schooling and vocational training.

Peneder (2001) has shown that Austria's industrial structure is biased towards medium-tech sectors. However, thanks to the highly-developed skill base, Austrian firms have been able to adopt and modify new technologies, which in the majority of cases had been developed abroad. This is reflected in the fact that Austria has been and remains a net importer of R&D intense industries (*OECD 2007a*). Furthermore, medium-sized Austrian firms are very successful in niche markets, where some of them operate close to the technological frontier in terms of products or processes. However, statistically they belong to sectors, which are not classified as high-tech (*Tichy 2001*). It has been argued that the slowdown of total factor productivity growth (TFP) in the years between 1980 and 2000 is associated with the exhaustion of the growth potential of this growth regime as the technological potential of the country moves closer to the technological frontier (e.g. *Gnan – Janger – Scharler 2004*). As a result, the OECD and also the Austrian Institute of Economic Research (WIFO) in its White Paper have called for an improvement of the innovation potential of the Austrian economy by developing the technological profile of the Austrian economy towards more technology and knowledge intensive fields (*OECD 2005a*, *OECD 2007a*, *Aiginger et al. 2006*).

Despite its industrial structure, Austria has experienced a distinctive increase in R&D spending over the past decade. This process was supported and accelerated through the Lisbon Agenda in the year 2000 that has received much attention by the political establishment and policy makers. Especially the Barcelona 3% target has shaped much of the political debate. Structural reforms of public funding of R&D and the redesign of the fiscal incentives for R&D in 2000 and 2002, as well as the expansion of R&D spending by foreign owned firms since the mid-1900s have contributed to this development (*OECD 2005a*, *OECD 2005b*). In the 1990s Austria's R&D intensity lagged behind both the EU 15 and the OECD average. Nowadays, it is larger than both. Down from 1.36% (EU 15: 1.89%, OECD: 2.25%) in 1990, it has reached 2.46% in 2006 (EU 15: 1.89%, OECD: 2.26%), and increased further to 2.63% in 2008. In this period R&D investment in Austria has grown much faster than in most other countries in the EU and the OECD. Notwithstanding the general praise, Austria has earned for this development, different reports have voiced concerns as to the viability of this fast growth of R&D outlays. These concerns are mostly related to

the concentration of R&D spending across sectors and the high share of business R&D under control of foreign owned firms,

the insufficient start-up activities and entry of innovative firms,

weaknesses in the educational system and in university research,

lack of competition in specific business areas.

The sector that has contributed most to the fast expansion of R&D spending in the past two decades in Austria was the business sector. The share of total R&D performed by the business sector has grown from 55.8% in 1990 to 70.4% in 2006. However, the share of total R&D financed by the domestic business sector has remained largely below average. In 2006 only 48.4% of total R&D was financed by the domestic business sector, whereas the figures for the EU 15 and the OECD were 55.6% and 63.9%. The cause for this deviation is the high share of total R&D expenditures in Austria was funded from abroad. It rose from 3.78% in 1990 to a peak level of 19.86% in 2000 and went down to 18.41% in 2006. In that year 23.9% of business R&D was financed abroad, whereas the EU 15 average was 10.03%. This expansion of international R&D activity in Austria is to a great extent related to the take-over of Austrian firms by foreign enterprises in a small number of sectors (*OECD 2005a*).[2] The internationalisation of Austrian business activities has increased the variety of the R&D portfolio of the Austrian business sector only marginally. Inflows and stocks of foreign direct

[2] Some authors stress that this concentration makes Austrian business R&D vulnerable to the relocation of R&D activities. It is enough that a few R&D departments of foreign owned corporations relocate to induce a drop in R&D expenditure (*Janger 2005*).

investment (FDI) have generally been below the EU 15 average. The Austrian figures are also below the levels observed for countries with similar size and level of economic development such as Sweden or Denmark. Possible causes for this pattern of internationalisation are unfavourable and restrictive FDI regulations that limit FDI inflows (*OECD 2007a*).

Another concern on the viability of the fast growth of R&D outlays is related to the creation and growth of innovative firms in Austria. Business start-ups and the entry and exit of technology-oriented, innovative firms into existing industries are important sources for the adoption of new technologies and of structural change towards more technology intensive sectors. The evidence shows that firm creation in Austria is average in international comparison. However, new businesses are generally not very innovative as about 80% of all market entries are by one person firms which typically are neither very technology intensive nor do these firms employ very sophisticated business or management models (*Hölzl et al. 2006*). As a consequence post-entry performance remains dismal and new firms hardly grow. The contribution of Austrian start-ups to a structural change towards a more technology intensive industrial structure is therefore limited. A number of indicators suggest that on of the likely causes for this pattern are high administrative costs, the duration of procedures to start up a company, and the minimum capital requirement to start up a limited company (*World Bank 2009*). Another reason for the unsatisfactory firm creation performance of the Austrian business sector may be related to the relatively limited supply of venture capital in Austria. Measured as a percentage of GDP venture capital investment accounted for 0.045% in 2005, whereas the EU 15 average was 0.112% (OECD: 0.124%). Three quarters of VC funds were made available for the expansion phase of small firms (*OECD 2007b*). The limited supply of venture capital may also reflect limited demand. The number of technology intensive firms and start-ups is relatively limited in Austria. Technology intense start-ups that relying on venture capital in the pre-seed, seed and expansion phase may therefore find conditions in Austria unfavourable.

Another factor that may seriously hamper the expansion of R&D intensity and the efficiency of R&D investment in Austria in the near future is the availability of highly educated personnel. The share of researchers in relation to total industrial employment is low in the Austrian business sector if compared to other countries of similar size and level of development (Austria 2007: 10.54 per 1000 employment in industry; Denmark 2007: 15.57 p.t.e., Sweden 2007: 20.16 p.t.e.). However, the demand for researchers has grown at a similar pace as R&D investment. In the business sector alone the employment of researchers has increased by 28% from 26728 to 34126 in full-time equivalents between 2002 and 2006. The same increment was measured for the higher education sector over the same period (*Statistik Austria 2008*). Even though one should expect that this dynamics will be dampened as a consequence of the economic crisis of the year 2009, employment forecasts to the year 2012 indicate that the demand for graduates with tertiary education in research professions will grow faster than other employment categories with the demand of S&E graduates growing the fastest (*Fritz et al. 2008*). However, the available empirical evidence suggests that the tertiary education system is not supplying enough graduates to satisfy the growing demand in the Austrian Innovation System. In 2006 the share of working age population that has attained a tertiary education was 18%, whereas the OECD average stood at 27%. Austria falls also off the OECD average in the share of tertiary A-level graduates in the typical age cohorts for tertiary education that should successfully complete education. In Austria the figure is just slightly above 20%, whereas in the OECD it is close to 40%. Dropout rates have been high as well, although recently this indicator has improved (*European Commission 2006*, *OECD 2008*).

These problems are partly related to deficiencies in the secondary educational system. The expenditures per pupil in primary and secondary schooling rank among the highest in the OECD the performance of Austrian pupils was not in the top ranks even though they scored above the OECD average in a statistically significant way (*OECD 2008*). In addition to this, the secondary educational system is characterised by a high level of social selectivity and intergenerational persistence. The differentiation of students on the basis of the chosen school type takes place at relatively young age. It is strongly related to the social background and educational attainment of the parents. Students are likely choose intermediate vocational schools if the educational attainment of their parents is low, conversely students are more likely to choose academic secondary schools if their parents' educational attainment is high or if they come from a wealthier background. The variation of performance across school types is also very high (*Bock-Schappelwein et al. 2006*, *OECD 2005a*). The academic secondary schools score significantly above intermediate vocational and general secondary schools in the PISA exercises. The strong vocational bias of the Austrian secondary school system leads to very low graduation rates from upper secondary schools designed to prepare students for tertiary education. In 2006 in Austria only 40% (OECD: 60%, Finland: 95%) in each age cohort of each age group graduated from these schools and basically all choose tertiary A-level education afterwards (*OECD 2008*).

As competition is an important driver for innovation, restrictive product market regulations can slow down innovation by restraining the diffusion of new products and best practice production techniques within the country and across borders.[3] Austria has broadly followed the OECD-wide trend toward more liberal product market regulations. In line with EC directives it has opened up network industries, such as telecommunications. This has reduced prices and increased productivity. Overall, the OECD economy-wide product market regulation indicator suggests a middle of the road position. However, regulations in service sectors remain restrictive, in particular in retail (licenses and permits, opening hours), liberal professions and railways (*OECD 2003, 2005a*). These regulations reduce productivity not only in the respective sectors, but also in sectors, which are economically linked with the regulated sectors. In times of rapid technological change, as since the 1990s, the detrimental effect of restrictive product market regulations on the diffusion of innovation, including Information and Communication Technologies (ICT), is particularly large (*Conway et al. 2006,*

[3] For recent surveys of the literature on the relationship of competition and innovation see Gilbert (2006) and Böheim (2004).

Conway – Nicoletti 2006a, 2006b). Austria has made some steps to reduce barriers in service sectors, but much more remains still to be done, also keeping in mind that many other countries are moving ahead quickly in this area. As a result, Austria may still benefit much less from general purpose technologies than countries with less restrictive regulations (*Leibfritz – Janger 2007*). General competition law and policy have lagged, as shown by the new synthesis indicator that places Austria at the bottom end of the OECD countries (*OECD 2007a*). By the 2002 amendment of the antitrust and competition legislation, the structure of Austria's competition institutions was finally levelled to European standards more than seven years after Austria has joined the European Union. However, some specific arrangements weaken enforcement (*Böheim et al. 2006*).

Challenges for government support and governance of STI policies

The Austrian Federal government has endorsed the Barcelona 3% target and as a consequence over the past decade R&D promotion has been strengthened. This was accompanied by several major reform initiatives targeting the funding agencies and fiscal incentives. In the past ten years the business enterprise R&D (BERD), financed by the government, has risen from 5.6% in 1998 to 9.6% in 2006 (in absolute terms: €472m). This figure lies above both the EU 15 and the OECD averages for the year 2006 of 7.1% and 6.8% respectively. The Austrian development does also not follow the general trend in the EU 15 and the OECD for this indicator where the shares of government-financed BERD have fallen from 14 and 15% in 1990 to the levels indicated above. In Austria the level was initially much lower (1990: 5.6%) and remained relatively stable until 2002 and started to rise towards the EU 15 and OECD levels in the years that followed.

Austria supports R&D through direct support measures and through fiscal incentives. The fiscal incentives consist of two types of tax allowances (one for the definition of R&D expenses following the Frascati manual and one for "economically" useful inventions) and a tax credit (also based on the definition of R&D expenses by the Frascati manual). These fiscal incentives were quite generous compared to international standards and guaranteed a gross rate of tax subsidy for 1 € of R&D between eleven and twelve percent. However, the reform of the corporate income tax rate in 2005 reduced the generosity of the fiscal incentives to values slightly below 9% which is almost identical to the gross rate of tax subsidies granted on average across the EU 15 member states. The volume of tax allowances claimed has been close to €500m in 2001 (at constant prices) and has declined later to €197m in 2005 (at constant prices). After the introduction of the tax credit in 2003, more and more firms switched to this source of funding and the grants claimed in 2005 amounted to €190m (at constant prices).[4] Fiscal incentives are generally preferred in the economic literature as they do not distort incentives to conduct R&D. They are also thought to imply lower administrative burden for both corporations and the government than direct support measures.

[4] All the reported figures are drawn from *Falk et al. (2008)* which present results of the current system evaluation which will be discussed later in this report.

Nevertheless, tax incentives may also involve deadweight loss. They may subsidise investments that firms would have carried out anyway. As the system of tax incentives has been evaluated for the first time in the evaluation summarised in this report, little prior evidence on the effects of tax incentives in Austria is available. However, the OECD has criticised that the lack of transparency of the current legal arrangements. Firms have to choose their optimal tax regime among three options. This is likely to increase compliance costs to firms and therefore affect particularly small firms negatively (*OECD 2007*, p. 115).

The largest share of direct support for R&D is channelled through three funding agencies. The three principal funding agencies are the *Fonds zur Förderung der wissenschaftlichen Forschung* (FWF) that focuses on funding academic research, the *Forschungsförderungsgesellschaft* (FFG), specialised in funding applied industrial research and the cooperation between the higher educational sector and industry, and finally the *Austria Wirtschaftsservice* (AWS) that is mainly active in support programmes for SMEs. The actual cash value of support measures of these three agencies all in all amounted to €561m in 2007 (FWF: €163m , FFG: €249m , AWS: €149m). These figures conceal that support measures also include letters of credit and other commitments such that the total volume of support measures is also larger. The principal agencies administer a large number of direct support programmes.

A reorganisation of the system of direct R&D support was carried out in the aftermath of a major evaluation (*Arnold et al. 2004,* for a short summary *Bundesministerien 2004*) that was critical of the proliferation of R&D funding institutions that had taken place since the Research Promotion Act of 1967 came into effect.[5] It is generally acknowledged that these structural reforms have successfully reduced the institutional fragmentation of the system of direct support for R&D in Austria (*OECD 2005a*). However, there is a general agreement among innovation scholars and policy makers alike that the proliferation of direct support programmes has been excessive. There are about 120 different schemes in operation. An advanced economy needs a differentiated set of support instruments, however it is often argued that the large number of support schemes make coordination across agencies and within agencies difficult and costly. There are also overlapping programs that often have a subcritical scale with little impact and high cost (*OECD 2005*). Some studies have therefore stressed the need to put in place an appropriate portfolio management within and across agencies that could contribute to increase the coherence and efficiency of direct support measures (*Jörg 2005*).

In addition to the fragmentation of support measures a number of other issues have been raised concerning the granting procedures of the agencies themselves. It has been criticised that grants are often allocated to projects arising from routine innovation activities of firms. This increases the risk of deadweight loss and reduces the efficiency of scarce R&D funds. The generally low risk profile of funded projects also supports more incremental innovation and

[5] *Pichler—Stampfer—Hofer 2007* and *Jörg 2005* give detailed accounts on the historical evolution of the Austrian funding system.

therefore does not support structural change. Hence, the way agencies grant R&D funds selects against risky, but potentially more significant innovation projects with a higher impact on the business sector performance. Despite the conservative grant awarding approach numerous evaluations of Austrian grant programmes suggest that they significantly increase the recipients' R&D investments. However, it has been argued that evaluations are more conceived as a tool to legitimise existing programmes rather than using them as a vehicle to improve them (*OECD 2005a, European Commission 2006*). In the majority of cases they have little or no impact on the design or the continuation of a programme.

The development of the principal funding agencies and their programmes to some extent reflects the institutional set-up and the related deficiencies in the governance of STI policies. There are three major ministries in charge of STI policy (Federal Ministry of Economy, Family and Youth, BMWFJ, the Federal Ministry of Transport, Innovation and Technology, BMVIT, and the Federal Ministry of Science and Research, BMWF). In addition to them, the Ministry of Finance also plays an active role in monitoring the allocation of public spending and participates in the design of new programmes. The Austrian Council for Research and Technological Development (Rat-FTE) was created in 2000 with the mission to act as an advisory body to the government. A second advisory body is the Austrian Science Board that advises the Ministry of Science. The two funding agencies FFG and the AWS are under control of the BMWFJ and BMVIT, whereas the FWF is under the control of the BMWF. This set-up has been criticised on several grounds. The fragmentation of competencies reduces the cost-efficiency of support measures and leads to a high burden of coordination between the ministries and consequently hampers the development of coherent policies. On the other hand, there is also a competition amongst ministries to develop new measures often tied to specific units within ministries. The ministries do not only design the policies and control their implementation via their ownership function in the agencies, but they also actively intervene into the operational implementation of new programmes. It has therefore been suggested that the division of tasks between the agencies and the ministries should be clarified and that ministries should focus on strategy whereas the agencies should focus on implementation (*OECD 2007a*). To date no steps have been taken to reform governance along the lines of these suggestions. Despite the important integrative process that followed in the aftermath of the evaluation of the major funding agencies in 2005 the streamlining of governance beyond the reorganisation of the institutional landscape has not made any significant progress (*te Velde 2008*).

The Austrian Council for Research and Technological Development (Rat-FTE) was established in 2000 as an independent advisory body to the government. As the allocation of "special funds" by the Ministry of Finance was made conditional on a recommendation of the Council it was at first very influential and helped to bring change into the system. With its recommendations it also influenced the decision to carry out the first major evaluation of the Austrian research support system that triggered the reorganisation of research funding discussed above, and it supported the implementation and expansion of the competence centre programmes (now COMET). However, unlike the research councils in other countries it is no high-level government body. It has no formal decision-making powers and its recommendations are not binding for the government (*OECD 2007a*). Its influence l therefore depends on the goodwill of the Ministry of Finance and the government to commit itself to follow its advice (*te Velde 2008*).

It has been argued that the development of these governance structures is related to a lack of political leadership. *Jörg (2005),* for instance, argues that Austria's STI policy system lacks strategic focus and needs a centre of gravity and a referee function for supervising the allocation process and imposing a common point of reference for innovators and policy makers. Given the fragmentation of governance and the ambiguous role played by the research councils, there is a agreement amongst experts and stakeholders that the lack of clear political leadership is a principal problem. Innovation policy takes mostly place at the level of government officials, stakeholders and the agencies (*te Velde 2008*), whereas the processes taking place at the EU level mostly determine strategy formulation. The only legally binding strategy document that has been discussed and approved by parliament is the National Reform Programme, which even in its revised form of fall 2008 is too general to serve as a guideline for STI policy development.

Recommendations given in previous studies and evaluations

Based on the findings reported in the previous sections studies and evaluations of the Austrian STI system have devised recommendations for making innovation policies more effective. We will provide an overview on the principal lines they have followed. This short summary will draw on the OECD Economic Survey reports of the years 2005 and 2007, the WIFO White Paper of 2006 and the CREST Peer Review report of 2008. It is focused on the recommendations pertinent to principal challenges identified in the previous section.

Develop a long term vision and justify the overall targets better The CREST Expert Group Report that has been carried out as a principal activity of the Austrian Research Dialogue in 2008 has observed that Austrian politics *lacks both "a shared, holistic vision and a coherent set of public policies to stimulate the development of the entire R&D and innovation system"*.[6] It has also called for a "*cogent narrative explaining why a 1% target for 'basic' research makes sense for Austria*", and to consider benefits and costs of as well as alternatives to a technology policy focusing on high tech industries (*CREST 2008*). The report has also suggested the government should *reconsider the role played by the two Parliamentary Committees concerned with STI policies* as consultative inquiries and obligatory governmental responses could have a positive impact on quality of policy formulation.

Simplify the institutional framework conditions for STI-policies The CREST review team has also observed that the current degree of complexity of the Austrian STI-system may be an obstacle to major structural reform. The experts suggested that the "*autonomy of the agencies and the separation of responsibilities between ministries and agencies could also*

[6] The Austrian Research Dialogue was a series of events that focused on the future of Austrian research policy. It was organised by the Ministry of Science and Research.

be revisited". In line with other reports on the Austrian Innovation System (e.g. *OECD 2007a, Leo et al.2006, Jörg 2005*) the CREST review team has suggested that *funding agencies should be given control over programme design and implementation, whereas the ministries should exercise control through their ownership function*. The experts also concurred with previous recommendations that the *strong fragmentation of programmes should be improved through better portfolio management* based on better strategy formulation processes.

Streamline the governance of STI-policies Several expert reports have called for a clarification of STI-competences across ministries and for a better co-ordination of innovation policies across levels of government. The OECD Country Survey of the year 2007 (OECD2007a) for instance suggests that the responsibility for specific *innovation policies should lie within a single Ministry*. Along the same line the WIFO White Paper has also called for a reorganization of STI agendas into two ministries, where one ministry should be responsible for technology and innovation policies and the other should be in charge of science policies. In addition coordination mechanisms should be put in place that support the development of coherent policy that reach beyond the mission of single ministries (*Leo et al. 2006*). The OECD country survey for 2007 has called for advising bodies and the ministries involved in innovation policies to broaden their perspective by also considering the impact of general framework conditions on innovation, such as the availability of human capital, financial constraints and product market competition (*OECD 2007a*). It has also been suggested that the roles of the Council for Research and Technology and the Science Council should be clarified. However, whereas the OECD suggests to merge the two bodies (*OECD 2007a*), the CREST review advocates cross membership of Council Members in the two Councils to better coordinate actions.

Ensure efficiency of innovation subsidies The CREST review team has warned Austrian policy makers that "*the widespread dependence of firms on public support for R&D and innovation [...] could stifle innovative behaviour and encourage a 'subsidy culture'* " (*CREST 2008*). It has called for a re-examination of the "*wisdom of maintaining support levels across an extremely broad spectrum of technology areas and industrial sectors*" as resources should be diverted to key areas of strategic relevance to Austria. International reviewers have also called for changes in the programme portfolio: The CREST experts have suggested that policy makers should think about combining R&D support measures for single firms with programmes that support collaborative R&D in the business sector. The OECD in turn has proposed to reconsider the use of direct R&D support funds and "*enhance generic technology development programmes and university-industry cooperation at the expense of direct bottom-up firm support while avoiding giving undue emphasis to specific areas or sectors*" (*OECD 2007a)*. It has also suggested to *strengthen the links between public research centres and the business sector to ensure diffusion of innovation* generated in public research. While in several reports it was acknowledge that programme evaluations are carried out regularly, the CREST review team recommended Austrian policy makers *to develop mechanisms that evaluation results inform future policy and practice better* (*CREST 2008*). As for direct R&D

support measures, evaluation should be extended to tax expenditures in order to establish the relative benefits of direct subsidies and tax concessions (*OECD 2005a, Leo et al. 2006*). Both the OECD country report of the year 2005 and the WIFO White Paper have called for a simplification of the tax support system for R&D due to the fact that three different schemes increase search costs and the administrative burden for firms.

The CREST review team has also identified a policy gap in terms of demand-side policies designed specifically to nurture an innovation–friendly economic and market environment by increasing the absorptive capacity of the economy for innovative goods and services. Innovation-friendly procurement policies that could fill this gap (*CREST 2008)?*

Improve human capital development Several studies identify the supply of highly qualified human capital development as a crucial problem and therefore call for action. For this reason the CREST team has called for more efforts to be put into making careers in science, engineering and research attractive to schoolchildren and to encourage women and immigrants into this area. It also underscores that greater investment is needed in education generally and for the provision of PhD and Post Doctoral places in particular (*CREST 2008*). The OECD has come to a similar conclusion (*OECD 2005a, OECD 2007a)*. The WIFO White Paper (*Bock-Schappelwein et al. 2006*) has also proposed a bundle of measures to limit the social selectivity of the secondary educational system which negatively affects the supply of top level human resources as too many young people are channelled towards vocational career paths. On the upper end of the educational system the OECD calls for an improvement of the quality of tertiary education. One way to achieve this would be *to give the universities the right to select their students* (*OECD 2007a*).

Improve conditions for start-up firms Different reports have pointed to unfavourable conditions prevailing for business start-up firms. The WIFO White Paper (Hölzl et al. 2006), the CREST Report (*CREST 2008*) and the OECD (*OECD 2005a, OECD 2007a*) concord in their recommendations:

The cost of firm creation, including minimum capital requirements, should be reduced and administrative procedures simplified. At the same time the costs of closing down a business should be reduced.

There is the need to review of the supply of venture capital. The lack of of early-stage venture capital calls for policies to improve the availability of private equity. Restrictive investment rules with respect to venture capital should be relaxed. Rather than giving tax preferences to a particular legal form of investment funds, equity and venture capital participations should be made subject to roughly the same tax regime with low taxation of the returns across all types of investors, including business angels and partnerships.

The range of trades requiring certificates of qualification to set up a business should be further narrowed. Certification of qualification should be associated with employees rather than owners.

University reforms should proceed further Most studies on the Austrian STI system call for a continuation of the reforms of the higher education system. Starting with the 2002 University Organisation and Studies Act (UOG 2002) and the European Bologna Process Austrian public universities have begun to implement wide-ranging reforms. Part of these reforms concern the funding that is now related to performance indicators. As excellence is still a marginal phenomenon at Austrian universities (*Hölzl 2006b, Reinstaller—Unterlass—Prean 2008*) attention needs to be given to implement measures in order to raise the quality of research. The OECD has therefore suggested that in the specification of the budget *preference should be given to output related indicators over input-related ones* (*OECD 2005a*). However, the CREST peer review report has underscored that the targets set in negotiating the "*performance contracts need to be more ambitious in the future if excellence is to be engendered in the system, with rewards (and penalties) in the shape of future funding levels keenly tied to target attainment*" (*CREST 2008*). The WIFO White Paper in turn has suggested that in order to foster the scientific excellence of universities *competitive funds for basic research should be expanded*. Universities should also try to *differentiate their research activities and not organise them around classical scientific disciplines* around research subjects such as complexity research, public policy or nanotechnology (*Leo et al. 2006*). As the University Organisation and Studies Act implies also more autonomy for universities in the organisation and management of their activities both the OECD and the WIFO White Paper have suggested the *government should monitor whether the universities develop appropriate management capacity* (*OECD 2005a, Leo et al. 2006*). The University Organisation and Studies Act gives universities the freedom to engage into commercial activities. However, the OECD has urged the government to define admissible commercial activities for universities narrowly and not to bail out universities that are in financial difficulties (*OECD 2005a*). According to the OECD universities should also be allowed "*to decide on the level of tuition fees but at the same time introduce a universal and income-contingent student loan system and other policies which offset the potential negative effect of tuition fees on incentives to invest in tertiary education*" (*OECD 2007a*).

Remove barriers to competition in protected sectors To improve the overall competition framework and to strengthen enforcement, the OECD and other studies have recommended to *simplify the institutional set-up by merging the competencies of the Federal Cartel Attorney with those of the Federal Competition Authority (FCA)* leading to the establishment of a single competition authority with comprehensive area of responsibility (*OECD* 2005a, *Böheim* 2008a, 2008b). With respect to the FCA's human resources, an *increase both in quality and quantity of staff was recommended*. It was also suggested that the foundations of an evidence-based competition policy in Austria could be strengthened by the implementation of a forward-looking competition policy based on transparent quantitative competition monitoring. (*Böheim* 2008a, 2008b). The deregulation of professional services, especially of notaries and pharmacies, whose regulatory regimes belong to the most restrictive in Europe (*Paterson* et al. 2003) is still a pending issue.[7]

[7] Regulatory capture might play an important role in the successful prevention of deregulation by stakeholders in these professional fields. Reform pressure can only be expected from 'outside', i.e. the European Union (Böheim et al. 2006).

Conclusion

Past studies of the Austrian Innovation System and its governance reach in sum ambivalent conclusions on innovation policy and performance. Whereas most reports agree that Austria has considerably expanded its innovation activities and therefore improved its competitive position, there are concerns regarding the sustainability of this development. Austria's business sector has expanded its R&D investments, but there are weaknesses in the dynamic elements that underlie structural change and growth, namely foreign direct investment, firm creation and firm growth and human resources. Foreign direct investment flows are low, even though ownership of research-intensive firms is widespread. Firm creation in Austria is close to the EU average, but most of the newly founded firms are too small, have a low innovation potential, and do not grow in the years after their creation. Finally, the supply of skilled human resources at all educational levels but especially the tertiary level is too low and this is likely to jeopardise efforts to foster the technological intensity of production in the business sector and excellence in research in the academic sector. The R&D support system disposes of well developed instruments has been successful in promoting R&D in Austria. However, there are concerns whether the large sums of R&D subsidies are spent efficiently as the support seems to discriminate against risky R&D projects. Despite reform efforts the system and its instruments continue to be fragmented and governance is such that major changes are difficult because of competences are equally fragmented and competition between decision makers leads to stalemates that stifle the system. A major cause for this problem is the lack of political leadership in STI issues.

Most of the recommendations given by previous studies have therefore called for

the development of a long-term vision on the role of STI policies for Austria,

simplifying institutional framework conditions in STI policy,

streamlining the governance of STI policies,

ensuring an efficient use of R&D subsidies,

improving human capital development,

improving conditions for start-ups,

continuing university reform and ensuring that measures to foster excellence are taken, and for

removing existing competition barriers especially in the service sector.

Taken together the issues identified as being problematic for sustained growth and competitiveness span a wide array of interdependent policy areas This shows STI policies reach far beyond the narrowly defined fields of competencies defined for the Austrian ministries concerned with the issue.

2.2 Industrial Structure and Sectoral Drivers (Michael Peneder – WIFO)

This section addresses industrial specialisation and structural change in the Austrian economy, taking Germany, Finland, an aggregate of 'old' EU member states (EU10) and of new EU member states (NMS) as well as the US as benchmarks for comparison. In the first section we summarise the major patterns and changes of specialisation in terms of sector types, while in the second section we apply the growth accounting method to investigate the differences between industry types in terms of the various factor contributions to aggregate growth. For both analyses we use two new sectoral taxonomies which categorise manufacturing and service industries by their relative intensity in terms of education and innovation (see Box A.C.1).

Box 2.1: The WIFO Taxonomies of Manufacturing and Services

Sectoral taxonomies are important tools of structural analysis which condition our indicators of growth and productivity. Allowing for heterogeneity but nevertheless being selective, they help to identify major tendencies in the qualitative transformation of an economy. In this section we apply two sectoral taxonomies that focus on the major sources of competitive advantage in a knowledge-based economy, i.e. human capital and innovation.

The first taxonomy of **educational intensity** classifies manufacturing and service industries according to their educational workforce composition. It emanates from statistical cluster techniques applied to data for the US, Germany, France, the UK and Austria. For that purpose, an industry's workforce was segregated by the individual's highest level of educational attainment, for which, depending on the availability of data, the shares in total employment, wages or hours worked were calculated. For further details on the taxonomy see Peneder (2007).

To summarise briefly, the taxonomy separates the following mutually exclusive classes of *industries with* ...

... *low educational intensity*: e.g., agriculture, food, textiles and clothing, wood and products of wood, mineral products, basic metals and metal products, construction, sale & repair of motor vehicles, or hotels and catering;

... *intermediate educational intensity*: e.g., mining, pulp and paper, oil-refining, chemicals, rubber and plastics, mechanical engineering, motor vehicles, other transport vehicles, electricity, gas and water supply, retail and wholesale trade, transport, communications, real estate, and renting of machinery;

... *high educational intensity*: e.g., financial intermediation, computer related activities, research and development, other business services.

In the Tables we further separate a subset of high-tech manufacturing industries as defined by the OECD, which comprises of chemicals, electrical and optical equipment, as well as other transport equipment. The OECD technology classification covers only manufacturing sectors and is defined by their R&D intensity. All sectors identified by the OECD as high-tech happen to belong to the same category of intermediate educational intensity in the above taxonomy.

The second taxonomy of **innovation intensity** focuses on the distinction between creative and adaptive entrepreneurship, as well as the varying kinds and degree of technological opportunities, appropriability conditions and cumulativeness of knowledge. It is built from the micro-data of the Third Community Innovation Survey (CIS3) and covers 22 European countries (including Austria). Including innovation in service industries along those of manufacturing it thus emanates from a broader concept of innovation than the above mentioned OECD 'high-tech' sector types which are exclusively based on R&D intensity. Peneder (2008) provides a detailed documentation and validation.

To summarise, the taxonomy separates the following mutually exclusive classes of *industries with ...*

... *low innovation intensity*: e.g., mining, textiles and clothing, recycling, wholesale trade, land transport, water transport;

... *intermediate-to-low innovation intensity*: e.g., food, printing, electricity & gas, water supply, insurance & pension funding;

... *intermediate innovation intensity*: e.g., wood, pulp and paper, fabricated metal products, air transport, financial intermediation;

... *intermediate-to-high innovation intensity*: textiles, refined petroleum, chemicals, rubber & plastics, basic metals, motor vehicles, other transport equipment, post & telecommunications;

... *high innovation intensity*: machinery, computers, electrical equipment, communication technology, precision instruments, computer services, research & development.

In the tables we also display the numbers for the aggregate of sectors that remained *not classified*, because they had not been covered by the Community Innovation Surveys (e.g. construction or hotels and restaurants) (Peneder, 2007, 2008).

Specialisation and Competitive Strengths of the Austrian Business Sector

Investigating the patterns of specialisation for the distinct industry types with respect to gross output, intermediate inputs, value added and employment shares, we focus on the years 1985, 1995 and 2005 (Table 2.1). We find a few common characteristics as well as marked differences between the selected countries.

The data show that each country has (almost) uniformly increased its share of industries with 'high educational intensity' for each of the measures applied and with respect to both periods of comparison. Interestingly, this is not true for the subset of 'high-tech' industries as defined by the OECD. Practically for each of the measures used, the shares have increased only in Finland and the New Member States (NMS), whereas they have declined not only in Austria but also in Germany, the EU10 and in the US. The picture is more varied for the sectors characterised by high innovation intensity. For example, between 1985 and 2005 their share in total value added has remained constant in the US but dropped 1 and 1.5 percentage points in Germany and the aggregate of 'old' EU member states, respectively. In contrast, Finland almost doubled its value-added share, while Austria and the NMS also increased theirs. To summarise, the data demonstrate a pronounced and robust structural change in favour of education intensive industries but no general tendency among developed economies towards high-tech or innovation intensive industries.

If we take a closer look at the Austrian situation we see that the share of industries with a high *educational intensity* rose from 10.5% in 1985 to 15.6% in 2005. Austria moved along with the other countries and exhibits a pronounced structural change towards this type of knowledge-intensive production. However, the speed of structural change has not been sufficient to catch-up relative to the other countries. On the contrary, the structural gap even widened, for example from 3.6 to 4.4 percentage points in comparison with the EU10* or from 2.2 to 4.1 relative to Germany. Even in the NMS their share is higher, while among the countries compared, only Finland shows a lower specialisation than Austria.

Table 2.1: Industrial specialisation by educational intensity (shares in %)

	Austria			Germany			Finland			EU10			NMS			USA		
Industries	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005
High educational intensity																		
Gross Output	7,1	9,7	11,2	8,7	12,2	13,9	6,7	8,8	10,3	10,1	12,2	14,6	-	12,5	13,3	9,3	12,3	15,3
Intermediates	3,5	5,9	7,1	4,6	7,2	8,6	4,5	6,3	7,1	6,3	7,8	9,9	-	8,4	8,3	5,8	8,6	12,4
Value Added	10,5	13,1	15,6	12,7	16,8	19,7	9,3	11,7	14,3	14,1	16,5	20,0	-	16,9	19,5	12,3	15,5	17,8
Labour	10,3	11,6	17,7	10,8	15,1	21,8	10,1	15,4	19,5	13,7	18,2	23,0	-	11,9	15,2	17,9	22,2	25,1
Intermediate educational intensity, high-tech																		
Gross Output	5,8	5,3	5,2	10,1	8,1	8,4	4,6	7,9	10,8	7,5	6,7	6,2	-	3,8	6,6	7,0	7,4	5,4
Intermediates	7,3	6,7	6,4	11,7	10,1	10,3	5,3	9,9	13,0	9,5	8,8	8,0	-	5,1	9,3	9,3	9,6	6,9
Value Added	4,3	4,0	3,8	8,4	6,1	6,4	3,8	5,5	8,0	5,5	4,7	4,1	-	2,4	3,4	5,0	5,4	4,2
Labour	3,4	3,1	2,6	6,9	5,4	4,6	3,1	4,2	4,3	4,7	3,8	3,2	-	3,4	3,5	4,2	3,2	2,4
Intermediate educational intensity																		
Gross Output	49,1	48,6	51,6	51,5	47,9	52,2	48,0	51,1	47,9	49,4	47,1	50,0	-	42,9	44,7	53,2	50,3	50,2
Intermediates	47,3	48,2	56,4	52,3	49,9	58,0	46,8	50,8	49,4	49,7	48,3	53,5	-	43,3	44,5	54,2	51,0	52,4
Value Added	50,7	48,9	46,6	50,6	46,0	46,0	49,5	51,5	46,1	49,0	45,9	46,0	-	42,4	45,1	52,4	49,8	48,3
Labour	40,8	42,7	41,8	52,8	51,2	48,2	47,2	48,7	46,4	48,5	47,6	45,0	-	44,4	43,7	50,2	47,4	45,1
Low educational intensity																		
Gross Output	38,1	36,5	32,0	29,8	31,9	25,4	40,7	32,2	31,0	32,9	34,0	29,3	-	40,8	35,3	30,5	30,0	29,1
Intermediates	41,9	39,2	30,1	31,3	32,7	23,1	43,4	33,0	30,5	34,5	35,1	28,6	-	43,2	37,9	30,6	30,8	28,4
Value Added	34,5	34,0	33,9	28,3	31,0	27,9	37,4	31,2	31,7	31,3	32,9	30,0	-	38,2	32,1	30,4	29,3	29,8
Labour	45,4	42,6	37,8	29,4	28,3	25,4	39,6	31,8	29,8	33,1	30,4	28,8	-	40,3	37,6	27,7	27,1	27,4

Note: The EU10 consists of Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain and the United Kingdom; the NMS are: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia.

Sources: EU KLEMS database, WIFO calculations.

Turning to the sectors with high innovation intensity, their value added share in Austria grew by 0.7 percentage points from 1985 to 1995 and by 1.2 percentage points from 1995 to 2005. Though it started from a considerably lower level than e.g. in the EU10, and the overall speed of structural change was much less spectacular than in the case of education intensive industries, Austria has narrowed this structural gap from 4.2 percentage points in 1985 to 0.8 percentage points in 2005. Compared to Germany, the structural gap in innovation intensive industries reduced from 7.1 to 4.2 percentage points. In short, while in Austria structural change was more pronounced towards education intensive sectors, it has not kept pace with the other benchmark countries. Conversely, structural change towards innovation intensive industries was less pronounced, but Austria has narrowed its gap relative to the EU average.

Table 2.2: Industrial specialisation by innovation intensity (shares in %)

	Austria			Germany			Finland			EU10			NMS			USA		
Industries	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005	1985	1995	2005
High innovation intensity																		
Gross Output	7,8	9,3	10,5	16,4	12,7	13,8	8,3	14,0	19,2	13,7	13,4	12,7	-	7,4	13,9	9,2	10,6	9,0
Intermediates	8,3	10,5	11,6	16,6	13,6	14,2	7,6	15,6	20,7	13,9	14,6	13,5	-	8,3	16,4	9,6	11,7	9,1
Value Added	7,3	8,0	9,2	14,4	11,7	13,4	9,2	11,9	17,0	11,5	9,6	10,0	-	5,6	8,3	8,8	9,4	8,8
Labour	7,8	7,5	8,2	14,0	10,5	10,7	8,8	11,3	13,4	10,4	8,7	8,7	-	8,4	8,4	7,7	6,8	6,3
Med-high innovation intensity																		
Gross Output	20,7	15,8	18,6	25,6	21,0	25,1	18,2	16,0	17,4	27,7	25,9	29,9	-	17,2	22,9	23,2	21,1	19,4
Intermediates	25,0	18,2	22,4	29,4	24,2	30,9	20,9	17,9	19,9	30,8	28,1	33,9	-	18,8	25,5	28,9	25,9	25,3
Value Added	15,9	13,3	13,7	20,8	17,4	17,5	14,4	13,3	13,7	18,7	16,6	14,9	-	12,2	13,4	17,3	16,4	13,6
Labour	13,6	10,6	9,2	16,3	13,1	11,7	12,7	12,0	10,0	14,3	12,0	10,2	-	14,8	12,2	11,5	10,1	8,3
Intermediate innovation intensity																		
Gross Output	16,0	19,1	19,6	11,8	19,2	20,1	20,5	25,2	20,1	1,2	1,4	1,2	-	2,0	2,2	15,6	18,8	20,8
Intermediates	14,8	18,3	18,5	8,2	15,7	16,6	21,4	25,3	20,3	1,3	1,5	1,3	-	2,2	2,3	12,1	15,2	17,2
Value Added	17,4	20,0	20,9	18,3	23,0	24,9	19,3	25,1	19,9	14,7	21,5	24,0	-	16,1	19,2	19,2	22,4	24,2
Labour	17,3	18,7	23,6	12,4	19,3	23,8	18,2	20,8	21,2	14,4	19,7	23,0	-	12,3	16,8	18,1	21,6	22,7
Med-low innovation intensity																		
Gross Output	16,5	14,2	12,2	16,7	12,3	12,1	16,1	13,5	9,3	16,8	15,1	13,6	-	22,4	17,6	16,2	14,8	13,5
Intermediates	20,3	16,3	14,5	20,3	14,6	14,0	18,6	14,4	9,6	20,3	17,3	15,3	-	25,2	19,5	19,8	16,5	15,4
Value Added	12,4	12,0	9,3	11,2	9,8	9,6	12,6	12,2	8,8	10,3	10,6	9,4	-	13,3	11,6	12,4	13,0	11,6
Labour	9,2	8,2	6,4	9,1	8,3	7,5	9,7	9,3	6,8	8,1	7,8	6,6	-	11,4	9,8	8,5	8,0	6,9
Low innovation intensity																		
Gross Output	16,5	15,8	16,3	10,5	13,7	12,6	16,1	15,3	15,8	10,5	10,1	9,6	-	12,6	10,3	14,7	13,9	14,7
Intermediates	13,2	14,0	15,1	9,2	12,9	11,6	12,3	12,0	12,8	7,5	8,0	7,8	-	10,9	8,0	12,1	12,3	12,4
Value Added	20,3	17,7	17,8	15,6	14,6	13,9	21,4	19,8	20,2	19,0	16,8	16,6	-	23,5	21,1	17,4	15,5	17,0
Labour	18,1	17,9	16,9	15,7	14,9	13,9	18,6	17,6	17,0	16,2	16,2	15,4	-	23,4	20,6	14,7	13,3	12,5
Not classified																		
Gross Output	22,4	25,8	22,8	19,1	21,1	16,2	20,8	16,0	18,3	30,1	34,0	33,1	-	38,5	33,0	21,1	20,9	22,6
Intermediates	18,5	22,7	17,8	16,4	19,0	12,8	19,1	14,8	16,8	26,2	30,5	28,2	-	34,6	28,3	17,5	18,4	20,5
Value Added	26,8	29,0	29,1	19,8	23,5	20,8	23,1	17,7	20,5	25,8	25,0	25,0	-	29,3	26,4	24,9	23,3	24,7
Labour	34,0	37,0	35,7	32,5	33,9	32,4	32,0	29,1	31,7	36,7	35,5	36,2	-	29,7	32,2	39,5	40,3	43,3

Note: The EU10 consists of Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain and the United Kingdom; the NMS are Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia.

Sources: EU KLEMS database, WIFO calculations.

Growth contributions by industry type

Pronounced differences in the structural dynamics also become apparent when we turn to the question, to what extent each industry type has contributed to the aggregate performance in terms of growth and productivity. Table 2.3 and 2.4 depict the shares and the annual growth rates for the period 1995 to 2004, respectively. The data reveal some general differences between industry types that appear to be rather common among countries.

Again, the data reveal education intensive and high-tech or innovation intensive industries to be quite different forms of knowledge based production.

For example, we observe a consistent negative contribution of industries with high education intensity to the MFP part of aggregate growth. At the same time, we find a particularly high share in the total MFP contribution to aggregate growth of high-tech manufacturing with intermediate educational intensity and the group of innovation intensive industries more generally. In the EU10 during the period 1995 to 2005, innovation intensive sectors accounted only for 8.8% of the total economic growth in gross output, 9.8% in the growth of intermediate inputs, and 7.1% of total value added growth. These contributions are largely consistent with the small overall size of the innovation intensive sectors, even though they clearly lie above its shares in total gross output or value added. It is however remarkable that the innovation intensive sectors are the source of more than 30% of the entire MFP growth in the EU10. In the US its share in the total MFP growth is almost 48%, in Germany 68%, and in Finland about 38%. In Austria the innovation intensive industries contributed just above 13% to total MFP growth. Again this is higher than its share in overall production, but much lower than in all the other countries compared. The patterns are similar for the period before 1995 (not displayed in the table).

The upshot is, that industries with high innovation intensity generally contribute more than proportional to a country's MFP growth, but in Austria they did so to a minor degree than in the other countries. Conversely, while showing a weak performance in terms of MFP, industries with high educational intensity generally contribute more than proportional to the generation of jobs, and in Austria they did so more than in the other countries.

Summary and Conclusions

This section analysed differences in the patterns of specialisation and the decomposition of growth contributions applying two sectoral taxonomies that distinguish industries by their degree of educational and innovation intensity. While the data displayed in the tables provide a wealth of detailed information about the country differences, the most striking results refer to rather general characteristics of the various sector types:

Firstly, the share of industries with a particularly high educational intensity in total gross output, value added, or employment has been consistently growing in each of the countries. While this might be expected, it is more surprising that the same tendency cannot be detected with respect to the sectors classified as high-tech by the OECD or characterised by high innovation intensity in Peneder (2008). In the developed economies, the data thus demonstrate a powerful tendency of structural change towards education intensive, but not towards innovation intensive sectors.

Secondly, starting from considerable lower shares, the Austrian business sector exhibits a positive structural change towards both education intensive and innovation intensive industries. The structural change towards education intensive industries is generally more pronounced, but not fast enough to catch-up relative to the other EU countries. The consequence is a growing structural gap. Conversely, the less pronounced change in specialisation towards innovation intensive industries has been sufficient to narrow the structural gap relative to the EU, where the shares have even declined.

Thirdly, innovation intensive industries account for a huge portion of the MFP contribution to aggregate growth. In all the countries compared, the MFP contribution by far surpassed its shares in gross output, value added, or employment. In Austria, while displaying an overall satisfactory rate of MFP growth above the rate for the EU10, the contribution of the innovation intensive industries was much smaller than in the other countries (both with respect to the absolute percentages as well as the relative ratio of contributions to MFP and value added growth).

Table 2.3: Growth and growth contributions by educational intensity, 1995-2005

	Share of industries with ... educational intensity				Total	Annual
	high	intermediate		low		growth
		high-tech	other			
Gross output growth						
Austria	14,2	6,5	63,6	15,7	100,0	3,03
Germany	17,8	13,9	63,7	4,7	100,0	1,80
Finland	9,4	29,7	38,3	22,6	100,0	3,99
EU10	19,0	7,6	53,6	19,9	100,0	2,55
NMS*)	12,1	13,6	44,1	30,2	100,0	4,43
USA	21,4	11,1	46,4	21,1	100,0	3,07
Intermediates growth						
Austria	8,3	6,9	72,7	12,2	100,0	4,15
Germany	12,9	15,1	78,5	-6,6	100,0	2,43
Finland	7,8	30,0	36,8	25,5	100,0	4,48
EU10	15,4	8,6	57,7	18,4	100,0	3,18
NMS*)	8,6	17,3	39,8	34,3	100,0	5,31
USA	22,2	7,1	50,6	20,1	100,0	3,34
Value Added growth						
Austria	23,9	5,7	48,7	21,7	100,0	2,14
Germany	25,6	11,6	37,5	25,3	100,0	1,27
Finland	11,5	29,3	40,7	18,5	100,0	3,55
EU10	25,6	5,9	46,5	22,0	100,0	1,89
NMS*)	18,2	7,6	50,2	24,1	100,0	3,23
USA	20,2	14,8	43,0	22,0	100,0	2,95
Labour service growth contributions						
Austria	112,1	-9,0	20,5	-23,6	100,0	0,42
Germany	-79,7	23,0	93,5	63,2	100,0	-0,36
Finland	44,4	11,0	29,0	15,6	100,0	0,80
EU10	84,4	-6,4	9,9	12,1	100,0	0,49
NMS	-	-	-	-	-	-
USA	52,2	-5,1	29,0	23,8	100,0	0,63
Non-ICT-capital services growth contributions						
Austria	22,6	1,1	13,4	62,9	100,0	0,41
Germany	40,9	1,7	16,6	40,9	100,0	0,65
Finland	5,9	37,4	-6,1	62,8	100,0	0,43
EU10	21,9	2,8	28,5	46,8	100,0	0,62
NMS	-	-	-	-	-	-
USA	14,0	3,9	31,3	50,8	100,0	0,74
ICT-capital services growth contributions						
Austria	29,0	2,8	60,0	8,1	100,0	0,44
Germany	60,4	2,5	33,7	3,4	100,0	0,36
Finland	12,1	15,1	66,6	6,2	100,0	0,47
EU10	33,1	4,4	53,2	9,4	100,0	0,41
NMS	-	-	-	-	-	-
USA	29,9	5,1	57,0	8,0	100,0	0,77
MFP growth contributions						
Austria	-26,1	17,7	75,4	33,0	100,0	0,77
Germany	-95,4	41,9	102,7	50,8	100,0	0,47
Finland	-2,8	37,8	52,8	12,2	100,0	1,57
EU10	-66,6	32,3	128,7	5,5	100,0	0,32
NMS	-	-	-	-	-	-
USA	-12,5	53,6	53,2	5,7	100,0	0,67

Note: The EU10 consists of Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain and the United Kingdom; the NMS comprises Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia.

*) 1996 – 2005.

Sources: EU KLEMS database, WIFO calculations.

Table 2.4: Growth and growth contributions by innovation intensity, 1995-2005

	Share of industries with ... innovation intensity						*Total*	*Annual*
	high	med-high	med	med-low	low	n.c.		growth
Gross output growth								
Austria	9,9	35,9	20,1	7,7	20,0	6,3	100,0	2,77
Germany	18,1	61,7	17,3	4,8	10,0	-11,9	100,0	1,54
Finland	37,2	19,7	13,3	2,4	17,8	9,6	100,0	3,55
EU10	8,8	43,6	16,5	3,5	19,4	8,2	100,0	2,23
NMS*)	17,6	29,2	17,7	8,0	18,0	9,4	100,0	3,60
USA	13,4	35,6	19,0	0,4	22,5	9,1	100,0	2,52
Intermediates growth								
Austria	11,3	33,4	23,1	7,7	20,1	4,4	100,0	3,89
Germany	19,9	53,8	25,4	4,5	3,7	-7,3	100,0	2,35
Finland	38,5	18,7	15,4	1,5	13,3	12,6	100,0	4,03
EU10	9,8	40,0	18,7	4,3	17,8	9,3	100,0	2,90
NMS*)	21,4	25,4	16,3	9,6	15,1	12,1	100,0	4,33
USA	8,7	43,4	21,2	-0,5	15,3	11,9	100,0	2,92
Value Added growth								
Austria	6,6	45,1	13,8	7,5	18,0	9,1	100,0	2,02
Germany	12,2	84,3	-4,9	5,1	23,9	-20,6	100,0	0,93
Finland	34,5	23,5	10,1	3,6	23,2	5,1	100,0	3,19
EU10	7,1	48,8	12,6	2,0	23,2	6,3	100,0	1,48
NMS*)	11,5	34,9	21,1	3,7	24,0	4,8	100,0	2,55
USA	17,5	30,8	16,0	1,5	28,7	5,6	100,0	2,39
Labour service growth contributions								
Austria	-5,3	109,6	-3,5	-24,3	23,3	0,2	100,0	0,33
Germany	24,9	-50,1	26,1	22,7	31,3	45,1	100,0	-0,30
Finland	17,8	41,5	1,2	-5,3	22,8	22,0	100,0	0,77
EU10	-5,4	75,3	0,9	-13,5	19,4	23,4	100,0	0,40
NMS	-	-	-	-	-	-	-	-
USA	-7,0	44,7	12,5	-6,9	27,4	29,3	100,0	0,49
Non-ICT-capital services growth contributions								
Austria	4,2	38,5	25,8	2,6	24,7	4,2	100,0	0,41
Germany	2,9	66,9	14,2	1,4	13,9	0,7	100,0	0,34
Finland	17,4	24,1	28,9	3,8	24,4	1,4	100,0	0,43
EU10	5,0	49,9	21,3	3,3	17,6	2,9	100,0	0,37
NMS	-	-	-	-	-	-	-	-
USA	4,9	46,2	24,3	2,9	18,3	3,4	100,0	0,70
ICT-capital services growth contributions								
Austria	1,9	38,5	11,8	4,0	37,5	6,4	100,0	0,27
Germany	2,1	78,4	4,5	1,3	13,0	0,6	100,0	0,37
Finland	54,7	29,6	-29,3	5,8	37,1	2,1	100,0	0,28
EU10	4,2	57,2	9,7	4,0	21,3	3,5	100,0	0,31
NMS	-	-	-	-	-	-	-	-
USA	7,3	33,2	16,9	5,0	31,7	6,0	100,0	0,41
MFP growth contributions								
Austria	13,4	12,4	14,6	27,1	15,2	17,2	100,0	0,91
Germany	67,9	-59,8	-17,9	39,6	91,4	-21,2	100,0	0,23
Finland	37,8	12,9	15,2	7,7	28,3	-1,9	100,0	1,59
EU10	30,3	20,3	24,1	16,1	31,1	-21,8	100,0	0,30
NMS	-	-	-	-	-	-	-	-
USA	47,9	4,6	9,1	4,8	44,3	-10,7	100,0	0,73

Note: The EU10 consists of Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain and the United Kingdom; the NMS comprises Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia. – n.c. = not classified.

*) 1996 – 2005.

Sources: EU KLEMS database, WIFO calculations.

2.3 External Competitiveness (Karl Aiginger, Susanne Sieber – WIFO)

As Austria is a small open economy its prosperity largely depends on its capability to be competitive on international markets. This is important for two reasons: Firstly, if Austria is to maintain its high social standards and high employment it is crucial not to engage into price competition on international markets but to compete in quality, knowledge and skill intensity, and markets that produce superior goods. Secondly, in order to develop and sustain competitive advantage on international markets is necessary to learn about international needs and develop new and innovative products with global scope. Foreign firms with high levels of competence can be an important source for such critical knowledge. They can also be important drivers of dynamic change in the economy in small open economies. This part of the report therefore provides and discusses indicators on the competitiveness of the Austrian economy on global markets, and its attractiveness for foreign direct investment.

Austrian Foreign Trade Performance[8]

In the coming years important challenges for Austria - one of wealthiest EU countries measured by GDP per capita - will be the change from an applier to a provider of technology (or from a middle technology position to the technological frontier) as well as a stronger focus on the production and export of high quality products. Therefore a structural change to more sophisticated industries, like industries dominated by a high degree of quality competition or industries with high skills requirements, will be important.

Table 2.5: Austrian foreign trade performance in comparison to EU 15, 2007

	Austria				EU 15		
	Export shares	Trade balance	RCA value	Market share in EU15 exports	Export shares	Trade balance	RCA value
	As percent	mn €		As percent	As percent	mn €	
Human capital							
Low skill	26.6	157	-0.033	3.72	24.7	-40,164	-0.114
Medium skill/blue c.w.	29.4	6,390	0.183	4.77	21.3	50,536	0.013
Medium skill/white c.w.	22.3	-4,944	-0.222	2.60	29.7	48,243	-0.012
High skill	21.7	2,522	0.074	3.08	24.3	139,473	0.135
Quality competition							
Low RQE	29.9	1,884	0.021	3.81	27.1	-47,832	-0.119
Medium RQE	24.1	-2,566	-0.131	3.20	26.0	14,347	-0.047
High RQE	46.0	4,808	0.062	3.39	46.9	231,573	0.105
Manufacturing	100.0	4,126	-	3.45	100.0	198,088	-

Source: Eurostat, WIFO calculations. - Including Intra-EU-trade. - RQE = Revealed Quality Elasticity - Classification of industries according to Peneder (2001) und Aiginger (2000).

[8] The following analysis is based on trade in goods.

Table 2.5 shows the significance of the so-called sophisticated types of industries in Austria and in the EU15. In 2007 the share of industries with intensive quality competition reached 46% of total manufacturing trade, the share of so-called high skill industries achieved 21.7%. Both shares are lower than the corresponding EU-15 shares. The figures demonstrate furthermore a positive trade balance and a comparative advantage in these two industry types. Analysing Austrian competitiveness in foreign trade on the basis of the market share in EU15 exports reveals below-average market shares for the two above mentioned sophisticated industries.

Table 2.6: Change in Austrian foreign trade performance in comparison to EU 15, 1997/2007

	Austria				**EU 15**		
	Export shares	Trade balance	RCA value	Market share in EU15 exports	Export shares	Trade balance	RCA value
	Percentage points	mn €	Absolut	Percentage points	Percentage points	mn €	Absolut
Human capital							
Low skill	-1.2	1,290	-0.033	0.67	-1.6	-54,880	-0.030
Medium skill/blue c.w.	2.5	6,161	0.086	1.07	0.4	-2,233	-0.028
Medium skill/white c.w.	-3.5	-2,567	-0.131	0.10	-0.1	2,408	0.012
High skill	2.3	3,325	0.075	0.65	1.3	62,417	0.035
Quality competition							
Low RQE	-1.8	1,500	-0.084	0.26	1.4	-55,922	-0.019
Medium RQE	-2.1	-296	-0.048	0.49	-1.8	-9,586	0.019
High RQE	3.8	7,005	0.083	0.78	0.3	73,220	0.001
Manufacturing	-	8,209	-	0.58	-	7,712	-

Source: Eurostat, WIFO calculations. - Including Intra-EU-trade. - RQE = Revealed Quality Elasticity - Classification of industries according to Peneder (2001) und Aiginger (2000).

Table 2.6 depicts the change in the Austrian foreign trade performance between 1997 and 2007. One can observe a tendency of structural change toward a future-oriented industry structure. The share of high skills and quality dominated industries increased in that period, the trade balance of these two industry categories improved, the specialisation increased and both branches were able to gain market shares.

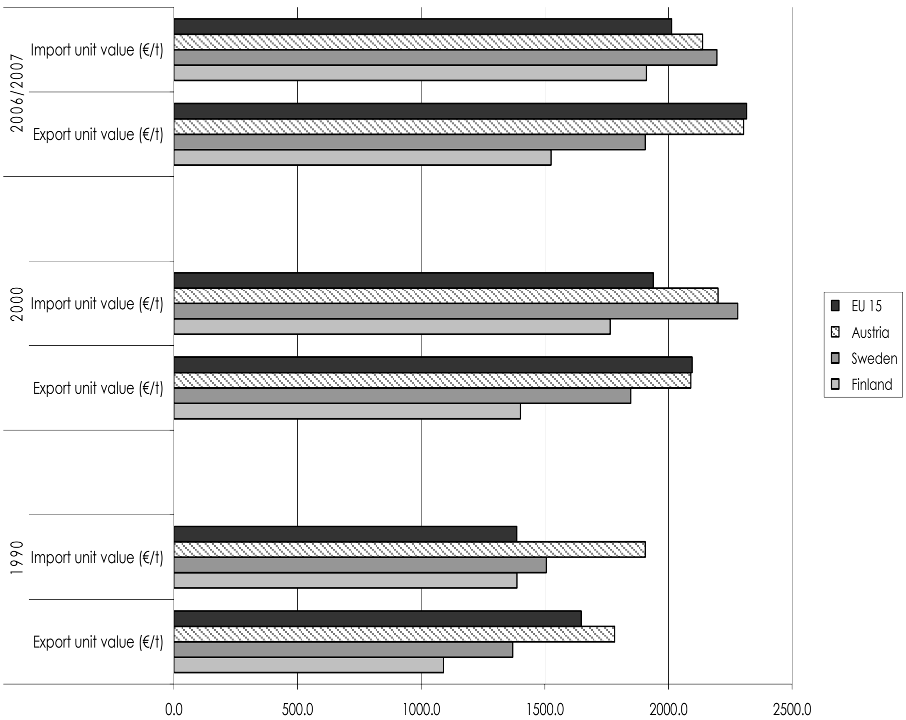
Table 2.7: Austrian export and import unit values in comparison to EU 15, 2007

	Export unit values	Import unit values	Industries[1)] Total	with higher export than import unit value	with lower export than import unit value	Industries with higher export than import unit value
	€/kg		Number			Percentage shares in total industries
Manufacturing						
Austria	2.35	2.27	1,040	647	393	62.2
EU15	2.42	2.09	1,190	881	309	74.0

Source: Eurostat, WIFO calculations. - Including Intra-EU-trade. - 1) Industries with export and import unit values on the 6-digit level.

The average value per kilogram of Austrian exports lies above the corresponding value of imports, signalling that more high-quality products may be exported than imported (see table 2.7).

Figure 2.1: Import and export unit values over time

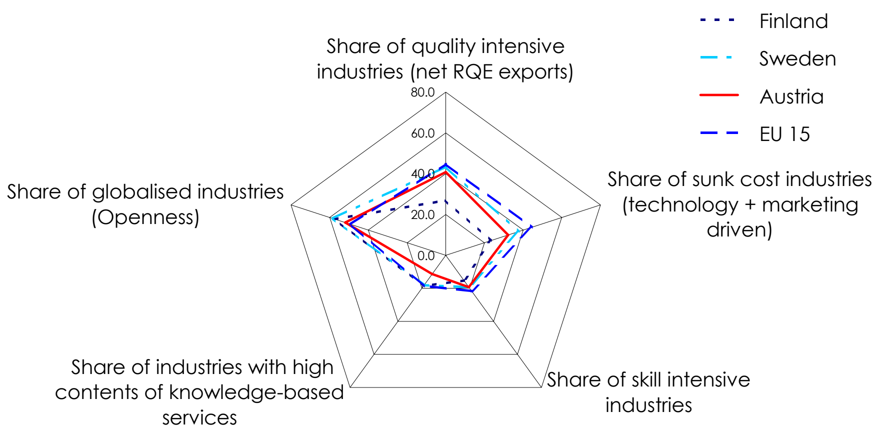


Eurostat, WIFO calculations. See *Aiginger (1997)* for a detailed description of the indicators.

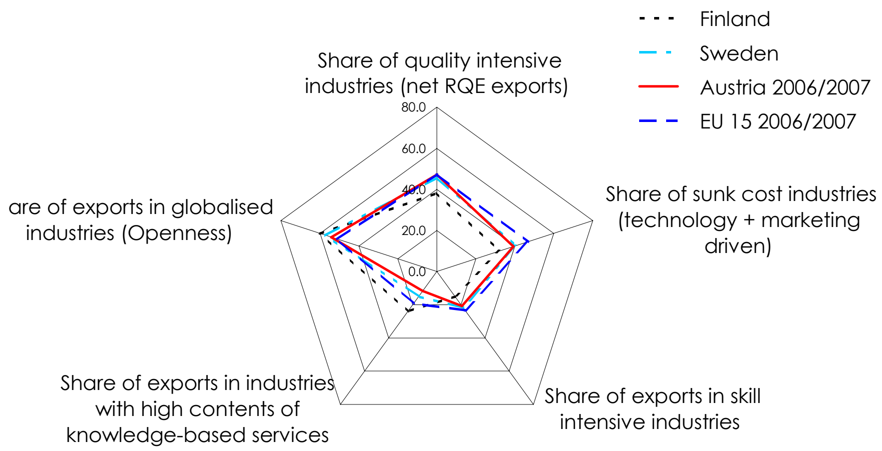
Figure 2.1 shows how the import and export unit values have changed over time in comparison to Sweden, Finland, and the EU 15 average. It is evident that in the period between 2000 and 2007 an upgrading of Austrian exports in relation to the imports has taken place. Up to the year 2000 the import unit values exceeded the export unit values. In 2007 the situation was reversed. This indicates that the competitive position of Austrian imports has improved.

Figure 2.2: Quality indicators for Austrian exports

1990



2007



Source: Eurostat, WIFO calculations. See *Aiginger (2000)* for a detailed description of indicators.

Figure 2.2 shows how the quality position of exports has changed between 1990 and 2007 in comparison to Finland, Sweden and the EU 15. Austria has succeeded to increase its share of industries sheltered from price competition between 1990 and 2007 (from 40.8% to 47.1% in 2007) as indicated by the share in exports of quality intensive industries. However, it has just followed here the general trend across EU 15 where the value stands equally at 47%.

The share of sunk cost industries in total exports (technology driven plus marketing driven) is another indicator for the favourable structural composition of the structure of manufacturing, and the exposition to global competition. The export share of these industries has remained constant over time with 39%. It lies below the EU 15 average of 46.7%, but it close the value observed for Sweden.

Also the export share in skill intensive an industry is has remained constant over time and is closed to 20%. The value for Austria is higher than that of Finland and close to that of Sweden (21.8%), but it is lower than for the EU 15 on average (23.4%).

The share of exports of knowledge based industries for Austria is disappointing. It is at 11.3% and after an increase form11 to 14.3% between 1990 and 2000it has fallen back to 11.3% in 2007. In Finland the share of exports in these industries in 2007 was at 24% and EU 15 wide it was at 19.2%.

The share of exports of "globalised" industries (as measured by exports plus imports to total production) has increased. Austrian industries have opened up over time. The share of exports of these industries has increased from 34% in 1990 to 41.7%. However, this is still below the EU 15 average (42.6%) and well behind the values measured for Sweden (52.1%) and Finland (52.7%).

These indicators show that an upgrading of production has taken place in the Austrian business sector. Due to EU membership the business sector has also become more globalised. However, clear deficits in knowledge based and skill intensive industries remain.

Trends in Austrian inward foreign direct investment

Austria's inward foreign direct investment (FDI) represents an increasingly important part of Austria's external economic relations. Austria is an attractive business location for foreign investors. In 2006, Austrian inward foreign direct investment (FDI)[9] – excluding Special Purpose Entities (SPEs) and real estate - amounted to € 84.3 billion (total capital at market value) at the end of the year. Foreign direct investments flows to Austria 2007 reached a new peak value with € 21.7 billion. The variable foreign direct investment flows – depicting the increases in FDI within one year – are generally more volatile, and may be considerably influenced by

[9] Direct investments are investments across borders, their main aim is to obtain a lasting interest in the target enterprise. Foreign direct investment covers equity capital - since the reporting year 2006 market values instead of book values have been used for enterprises listed on the stock exchange – and other capital (like intra-company loans).

single transactions, especially in small countries like Austria.[10] This may explain also the relative volatile behaviour of the Austrian share in world wide FDI flows (see Table 2.8). Contrary to the development of FDI flows, FDI stocks develop quite soundly. The data show an ongoing increase in the Austrian share in total worldwide inward FDI stocks in the last years (see Table 2.8), 2006 Austrian inward FDI stocks reached a share in total worldwide FDI stocks of 0.89%.

Table 2.8: Development of foreign direct investment, in Austria and worldwide

	Inward flows			Inward stocks		
	World	Austria	Austria	World	Austria	Austria
	Billion €		Percentage shares	Billion €		Percentage shares
1999	1,020	2.59	0.25	4,899	24.26	0.50
2000	1,513	9.23	0.61	6,219	33.49	0.54
2001	920	6.36	0.69	6,994	39.71	0.57
2002	662	0.15	0.02	6,446	42.81	0.66
2003	496	5.49	1.11	6,469	45.63	0.71
2004	577	2.56	0.44	7,038	51.92	0.74
2005	770	8.67	1.13	8,629	69.98	0.81
2006	1,124	6.32	0.56	9,469	84.34	0.89
2007	1,338	21.74	1.62	10,333	.	.

Source: Values for the world: UNCTAD, World Investment Report 2008; Values for Austria: OeNB (update September 2008); WIFO calculations.

One measure of a country's degree of internationalisation is the ratio of outward FDI stocks to the GDP of a country. The comparison of Austria's inward FDI position - according to this indicator - relative to other developed countries shows two main points: Firstly, a catching-up process referring to the stock level in percent of GDP can be seen, but secondly the absolute level of this indicator (Austrian inward FDI stock in percent of GDP) lies 2007 with (34%) still below the EU27 average. 10 years ago Austrian inward FDI stocks in relation to GDP were still quite low (9.4% of GDP in 1997) compared not only to the average result for the EU27, but also in relation to the world or the group of industrialized countries. However, during the last few years the Austrian position has improved, outperforming in 2007 with 34% the average figures for the group of industrialized countries or the world. Nevertheless the figures are still below the EU27 result (40.9%), see Table 2.9.

[10] For instance, the relative high amount of FDI flows to Austria in 2007may be partly due to the change in ownership of the Bank Austria.

Table 2.9: Inward FDI stocks in percent of GDP, Austria and selected EU member states

	1997	2002	2006	2007	2007
	as percentage of GDP				1997=100
Inward FDI stocks					
Austria	9.4	20.9	26.0	34.0	361.7
Germany	7.4	14.8	19.9	19.0	256.8
Finland	7.7	25.1	32.4	34.8	451.9
France	13.7	26.4	34.3	40.1	292.7
United Kingdom	19.0	33.3	47.3	48.6	255.8
Ireland	60.2	149.2	71.4	73.6	122.3
Italy	7.2	10.7	16.0	17.3	240.3
Sweden	16.4	48.0	57.6	56.0	341.5
Switzerland	22.5	44.8	56.2	65.7	292.0
Spain	18.4	37.5	35.8	37.4	203.3
EU 27	14.6	31.1	39.0	40.9	280.1
Industrialised economies[1])	10.2	19.2	24.9	27.2	266.7
World	11.6	20.5	25.5	27.9	240.5

Q: UNCTAD, World Investment Report 2008. - 1) EU 27, EFTA, USA, Canada, Australia, Gibraltar, Bermuda, New Zealand, Japan, Israel. – Despite the efforts to harmonize data, FDI are still not fully comparable between countries.

The highest number of foreign direct investors in Austria was reached in 2003 with 3.159 investors, in 2006 this amount decreased to 2.921. The number of direct investment enterprises in Austria after the peak level of 2,721 in 2005 dropped to 2,468 in 2006. Also the number of employees of direct investment enterprises in Austria – the number of employees is weighted for the non-resident investors' share in the nominal capital – has decreased within the last years: after its peak in 2000 (252.400 persons) it fell to 237.400 in 2006.

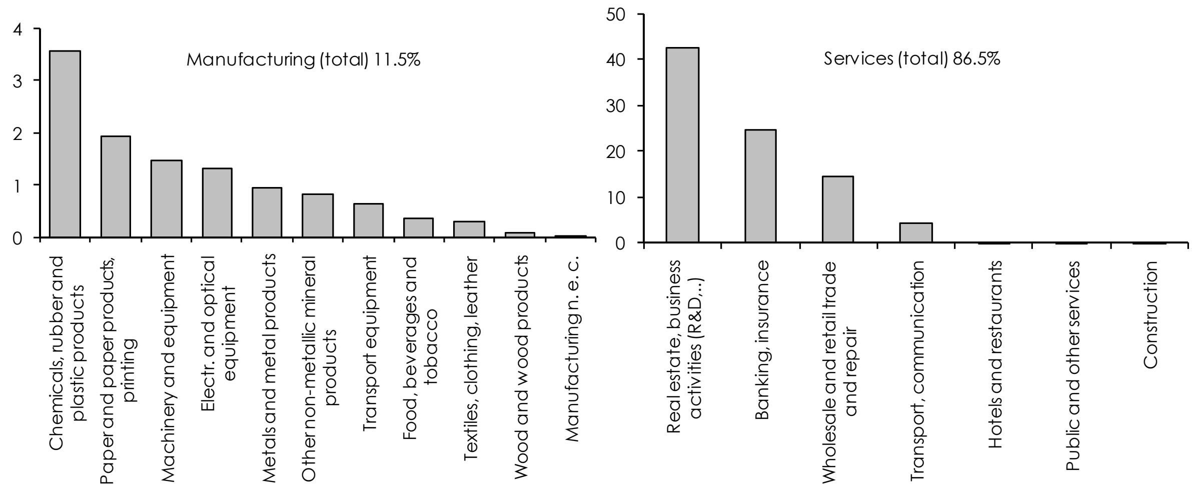
Table 2.10: Austrian Inward FDI stocks

	Employees	Foreign Investors	Direct investment enterprise	Patent, license fee (Payments to the foreign stockholder)
	1.000 people	Number		€ million
1999	229.7	3,010	2,547	248
2000	252.4	3,069	2,595	259
2001	246.9	3,094	2,614	388
2002	246.7	3,104	2,647	252
2003	240.9	3,159	2,679	270
2004	232.8	3,125	2,665	300
2005	220.7	3,153	2,721	293
2006	237.4	2,921	2,468	346

Source: OeNB, "Direktinvestitionen 2006", Statistiken Sonderheft, Dezember 2008.

The sectoral structure of Austrian inward FDI is dominated by the service sector, which accounts for 86.5% of total 2006 inward direct investment stocks in Austria. The main target branches are "real estate, renting and business activities (like IT or R&D)" – with a share of 42.7% in total inward FDI stocks, "the financial sector" (24.7%) as well as "trade and repair" (14.3%). Breaking up the data of the Austrian inward FDI stocks structure in manufacturing branches shows that most investments in the "chemicals, rubber and plastic products", the "paper, paper products and printing" and in the "machinery" branch (for more details see Figure 2.3).

Figure 2.3: Austrian inward foreign direct investments stocks 2006 by industry, share in total foreign direct investments stocks in percent



Source: OeNB, remark: FDI stocks in agriculture, forestry, fishing, mining and electricity, gas and water supply - which are not displayed in this diagram - achieve together a share of 2.0% in 2006.

Inward vs. outward FDI

Looking at outward FDI one can see an even faster catching-up process compared to that of Austrian inward FDI. The original deficit in Austrian outward FDI – compared to inward FDI – has nowadays nearly vanished. Austrian outward FDI stocks have reached € 80 billion at the end of 2006. Outward flows (2007: € 24.9 billion) even surpassed the corresponding inward flows in the last years. More than a quarter of all resident investors are influenced or controlled by non-resident owners. When looking at the amount of stocks the share is even higher, more than one third of total Austria outward FDI stock 2006 is related to so-called "Bridgeheads", i.e. large multinationals active in Austria that invest abroad. These figures once again underline the importance of the role of regional headquarters and therefore indirectly also of the role of inward FDI for the internationalisation process in Austria.

Conclusions

The evidence presented in this part of the report shows that over time the Austrian business sector has been able to upgrade the quality of exports in Austria's traditional industrial segments. The openness of the industry has increased indicating that Austrian firms are increasingly capable of position their products in the international markets. The export shares in knowledge or skill intensive industries, however that has traditionally been low has hardly improved over time. This confirms the evidence presented in the previous part of this report indicating that even though the innovation intensity of the Austrian business sector has improved over time, but gaps have opened in knowledge and education intensive sectors. Hence, the export data confirm these structural deficits of the Austrian business sector.

The evidence presented in this section also shows that Austria has become increasingly attractive as a target destination for foreign direct investment. Both the stocks of inward and outward investment have increased over time, even though they are still below the EU 27 average. Inward investment has been particularly intensive in the chemical industry, and in real estate and business services (amongst which figures also R&D). This shows that Austria is an attractive business location for foreign investors.

2.4 Innovative performance: Effects and Impact (Andreas Reinstaller – WIFO)

It is the crucial task of the R&D support system of an economy to foster the ability of national firms to innovate by taming systemic and market failures that may lead to an underinvestment into research and development. As this evaluation focuses on the Austrian R&D support system, it is necessary to gain an overview on the overall innovation capabilities of the Austrian business sector and their change over time, in order to be able to assess the adequacy of its policies and instruments. This section therefore gives a short overview on the characteristics of the innovation activities of Austrian companies.

General overview

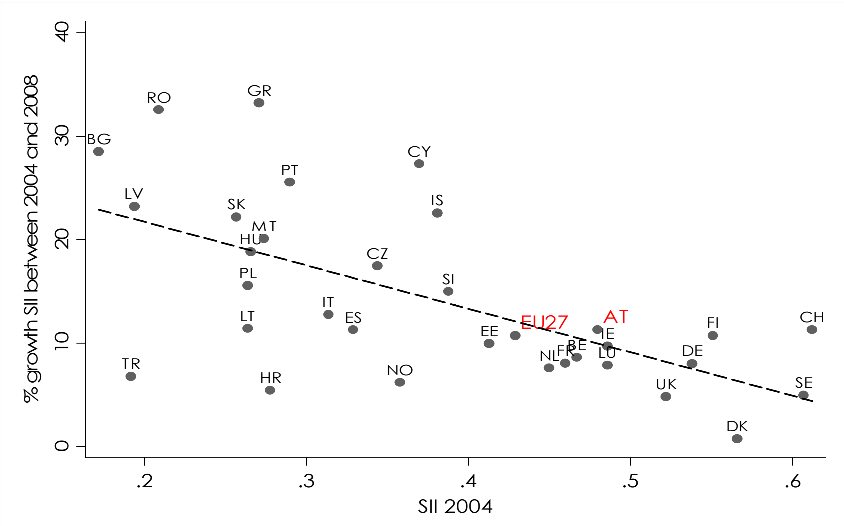
The European Innovation Scoreboard ranks EU member states into four groups of countries in dependence of their innovation potential according to the scores the countries have attained in the Summary Innovation Index (SII) that condenses the information of thirty different indicators into one composite index.[11] In the year 2008 the United Kingdom, Denmark, Germany, Finland and Sweden ranked as innovation leaders. Austria, Belgium, France, Ireland, Luxembourg and the Netherlands are the innovation followers, with SII scores below those of the innovation leaders but equal to or above that of the EU27.[12] Austria is in the group of innovation followers, but the latest EIS Report has argued that it could join the group of the innovation leaders the coming years.

Figure 2.4 shows that between 2004 and 2008 a process of convergence across the EU has taken place. Countries with a relatively high score in the Summary Innovation Index in 2004 such as Austria have progressed more slowly, whereas countries that scored low in 2004 were able to improve their Summary Innovation Index more rapidly than other countries. Despite Austria's recent progress towards the group of innovation leaders, annual changes in the relative position of the country with respect to other countries should not be considered. Data are rarely consistent the year they are delivered by the statistical offices. What is more relevant is the relative stability of Austria in the group of innovation followers for several years now. This indicates that despite the progress made in the past decade Austria has not yet made the transition into a position of technological leadership.

[11] The use and interpretation of this composite indicator is critical: by construction the indicator is based on the implicit assumption that all sub-indicators entering the SII are mutually independent. This leads often to the interpretation that their effect is cumulative and substitutable, i.e. that weaknesses in one indicator can be compensated by strengths in another indicator. However, many sub-indicators are interdependent. When interpreting the scores of the SII it is therefore necessary to consider the systemic interdependencies and design policies accordingly. For a discussion of the limits of composite indicators such as the SII see *Munda and Nardo 2005*.

[12] The four groups of countries identified by the EIS are the catching up countries (BG, LV, RO, LT, PL, SK, HU, MT), moderate innovators (IT, GR PT, ES, CZ, SI, EE, CY), innovation followers (NL, FR, BE, LU, IE, AT), and innovation leaders (UK, DK, DE, FI, SE, CH). See List XX in the appendix for country abbreviations.

Figure 2.4: Process of convergence in the Summary Innovation Index (SII) of the European Innovation Scoreboard



Source: European Commission 2009, WIFO calculations.

The thirty indicators, used to construct the SII of the European Innovation Scoreboard, are organised in three groups. One summarises information on innovation activities, the second comprises indicators describing the outcomes of innovation activities and the third one captures the framework conditions for innovation. Important aspects of the first two groups will be discussed in this section, whereas strengths and weaknesses in the framework conditions for innovation will be discussed in the next section.

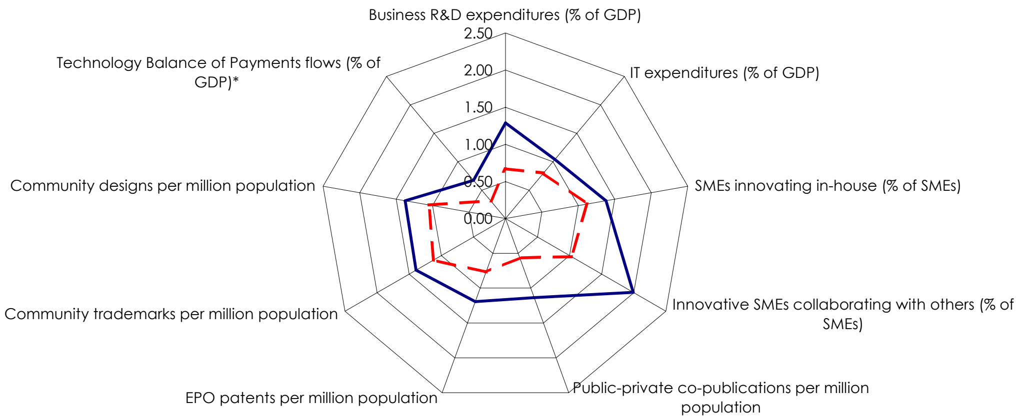
Innovation activities of firms

The overall picture on innovation activities in the Austrian business sector form the EIS sub-indicators

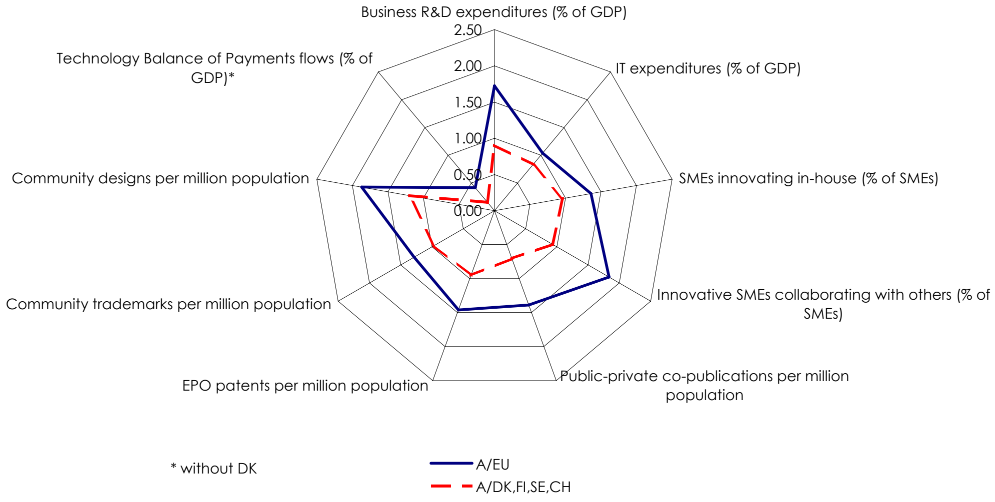
Figure 2.5 shows the development of indicators for innovation activities of the Austrian business sector over time. It relates the indicators to the EU 27 average (solid line) and to the average of the small open economies in the group of EIS innovation leaders (Sweden, Denmark, Finland, Switzerland; broken line). If an indicator in the figure is larger than one the value measured for Austria is larger than that of the benchmark. The upper quadrant shows the relative values for 2002, the lower quadrant the values for 2008. It is apparent that already in 2002 the majority of indicators for Austria lie above the EU 27 average. This is the case for the share of business expenditures on R&D (BERD), the share of small and medium enterprises (SMEs) collaborating with other companies, EPO patent applications, and the number of registered community trademarks and designs in terms of per million of population. The Austrian Innovation System fell behind the EU 27 average only in the technology balance of payments indicator that measures the openness of the Austrian economy in terms of royalties and license fees paid and received. The lower quadrant of Figure 2.4 shows that the relative strengths and weaknesses observed in 2002 have widened relative to the EU 27 average over time. Nevertheless, Austria trails the group of innovation leaders in most indicators. In 2002 Austria performed better or as well as the benchmark for the innovation leaders only for the share of innovative SMEs, the share of SMEs with collaborations and the use of community trademarks and designs. Austria lagged behind the reference countries in filed EPO patents, public-private co-publications, IT investment, the technology balance of trade and the share of business expenditures on R&D. By 2008 Austria has caught up in most indicators, but it continues to lag behind in public-private co-publications, IT investments and the technology balance of payment. We are going to interpret this evidence later. Now we focus on some crucial aspects of the innovation activities of the Austrian business sector.

Figure 2.5: Innovation activities, EIS 2008 indicators

2002



2008

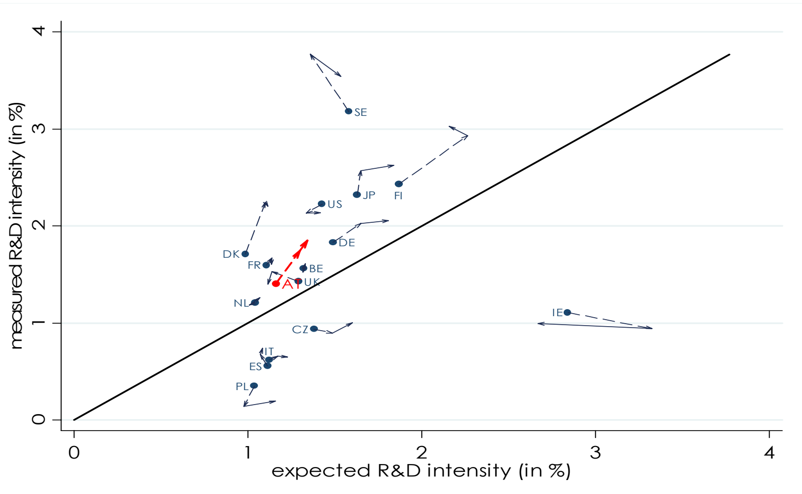


Source: Eurostat, Pro-Inno Europe, WIFO representation.

R&D and technology diffusion in the business sector

The R&D investment by the Austrian business sector has contributed most to the fast expansion of R&D spending in the past two decades in Austrian. The share of total R&D performed by the business sector has grown from 55.8% in 1990 to 70.4% in 2006. Between 1981 and 2007 Business enterprise R&D (BERD) has increased from 0.62% to 1.8% of GDP. BERD has therefore expanded more rapidly in Austria than both the EU 15 and the OECD average. However, the development was less dynamic than in Sweden or Finland where business R&D investment has expanded faster.

Figure 2.6: The development of business R&D over time and structural change 1998-2004

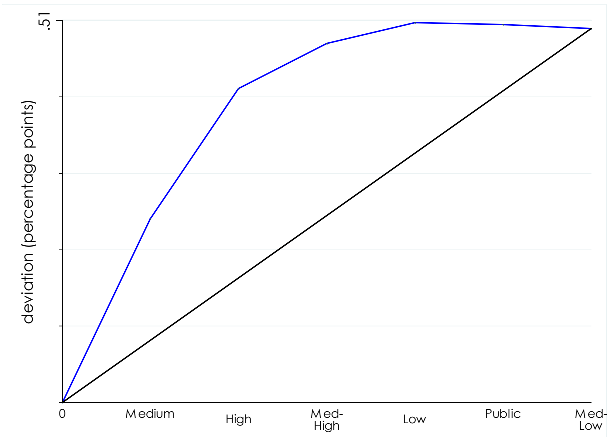


Structurally adjusted business R&D intensity between 1998 and 2004

Source: OECD ANBERD data, WIFO calculations. For details on the used method see Reinstaller – Unterlass 2008.

Figure 2.6 shows the dynamic expansion of business R&D investment in Austria and other OECD countries. The figure plots the structurally adjusted values for business R&D. As BERD is largely determined by the industry structure of a country direct comparison of BERD shares across countries is not admissible. Countries differ in their industrial specialisation profile. Structural adjustment corrects for this industry effect? In the figure the vertical distance of an observation from the diagonal line indicates the importance of country specific effects as opposed to the industry effect. If a deviation is significant, country effects are very important. On the other hand, given the way the structurally adjusted R&D intensity is calculated the farther on the right an observation lies, the higher is the technological intensity of the industrial structure of a country. For Austria we see that the Austrian business sector holds an intermediate position in terms of its technological intensity. Nevertheless, between 1998 and 2004 structural change towards industries with a higher technological intensity has taken place as indicated by the arrow pointing to the right. Despite this structural change the technological intensity of the Austrian business sector remains below that of innovation leaders like Finland, Sweden, Denmark or Japan. On the other hand, there is also a considerable country specific effect. Given its industrial profile in 2004 the R&D intensity of the Austrian business sector would have been expected to be close to 1.3% of GDP. However, it was above 1.8%. The country specific effect was therefore half a percentage point. This indicates that the Austrian industries on average invest more in R&D than across the OECD. Unreported results indeed show that the R&D intensity in almost all industries lies above the OECD median.[13]

Figure 2.7: Concentration of country specific effects in R&D spending 2004 in Austria according to the innovation intensity of industries.



Source: OECD ANBERD data, WIFO calculations. For details on the used method see Reinstaller – Unterlass 2008. Country specific contribution of industry groups is calculated as deviations from the OECD median R&D intensity in each group.

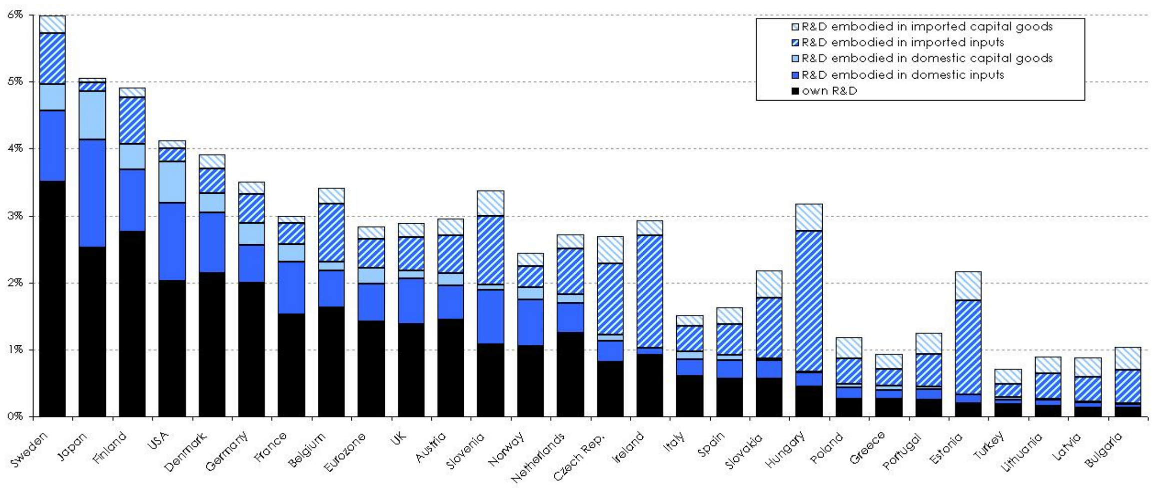
Figure 2.7 plots the distribution of country specific effects across industry groups following the WIFO taxonomy for innovation intensity (see Box A.C.1, p. XXX). It shows that the R&D investment in the Austrian business sector is highest in the industries with medium innovation intensity and not in those with high innovation intensity. The Austrian business sector is therefore specialised in medium innovation intensity sectors in terms of R&D investment.

Figure 2.8 gives an idea on the relationship between direct and input-embodied R&D investment in Austria in comparison to other OECD countries. It is the result of an input-output

[13] The country specific effect is highest in the electrical equipment industry (see *Reinstaller—Unterlass 2008*).

analysis that has been carried out with the latest available data on input-output relations, and business R&D. By input-embodied R&D investment we mean the R&D investment that was carried out by the suppliers of capital good or other inputs used in domestic production. Input-embodied R&D investment therefore captures the investment into technologies or more generally technology diffusion. This indicator therefore gives important cues on the overall technological capability of the business sector, and it also gives evidence on where the domestic business sector is positioned in the international value chain. The figure shows five different categories of direct of input-embodied R&D investment. There is R&D embodied in foreign capital goods or inputs, R&D embodied in domestic capital goods or inputs, and finally direct R&D investment by firms. The share of embodied R&D in foreign capital goods or inputs reflects how much the domestic business sector is dependent upon external technology. The share of domestic embodied R&D capital goods and inputs as well as R&D investment proper capture the technological intensity of domestic production.

Figure 2.8: Direct and indirect R&D investment



Source: OECD ANBERD 2006, OECD Input-Output tables 2006, Eurostat Input-Output tables. Knell 2008. WIFO representation.

Figure 2.8 shows that less developed countries have low shares of both direct and input-embodied R&D, some countries (such as Ireland, Hungary or Estonia) rely heavily on foreign technology intensive goods but do not engage into own knowledge creation and technology production, and finally the more advanced have a high domestic share of both direct and input-embodied R&D. Austria is part of this group. Austria and other countries in the group of innovation followers invest relatively more on embodied R&D investment in relationship to direct investment than innovation leaders such as Sweden, Finland or Japan.

This implies that R&D intensive goods are important conduits of technology transfer between national as well as foreign industries for the Austria business sector.

Input-embodied R&D investment is typical for industries with a lower (low) technological intensity. The relative importance of this source of technology in relation to direct R&D reflects the fact that most firms in the Austrian business sector do not operate on the technological frontier.[14]

The internationalisation of R&D and the opening of the innovation process

Evidence on foreign direct investment discussed before has shown that in the past two decades the inflows of investment have been substantial. The question therefore is whether these have also led to the internationalisation of R&D and structural dynamics in the Austrian business sector. Looking at the sources of the R&D funds the data show that the share of total R&D financed by the domestic business sector has remained largely below the OECD and EU 15 average. In 2006 just 48.4% of total R&D was financed by the domestic business sector whereas the figures for the EU 15 and the OECD stood at 55.6% and 63.9% respectively. The cause for this deviation is the high share of Austrian R&D funded from abroad. It rose from 3.78% in 1990 to a peak level of 19.86% in 2000 and went down to 18.41% in 2006. In the business sector that same year 23.9% of R&D was financed from abroad whereas the EU 15 average was 10.03%. The concentration of R&D expenditures by foreign firms is also highly skewed. The four largest firms account for almost 80% of total R&D expenditures of all foreign firms (see *Gassler – Nones 2008*). BERD financed by the government has risen from 5.6% in 1998 and 2002 to 9,6 % in 2006. This figure lies above both the EU15 and the OECD averages for the year 2006 of 7.1% and 6.8% respectively. The Austrian development does also not follow the general trend in the EU 15 and the OECD for this indicator. Whereas the shares of government financed BERD were between 14 and 15% in 1990, they have fallen over time to the lower levels indicated above. In Austria in turn the level was initially much lower (1990: 5.6%) reflecting the structural deficits of the Austrian economy. The figures indicate that Austrian affiliates of foreign firms are very dynamic elements in terms of R&D investment. An examination of multinationals in Austria has confirmed that they are generally more innovative and also active in more technology intensive sectors than domestically owned firms see *Gassler – Nones 2008* for an overview).

To examine the internationalisation of research activities in the business sector further we look at patent data. Patent data indicate name and address of both the inventor and the applicant, i.e. the owner of the patent at the time of the application. In a growing number of

[14] This wholesale argument needs to be considered with care. Results for the automotive industry and the ICT equipment producing sector (see Figure A.I.1 in the appendix) show that there are differences across Austrian industries. Whereas in the automotive sector the mix between complex component producers and assembly plants determines a lower share of direct R&D and a higher use of R&D embodied in foreign inputs. The ICT producing sector has a higher share of direct R&D as opposed to foreign input-embodied R&D. For more information on cross country differences in innovation and the classification of countries on the basis of input-embodied and direct R&D see *Reinstaller – Unterlas--Böheim* (2009).

cases the country of residence of inventor and applicant are different and this cross-border ownership captures that multinational enterprises undertaking research in foreign markets either try to adapt products and processes to host markets or source specific important knowledge assets. Typically in the literature the foreign ownership of domestic inventions and the domestic ownership of foreign inventions are used as indicators to characterise the internationalisation of knowledge creation and innovation activities. Table 2.11 shows that large shares of domestic inventions are therefore under foreign control (about 40% of all Austrian EPO patent applications), whereas Austrian owners control just about half as many inventions as for instance Swiss owners (AT: 23,72%, CH: 55% in 2005). The relatively high share of domestic inventions controlled by foreign firms mirrors the results from the analysis of the R&D statistics. Table 2.11 shows also that a large majority of domestic inventions is owned by German firms. Foreign firms engage into R&D activities in Austria in order to tap into specific competencies or to exploit specific characteristics of the R&D support system. In comparison to countries that are innovation leaders the share of foreign ownership of patents in Austria is relatively high. The share of domestically owned patents of inventions made abroad (in terms of total patents owned by country residents) is similar to those observed for countries that are innovation leaders. However, it far below the values observed for Switzerland. Overall, the two indicators suggest that a few large foreign players by and large are carrying out research in business in Austria.

Table 2.11: EPO patent applications (% share of all applications in a country)

		Foreign ownership of domestic inventions							Domestic ownership of inventions made abroad						
year		1999	2000	2001	2002	2003	2004	2005	1999	2000	2001	2002	2003	2004	2005
Austria	World	38.80	36.77	39.75	42.18	37.91	39.37	39.46	21.55	26.23	28.34	30.77	29.08	26.96	23.72
	Germany	24.27	22.75	24.52	25.86	19.35	19.56	19.91	10.08	12.26	13.72	15.13	15.13	15.10	13.00
	Switzerland	6.33	6.03	4.93	4.58	6.60	5.24	6.32	6.79	7.61	7.35	7.69	8.08	7.11	4.57
	EU 27	27.19	25.65	29.46	31.50	26.27	28.70	28.23	14.33	16.38	19.55	21.20	20.84	20.95	16.23
Denmark	World	24.28	22.27	25.64	22.54	22.21	22.64	21.23	19.35	15.30	20.19	21.59	20.87	22.52	18.22
	EU 27	15.69	12.99	12.52	11.08	10.62	9.16	11.25	12.82	10.98	12.53	13.96	14.34	14.58	11.71
Finland	World	9.41	11.38	10.78	9.14	9.40	8.39	11.50	23.37	24.71	27.83	28.29	25.76	27.90	27.51
	EU 27	5.11	6.29	6.56	5.67	5.70	4.78	6.61	15.78	16.12	18.59	15.53	14.77	12.63	14.16
Sweden	World	18.32	19.00	19.98	20.56	20.65	21.85	21.31	27.60	29.81	31.44	28.34	34.41	33.66	34.42
	EU 27	9.86	10.16	10.38	10.12	11.01	11.09	10.40	18.49	20.69	23.23	21.02	23.43	20.55	21.01
Switzerland	World	24.91	24.02	24.20	24.49	24.24	24.50	24.75	48.48	49.57	50.83	52.04	52.78	51.80	55.16
	EU 27	16.46	16.59	15.02	16.40	16.47	17.37	17.98	36.57	35.44	35.53	36.41	37.26	37.79	40.48

Source: OECD STAT 2009.

Two other indicators also support the findings from Table 2.11. One is the technology balance of payments; the other is the international co-invention of patents. The technology balance of payments captures payments and receipts in terms of fees and royalties for patents, proceeds from sales, licensing or franchising of designs, trademarks and patterns, trade in services with technical content and inter-industrial R&D. Figure 2.5 indicates that Austria was performing well when compared to the EU 27 average in terms of EPO patent filings, in community trademarks and designs. Nevertheless, payments and receipts are below the EU 27 and the OECD average in levels and in the sum of the payments and receipts (reflecting the openness of Austria in terms of technology trade; AT: 2,17 %; EU: 4,2 % GDP). The balance is also negative (-0.26% GDP) reflecting that the outflows in terms of royalties and fees paid are exceeding the inflows. The fact that technology payments exceed receipt suggests that Austria is a net importer of technology. However, as the technology balance of payments captures also operations between parent companies and affiliates, it is possible that this valuation is distorted. The largest R&D investors in Austria are international firms that in most cases register their patents through their headquarters abroad. As a consequence, flows of royalties and license fees are registered for the country where the headquarters are located and not the Austrian affiliate. The figures suggest that foreign firms largely dominate technology development in Austria. This may hint at some vulnerability of the Austrian National Innovation System. It is necessary to support the embedding of multinational enterprises (MNEs) in Austria in terms of technological capabilities and the quality of human capital if this development should be sustainable.

Table 2.12: EPO patent applications (% share of all applications)

		International co-inventions						
Year		1999	2000	2001	2002	2003	2004	2005
Austria	World	23.38	25.36	28.05	28.12	24.44	26.02	24.45
	Germany	15.99	16.79	18.96	19.10	16.93	16.94	14.83
	Switzerland	3.49	2.98	3.31	2.98	3.92	3.84	3.54
	EU 27	18.75	20.49	23.33	22.68	19.54	21.02	18.67
Denmark	World	18.56	16.60	22.02	21.77	19.58	21.59	16.37
	EU 27	12.41	11.52	14.09	14.74	12.64	13.22	11.59
Finland	World	10.89	13.96	15.46	15.55	13.03	14.41	16.18
	EU 27	6.99	8.21	10.51	9.14	8.66	8.11	9.85
Sweden	World	16.37	16.55	17.52	15.82	16.87	17.65	18.23
	EU 27	9.49	10.49	11.20	10.03	11.41	12.11	11.57
Switzerland	World	30.02	31.11	30.64	33.39	33.09	34.99	36.11
	EU 27	24.50	24.76	25.32	27.47	26.86	28.66	30.73

Source: OECD STAT 2009.

Table 2.12 shows international co-inventions that present the share of patents of national inventions involving inventors with different countries of residence. Compared to the small open economies in the group of innovation leaders, the level of international cooperation is relatively high. Only in Switzerland it is about ten percentage points higher. This is additional evidence for the important role multinational firms especially from Germany are playing for innovation in Austria. Indeed, Germany is by far the most important country of origin of inventors in co-invented patents. On the other hand, it captures also the interest of international partners in specific competencies offered by Austrian inventors and researchers.

The effects of innovation on Austrian business

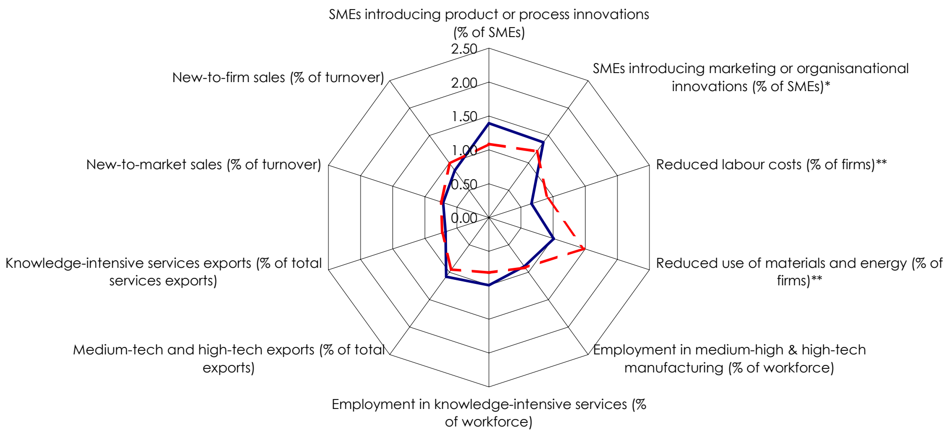
Innovation activities in the Austrian business sector

Figure 2.9 shows indicators used for the European Innovation Scoreboard comprising innovation outcomes for the years 2002 and 2008. According to the figures for 2002 Austria performed well as compared to both the EU 27 average and the average of the innovation leaders in terms of innovative SMEs and the reduced use of materials and energy through innovation. In 2002 Austria fell drastically behind both the EU 27 and the innovation leaders in terms of the average share of turnover from new to market product innovations; a bit less drastic was the difference between Austria and the innovation leaders in the indicators capturing the employment share of as well as the exports in knowledge-intensive service industries. By 2008 Austria's position has markedly improved in terms of share of turnover from new to market product innovation and new to firm product innovations relative to the innovation leaders. The weaknesses related to the knowledge intensive service industries observed in 2002 persists over time. The same holds for the relative strengths.

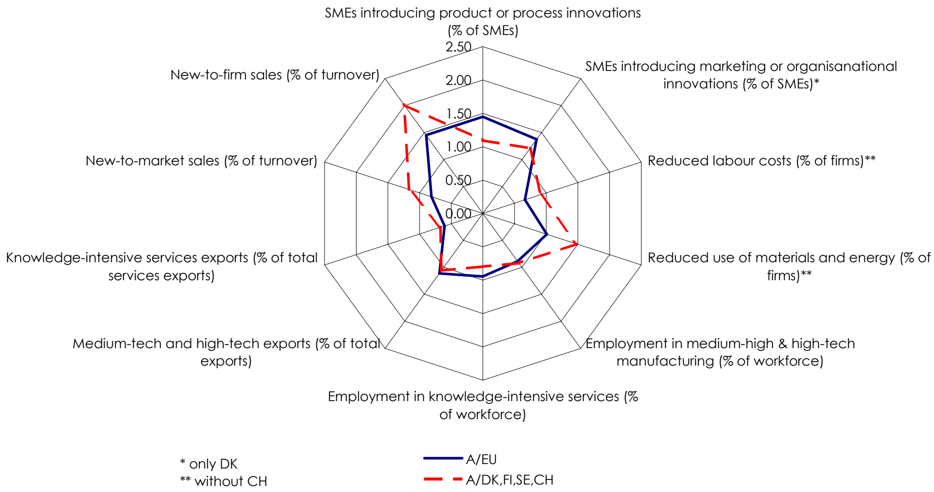
The evidence documents a gradual change in the growth regime. Indicators on innovation outcomes in 2002 captured a catching-up regime, where innovation in processes and new to firm product innovations were – especially for SMEs -- a means to keep production costs (expressed for instance in the use of materials and energy) low. In 2008 the situation has changed insofar as after 2002 businesses have started to make a transition towards an innovation led regime based on product innovations. This emerges also if the evidence is combined with the results presented in Figure 2.5 that clearly show that R&D investments have been considerably expanded relative to the EU 27 and the innovation leaders and that at the same time also innovation activities in terms of filed patents, trademarks and design have increased. The indicators in Figures 2.6 and 2.9 indicate also that this intensification of innovation activities is taking place alongside moderate structural changes towards more technology and knowledge intensive industries. However, this development has not affected indicators for structural change towards high-tech and knowledge intense(-ive) sectors. The stable position of the indicators for medium- and high-tech employment and exports as well as employment and exports in knowledge-intensive service industries have remained stable over time relative to the EU 27 and the innovation leaders. This evidence explicitly mirrors the results on the structural dynamics in Austria presented earlier in this report.

Figure 2.9: Innovation outcomes, EIS 2008 indicators

2002



2008



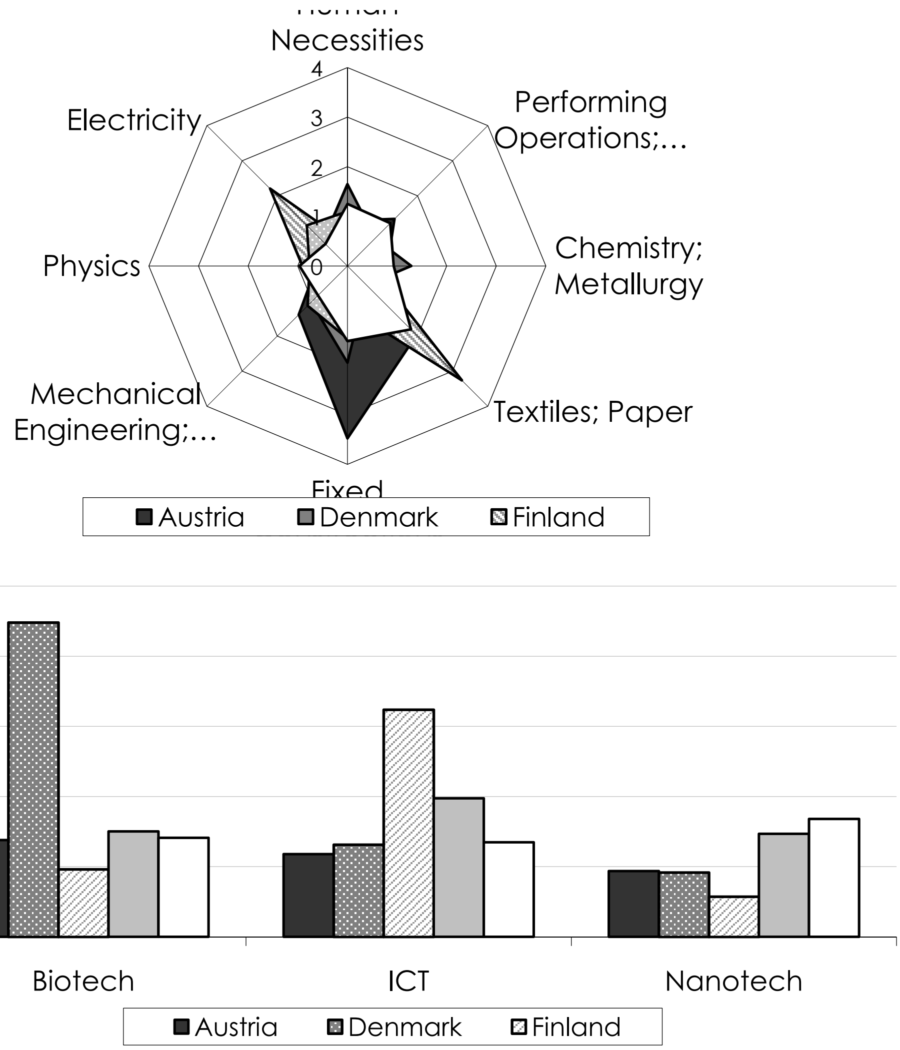
Source: Eurostat, Pro-Inno Europe, WIFO representation. * only DK, ** without CH

Patenting and knowledge specialisation profiles

The analysis of patent data shows that the specialisation of inventive activities in Austria lies in areas such as fixed construction and mechanical engineering (see Figure 2.10 upper quadrant). The relative specialisation in fields like fixed constructions, mechanical engineering and to some extent metallurgy reflects very much the structural profile of the Austrian business sector and its long-standing competencies in these technological fields. In technological areas generally considered to be future growth drives such as biotech, ICT or nanotechnology specialisation is very limited (see Figure 2.10 lower quadrant). The fact is remarkable because for many years these areas have been supported by the Austrian Research Promotion Agency (FFG) with thematic programmes. However, in terms of patenting by Austrian inventors these programmes seem to have had little impact. The general picture captured by Figure 2.10 is supported by a more detailed and also dynamic analysis presented in the Austrian Research and Technology Report 2008 (Bundesministerien 2008). The results presented there show that relative strengths in areas such as constructions, metallurgy or mechanical engineering have deepened between 1993 and 2003. In areas such as material processing or semi-conductor technologies a relative comparative advantage has emerged over time. Areas where weaknesses have persisted or gradually emerged over time are ICT, telecommunications, optics or biotechnologies. Similarly, pharmaceutics, chemical processes and organic chemistry are areas with a persistent weakness. In a number of technology areas such as medical technologies or polymers patenting has been stable and did neither reveal a comparative advantage, nor dynamics of change.

This evidence suggests that technical change and innovation in Austria have largely focused on the technological upgrading of processes and capabilities in given industries. This has been supported by the expansion of R&D investment. Structural change towards more technology intensive industries as presented in Figure 2.5 on the other hand was mostly driven by the gradual decline of importance of less technology intensive industries and not so much through a change of technological capabilities in the Austrian business sector (sees also *Reinstaller – Unterlass* 2008).

Figure 2.10: Revealed comparative advantage (RCA) in patenting, broad technology classes and specific high tech fields



Source: OECD MSTI; WIFO calculations. RCA was calculated in relation to world shares of patents in technology classes.

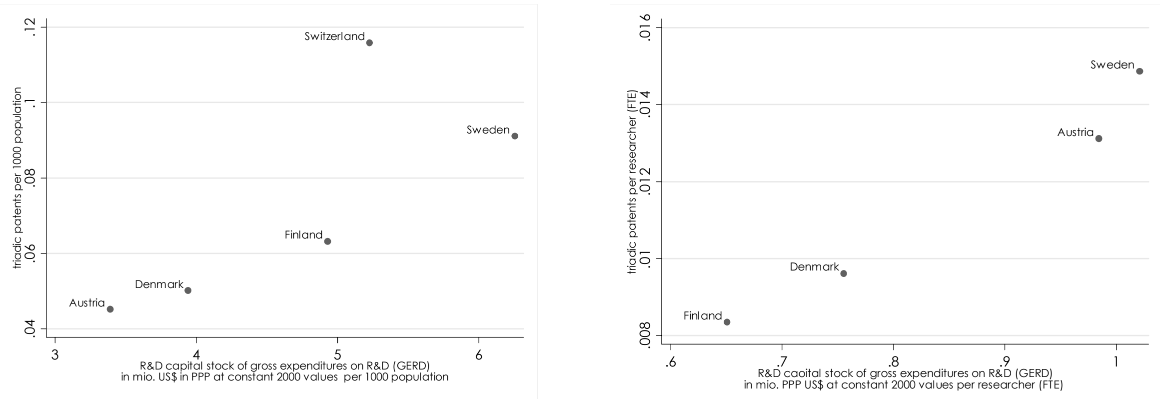
Note: Patents counts are based on the priority date, the inventor's country of residence and fractional counts.

Efficiency of innovation activities

Efficiency of innovation activities is generally improved if with the same amount of innovation inputs more innovation outputs are achieved, i.e. the efficiency of innovation activities is intrinsically related to the productivity of outlays for innovation. In general, it is difficult to measure the efficiency in innovation processes because innovation is no straight linear process where research and development activities are *directly* transformed into some innovation output. Despite these difficulties, innovation efficiency is an important notion for two reasons: Firstly, as innovation activities are in many instances supported with public funds, it is important to assess whether these funds are spent in the best possible way. Secondly, research and development productivity and innovation efficiency become increasingly important factors in the knowledge sourcing decisions of firms. Indeed, the relocation of R&D activities by large multinational firms are not only determined by specific knowledge and competencies firms can source in a country, but also by the productivity of R&D activities in that country. This implies that in the presence of similar competencies preference is given to a location where results can be produced more quickly (*Harrison – Griffith – van Reenen 2006*).

Aggregate measurements of the efficiency of innovation in Austria generally testify Austria an above average efficiency in transforming innovation inputs into applications (see e.g. *Lee – Park 2005*, *Hollanders – Celikel Esser 2007*, *European Commission 2009a*). However, the aggregate cross-country nature of these exercises makes it difficult to develop a more differentiated perspective of this issue for Austria, even more so as these exercises compare countries with very different levels of economic development. The indicators presented here are simpler but try to capture some salient features of the efficiency of R&D in Austria. The left quadrant of Figure 2.11 shows the relationship between "capital stock" of total R&D expenditures per capita and the number of triadic patent families per capita.[15] Triadic patents are an indicator for significant inventions as these have been filed in the three major patent offices (USPTO, EPO, JPO). The result indicates that countries that have invested more in R&D over time are also more likely to produce more significant inventions.

Figure 2.11: The relationship between the R&D capital stock and triadic patents



Notes: OECD MSTI; WIFO calculations. Patents counts are based on the priority date, the inventor's country of residence and fractional counts. R&D capital stock in mio. US$ PPP at 2000 values. The R&D capital stock has been calculated using the perpetual inventory method on the basis of past R&D investments.

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[15] The use of patents in relation to R&D expenditures as indicators for efficiency is often contested, as patenting propensities vary across industries and countries. However, Rassenfosse -- van Pottelsberghe (2009) argue that international filings, especially triadic patents capture variations in research productivity. We therefore use triadic patents and EPO patent applications in the following analysis.

Due to the relatively recent history of Austria to invest into R&D, the R&D capital stock per capita is relatively low and as a consequence also the number of significant inventions is at lower levels than in countries like Switzerland or Sweden that have a longer tradition in investing into research, but it depends also on the industrial structure of the countries. The figure also indicates that Switzerland needs less R&D investment than both Finland and Sweden in order to achieve a higher level of triadic patents per capita. The right quadrant of Figure 2.11 relates the R&D capital stock and the number of triadic patents to the number of researchers in each country. This gives a better indication on the productivity of research and development processes in each country as the per capita figures that are better suited to correct for country size. The right quadrant of Figure 2.11 shows that innovation processes in Austria seem to be quite productive in terms of patenting output. Austria performs better in this respect than Finland or Denmark and falls only behind Sweden. For Switzerland no data on the number of researchers are available.

Table 2.13: Decomposition of the productivity of knowledge production (as measured by triadic patents) in Austria and innovation leaders

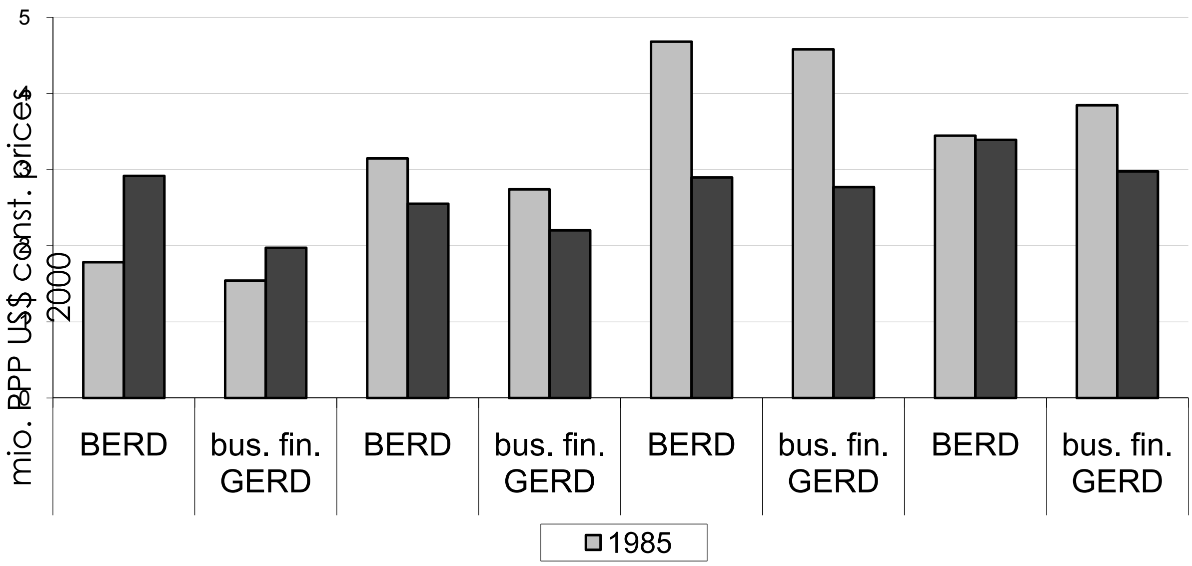
	Triadic patents/ 1000 researchers =	Triadic patents / R&D capital stock X	R&D capital stock/ 1000 researchers
Austria	12.18	0.0133	914.39
Denmark	9.05	0.0127	711.72
Finland	7.77	0.0128	606.93
Sweden	14.64	0.0146	1005.77

Notes: OECD MSTI; WIFO calculations. Patents counts are based on the priority date, the inventor's country of residence and fractional counts. R&D capital stock in mio. US$ PPP at 2000 values. Researchers are total researchers in full-time equivalents. Data on researchers are not available for Switzerland.

Table 2.13 presents a simple decomposition of the evidence presented in Figure 2.11. It decomposes the R&D productivity as measured by triadic patents per thousand researchers into a figure capturing the productivity of the R&D capital stock, and another figure capturing the productivity of R&D in terms of the R&D capital stock per researchers. The results indicate that the productivity of R&D investment is slightly above that of Denmark or Finland. However, the good result for Austria is determined by the relatively large R&D capital stock per researcher, which is due to the relatively small population of researchers in Austria, and dynamic expansion of R&D investment in the past decades. This evidence can be interpreted in two ways: it could either mean that Austria has been active in technology intensive fields (requiring high levels of R&D capital per researcher) in which technological opportunities could be exploited well (captured by the relatively high R&D capital productivity), or it could mean that Austria has increased the technological intensity in previously less technology-intensive fields where intensification is a precondition to exploit further technological opportunities. This would imply thatresearch and development have led to an upgrading of areas previously considered to be low- or medium tech. The evidence presented so far suggests that the second option is more likely to be true, and evidence presented in Figure 2.12 lends additional support to this conjecture.

Figure 2.12 shows the R&D expenditure per patent of businesses (not triadic patents) in 1985 and 2005 as compared to Denmark, Finland and Sweden.[16] The figure shows total R&D expenditures by businesses as well as total R&D financed by businesses per patent. The difference between the two indicators is that R&D financed by business includes also public subsidies to business R&D and therefore captures to a large extent private and public costs of patents, whereas R&D financed by businesses alone captures only the private cost of patents to firms.

Figure 2.12: R&D expenditures per patent



Source: OECD MSTI; EPO patent applications; WIFO calculations.

Note: Patents counts are based on the priority date, the inventor's country of residence and on fractional counts.

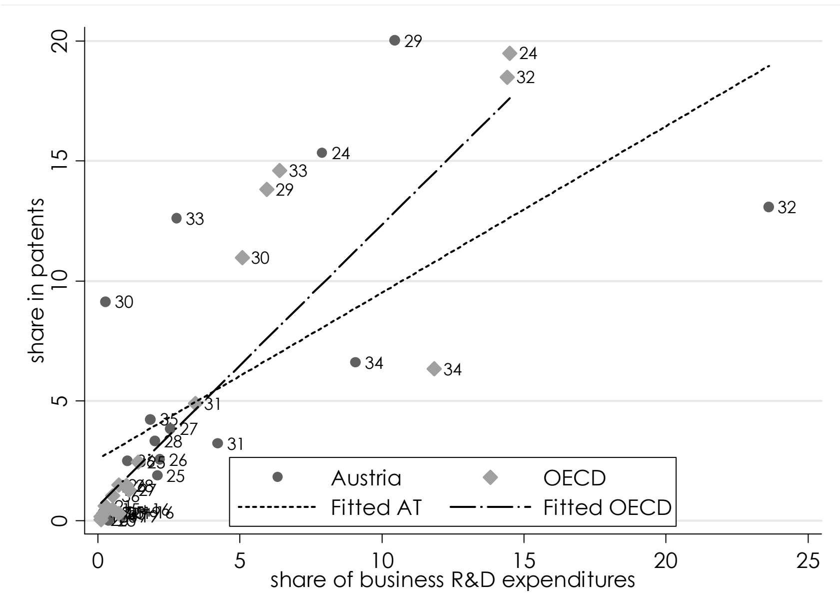
Two aspects in Figure 2.12 are worth mentioning. The first is that compared to other countries the 'costs' per patent were relatively low in Austria in 1985. The second aspect is that whereas costs per patent have fallen over time in the other countries shown in the figure, they have risen in Austria. This increase of costs per patent over time indicates a low productivity of R&D in Austria and could potentially be troubling. It could imply that the expansion of R&D investments in the business sector was inefficient, or that R&D has expanded most dynamically in sectors that have a low propensity to patent. However, the evidence presented in Figure 2.11 suggests that the most plausible interpretation is that the patents have become more costly in Austria, as their technological content and sophistication have increased over time. This upgrading process has increased the costs incurred per patent. The causes for the drop in R&D investments per patent in the other countries can have several

[16] Note that there is also a change in perspective in as in Figure I.8 total R&D expenditures were shown, whereas in Figure I.9 only business R&D expenditures are shown. However, this part of gross expenditures on R&D has grown most dynamically over time while other aggregates have by and large expanded just in proportion to nominal GDP.

causes, however a likely interpretation is that the other countries have more R&D intensive patents and they have tried to increased their research productivity over time. However, this purely descriptive evidence cannot replace a more rigorous study of the phenomenon. The interpretation of the statistical material presented here should therefore be considered carefully.

A final aspect that emerges from Figure 2.12 is that business expenditures on R&D per patent have increased more than total R&D costs financed by businesses per patent. In other words, 'public' and 'private' costs per patent have increased more markedly and are indeed higher than in Denmark and as high as in Finland, whereas 'private' costs have remained low relative to Denmark, Sweden and Finland. This indicates that the upgrading of the technological content of Austrian patents has been heavily supported by public subsidies. This aspect would merit further research. For firms the lower (private) cost for patents, the high productivity of the R&D process and the support for R&D make Austria certainly an attractive location for R&D. However, there are also a number of less favourable factors: the technological focus of industry research has changed little over time, the number of researchers in Austria is low, and other framework conditions are not so favourable to an innovation based growth regime. For this reasons concerns remain on whether this advantage is sustainable.

Figure 2.13: The relationship between R&D investment in the manufacturing sector and patenting (averages 1999-2005), Austria in comparison to the OECD average



Source: OECD MSTI; WIFO calculations;
Note: Patents counts are based on the priority date, the inventor's country of residence and on fractional counts. Numbers close to the dots indicate the NACE code numbers (see appendix for list). Patents have been allocated to industrial sectors through the NACE-IPC correspondence table provided by the European Commission (DG Research).

Figure 2.13 is trying to provide some indication on the efficiency of innovation in the Austrian National Innovation System at the industry level. The comparison is in relation to the average across OECD countries. The figure captures the efficiency of R&D expenditures and not on the efficiency of the R&D process. R&D investments and patenting differ considerably across industries reflecting differences in technology, in technological opportunities, and appropriability of inventions. The left quadrant of Figure 2.13 plots the share of total business R&D executed in any particular industry against the share of EPO patents in total patent applications filed in each industry. Typically industries investing more in R&D should also patent more even though the propensity to patent may vary across industries. This is represented by the straight lines that capture this relationship for Austria and the OECD countries. The steeper these line, the more efficient are the R&D expenditures on average across all industries. The difference in slopes between the regression line for the OECD and Austria indicates that R&D expenditures are less efficient in the Austrian industry than on average in the OECD countries. However, the results for Austria are largely determined by one industry (NACE 32 – communication technology) that spends about one quarter of the total R&D investment of the entire business sector. However, the share of patents filed by this sector in the total patents filed by the business sector is much lower. Across the OECD countries firms spend on average less on R&D and patent more in this industry. If this (however significant) outlier is removed, the slope of the regression line for the Austrian sector is very similar to that obtained for the OECD countries. This result needs to be interpreted with care as statistical classifications of research and development figures and the concordance table between industry classifications and technology classes for patents are likely to introduce a bias such that R&D investments in this sector may be overestimated and the assignment of patents to the industry may under assign relevant patents. Further research is certainly needed on this issue.

A pair wise comparison of the values observed for the Austrian industries with the OECD average for these industries reveals that the machinery (NACE 29), the basic metals (NACE 27), the fabricated metal products (NACE 28), and the mineral products industries (NACE 26) in Austria spend more on R&D and patent also relatively more. The motor vehicles (NACE 34) and the transport equipment (NACE 35) industries are more efficient than the OECD average as they spend less on R&D but patent more. The communication technology industry, the electrical equipment industry and the rubber and plastics industry are relatively inefficient in terms of R&D outlays per patent. Overall this is additional evidence for the technological upgrading of medium tech industries.

Conclusions

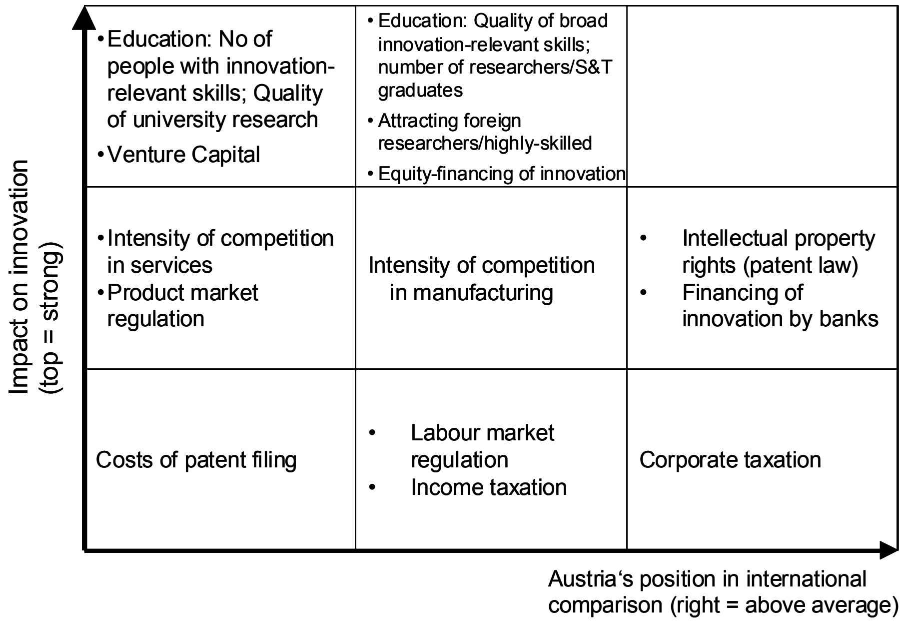
The evidence presented in this part of the report shows that the Austrian business sector is developing into an innovation led growth regime. Most indicators show that over time the technological intensity and innovation activities have expanded. This change was mostly driven by the (technological) upgrading of technological capabilities in the established industries that are predominantly industries with medium to medium-high innovation intensity. This transition was not so much determined by structural change towards technology intense industries. Foreign direct investment and R&D activities of foreign firms have been very important determinants of the observed dynamics. This of course suggests some vulnerability of the Austrian National Innovation System.

The efficiency of innovation activities has shown to be relatively high in terms of innovation processes (i.e. the productivity of the R&D stock and R&D personnel). Together with the public support firms receive for R&D this contributed to relatively low R&D costs per patent. These factors certainly turn Austria into an attractive location for R&D. However, concerns remain as the technological focus of Austrian industries has changed little, the number of researchers in Austria is also low, and finally other framework conditions are also not very favourable to an innovation based growth regime.

2.5 Framework Conditions for innovation in Austria (Jürgen Janger – OeNB)

Framework conditions are public policies which influence innovation, but which are outside core innovation policy. They are crucial to assess whether a specific innovation policy is appropriate, effective and efficient. Furthermore, framework conditions need to be taken into consideration in order to gain systemic understanding of public intervention in favour of innovation.

Figure 2.14: Defining priority fields



Results of the analysis

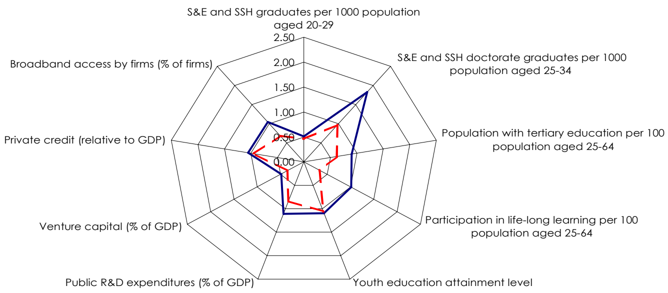
The work package distinguishes between incentives/disincentives for innovation (e.g. product market and labour market regulation, tax system) and drivers of innovation (human capital, innovation finance). It answers the following questions: Which framework conditions are relevant to the Austrian innovation system? What is Austria's international position in each policy field as measured by empirical indicators? What could be changed to improve framework conditions in Austria? Which interactions exist with core innovation policies?

Figure 2.14 shows a classification of policy fields in accordance with their impact on innovation and Austria's position in international comparison.

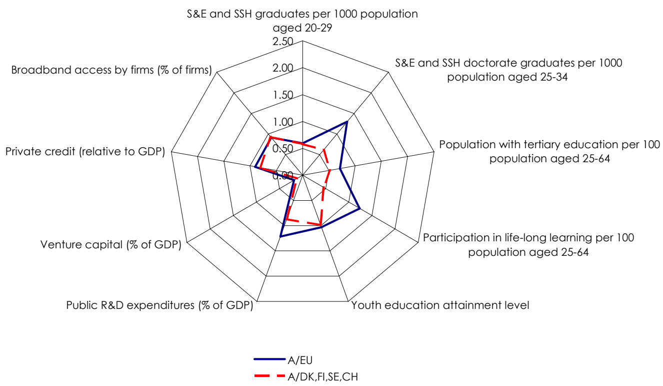
Priority fields for reform are the educational system and innovation finance; besides, competition in services and product market regulation call for improvements, too. Figure 2.15 illustrates the fact that between 2002 and 2008 Austria has improved its R&D ratio, but in areas such as tertiary education and innovation finance it did not catch up with the leading EU-innovation countries. This relative lack of crucial innovation inputs is a threat to Austria's efforts to upgrade innovation performance.

Figure 2.15: Framework Conditions supporting innovation

2002



2008



Source: Eurostat, Pro-Inno Europe, WIFO representation.

Incentives/disincentives for innovation

Increased **competition** may provide stronger incentives for innovative activity. The (limited) available evidence on Austria's relative competition intensity points to low competition in services, as manufacturing is generally exposed to global competition. To strengthen competition, the Austrian competition authority should get more resources and more powers; product market regulations in several sectors creating barriers to entry should be reformed. As a result, increased competition in Austria would spur innovative activity by using more innovations in the services sector and start up activity. Increasing competition is a very cost-effective way to improve innovations in services.

Intellectual property rights (IPR), in particular **patent rights**, can secure the private return on innovation efforts and thus foster both innovative activity and diffusion. Stricter patent rights lead to higher innovation incentives in only a few sectors. Austria's patent rights are quite strict in international comparison. However, companies in Austria as well as in all other EU countries, are suffering from high patent filing costs. A Community patent would help innovative activity of Austria's SMEs and make public support schemes for the transfer of university patents more cost-effective.

The impact of **labour market regulation** on innovation is not clear cut. While flexible employment regulation may foster cost-reducing innovations and accelerate structural change, less flexible employment regulation may incentivize the accumulation of firm- or sector-specific human capital. Austria's employment regulation is average following OECD-indicators, and reform efforts in this area do not seem crucial for improving innovation in Austria. Strict researcher immigration rules were significantly relaxed in 2008. However, a problem is to be seen in the prevalence of seniority pay and a high share of insiders in the Austrian labour market, which act as a barrier to the acceptance or admission of foreign qualifications.

Low **corporate taxation** increases the cash flow which may be potentially used for innovation financing. At the same time, however, it reduces innovation incentives arising from R&D allowance schemes. Corporate taxation does play an important role in the location decision of research-active firms, but it is considered to be less important than the quality of university research, the availability of qualified human resources and the IPR-regime. Austria's effective corporate tax burden is low in comparison. **Income taxation** may impact negatively on researcher mobility which is why countries such as Sweden grant tax breaks to foreign researchers. Austria's average income tax for higher income brackets (relevant to researchers) is average, while marginal tax rates for higher income brackets are below average.

Support for innovation

Human capital and educational systems are crucial for well-functioning innovation systems. Without appropriately qualified employees and researchers, it is difficult to develop or adopt innovations. Innovative activity in general, the level of R&D-expenditures, diffusion and absorption of knowledge and technologies, start-up activity and firm location decisions are all more or less influenced by the quantity and the quality of available human capital. To compare Austria's human capital to other countries, a distinction is made in this report between the quality and the quantity of broad, innovation-relevant skills ("the base") and the quality and the quantity of innovation-creating skills ("the top"). Generally speaking, the base matters for diffusion and absorption of innovation, the top for innovation development. A further criterion is the focus of an educational system on vocational or on general skills.

Indicators show that Austria's educational system could considerably improve both the "base" and the "top" of innovation-relevant skills; its focus is very much on vocational skills. The quality of the "base" suffers from high dispersion (a comparatively high share of students with low competence levels) and a lack of improvement from one generation of immigrant students to the next. Austrian female students show one of the lowest levels of instrumental motivation throughout Europe in the fields of mathematics and natural sciences, which means that they are little aware of how they could use these skills later on in life. The quantity of the "base" is characterised by low participation in tertiary studies as well as in vocational training for promising job areas (as opposed to traditional, declining job areas such as hairdressing or car mechanics).

The quality of the "top" suffers from outdated university structures. Old-fashioned Austrian PhD-studies do not adequately prepare for a career in science; university organisation is not conducive to scientific quality as it follows the old chair-based system with its well-known problems such as a lack of interdisciplinary research and strong hierarchies which hold back young, ambitious researchers. The quantity of the "top" is growing, but in several fields of study, such as in the engineering- and materials-related disciplines, there is a shortage of graduates. This is partly due to the very low share of women taking part in such studies (their low level of instrumental motivation, as mentioned above, influences their study choice later on).

Measures to improve the Austrian educational system must start at the pre-school level when interventions show greatest effectiveness. Higher participation in tertiary studies and a higher share of women in science- and technology-related occupations must also be fostered via reforms of the pre-university school system (especially, by introducing nation-wide standards, higher levels of autonomy for individual schools, full-day schooling, separation of children in different educational streams at a much later age than 10, and a package of measures to improve the teaching of mathematics and natural sciences, as well as showing their value for possible career opportunities).

Austrian training for careers in scientific research desperately needs a nation-wide introduction of modern, structured PhD-programmes. The career path-model should be changed to a tenure track-model as practiced internationally. This involves switching from the chair-based system to the "faculty"-model. In the latter model, tenure-track positions are filled by PhD-graduates or post-docs after an international competition has taken place, excluding the students from the university offering the position. This is in stark contrast to the career path currently discussed in Austria, which would allow students to obtain a tenure track-position at their university (i) before they have finished their PhD-studies and (ii) without international competition. Furthermore, the current career path-model in Austria maintains the hierarchy between associated and full professors which is inimical to the quality of scientific research. In the faculty model, assistant professors on a tenure track position have the same rights and duties as full professors. Another advantage of the international tenure track model based on modern PhD-studies is that scientists can enter tenure track positions and that they can get confirmed careers in science at a significantly lower age. This would be a major advantage for women.

Educational reforms concerning the vocational focus of the Austrian system should be carried out with great care, as many successful sectors in Austria partly rely on the vocational skills of the workforce. A model for modernisation could be Switzerland, where 20% of the students with vocational training have also earned the right to enter tertiary education.

Reforms to the Austrian educational system would have considerable impact on many core innovation policies such as policies which aim at increasing the level of innovative activities, start-ups, innovation in SMEs, diffusion and absorption of innovation, etc. It is important to point out those „front running“ strategies such as the planned initiative for "excellence" could prove highly ineffective without reforming university structures.

Financing innovation in most cases refers to the use of internal sources of finance (cash flow). However, well developed financial systems foster innovative activity via reducing the cost of external finance. Finance restrictions are most binding for technology-producing sectors, less so for technology-using sectors; the riskier an innovation, the more binding credit restrictions. The number and growth of start-ups are also influenced by financing restrictions. The focus of financial systems – whether bank - or market-based, or a hybrid version – matters partly: equity-based financing models facilitate the financing of small, technology-oriented firms as well as the financing of risky innovations.

The size of Austria's capital market, a proxy for the overall development of a financial system, is below average. In stock market capitalisation, a component of the overall capital market, it is in the lower third of EU countries. However, Austria's financial system cannot be called purely bank-based any more. Venture capital intensity is still very low.

Of course, any measures to improve Austria's financial system will have to pay close attention to the recent financial crisis which hit the world in fall 2008. Austria's low level of protection of minority shareholders is an important issue. Supply-side improvement of venture capital could be fostered via new legal structures for venture capital funds operating in Austria as well as a fund of funds-initiative. Demand-side improvements (i.e. more firms/start-ups asking for venture capital) may result from reforms in some of the framework conditions mentioned above (higher participation in tertiary education, quality of university research, start-up regulation).

Summary

Overall, improving framework conditions would considerably enhance the efficiency and effectiveness of core innovation policies. Without tackling the bottleneck "human capital" in its various forms, such as the quality of university research or participation in tertiary education, further upgrading of Austria's innovation system seems a difficult task. To address framework conditions, innovation policy actors should firstly stipulate mandatory reference to relevant framework conditions when designing new core innovation policies. Secondly, a coordination mechanism is to be set up to obtain a common understanding on framework condition-issues. This would make it possible to speak with one voice in political decision-making processes and further the cause of innovation-relevant framework conditions.

2.6 Conclusions: towards an innovation based growth regime

One way to increase productivity growth is to imitate advanced technologies, the other to make leading-edge innovations. Which strategy is more effective depends on its state of economic development and its distance to technological frontier of a country (e.g. *Aghion – Howitt 2006*, *Aghion – David – Foray 2009*).

Research has shown that if the distance to the technological frontier is large, firms use mostly technologies developed abroad, which they gradually adapt and modify according to own needs. Domestic technology development is sporadic and generally very few firms engage systematically into research and development. In such an imitation led growth regime large firms that exploit economies of scale typically drive growth. The labour mobility between firms is limited because firms engage extensively in firm specific training. For this reason secondary, job specific education and vocational training are more important than general secondary and tertiary education. Due to the long survival of large firms, and long-term investments into capital and labour competition is generally limited and firms rely on long-term bank finance. In such a growth regime there is a limited need for private equity financing. The role of the R&D support system in such an imitation led growth regime is to support investment into new technologies, to gradually lead firms to engage into R&D activities, to support technological upgrading and provide incentives for the development of new technologies for those firms that are already engaged into R&D.

If on the other hand economies are more advanced and productivity as well as technical know-how are either very advanced or even leading edge then the factors for successful growth change. The available evidence suggests that innovation, and therefore productivity growth in innovation led regimes is supported by: competition and innovative entry of firms drives entrepreneurs to be more innovative and constantly drive down unit cost or improve quality,

better protection of intellectual property rights to allow successful innovators to benefit from their endeavour,developed stock markets that provide also private equity financing, as tight credit constraints will limit entrepreneurs' ability to finance new innovative projects, and a quick selection of most promising projects is very important,better education especially in the field of tertiary education, as this will improve the ability to innovate and/or imitate leading edge technologies, more autonomous and well funded universities as a world class science is an important source for new technologies, spin-offs and especially future researchers that augment the scientific base of business research and absorptive capacities, andmacroeconomic stability, which allows for a lower, risk-adjusted interest rate that will enable entrepreneurs to invest more in growth-enhancing projects.In an innovation led regime the role of R&D support changes. The support of technological upgrading continues to be important in order to ensure optimal levels of investment also into development activities of firms. However, the support of innovative start-ups, the fostering of excellence through pre-competitive research on the basis of science-industry cooperations, and the support of risky research and development activities necessary under an innovation led regime to give decisive impulses for further innovation and growth.

For countries that are in a phase of transition from an imitation led to an innovation led growth regime, such as Austria, the crucial issue is the management of the transition between these two regimes. It requires to change the institutional setting and general framework conditions in such a way that they support the restructuring of the business sector towards more technology and knowledge intense modes of production that ensure the creation of jobs through innovation and higher competitiveness. The focus of policy must lie on the dynamic elements of the economy that support change. The most important drivers of change are:

education and scientific research,
the creation of innovative firms,
(disembodies) technology in- and outflows as well as research cooperations,
foreign direct investment by research intensive firms, and
large firms conducting advanced research.

Of these factors education and scientific research are considered to be the most important factors. National investment in primary, secondary, and tertiary education is the foundation of economic development in an innovation led growth regime as it provides a foundation for a portion of the indigenous population to secure advanced education and high-tech work experience.

From the previous sections of this part of the report as well as from other studies on parts of the Austrian National Innovation System the following aspects have emerged:

In the past decade structural change towards innovation intensive & education intensive sectors, has taken place. However, whereas the gap with respect to the EU 15 in innovation intensive sectors has been closing, a gap in knowledge- and education intensive industries has emerged.

Medium low innovation intense industries contribute the largest part to multifactor productivity growth

Business expenditures on R&D have expanded rather quickly. This has essentially supported the upgrading of technological capabilities in the business sector, but has not so much supported structural change towards knowledge-intense industries. As a consequence the export share of knowledge in intense services and products has remained low as has employment in these industries.

The upgrading of technological capabilities has led to an improvement of the competitive position through higher quality exports and an increase of product innovation across firms.

Foreign firms are the most dynamic element for innovation in Austria. They are generally more R&D intensive. However, this implies that many patents by Austrian inventors are owned by firms located abroad, which contributes to the vulnerability of the Austrian Innovation System. On the positive side it implies also that many research projects in the business sector are conducted in international cooperations.

Related studies not cited in this report have also shown that Austria shares a problem with most countries in the European Union in terms of firm creation. Firm creation activities are close to the levels observed across the European Union. However, the largest shares of start ups are one-person firms (about 80%) in the service sector and the observed exit rates are approximately identical with the entry rates. Newly created firms have a generally low innovation potential and most do not grow over time which implies that only very few jobs are created through entry (*Hölzl et al. 2006, Hölzl et al. 2008, European Commission 2009b*).

In terms of framework conditions results from this evaluation and other related studies have shown that

in Austrian higher education institutions produce too few graduates, of which many have graduated in disciplines where labour market perspectives are unfavourable (Hölzl 2006a, Reinstaller – Unterlass – Prean 2008, Janger et al. 2009, Bundesministerien 2009 forthcoming),

the overall quality of research at Austrian universities is generally not excellent even though there are notable exceptions, (Hölzl 2006a, Reinstaller – Unterlass – Prean 2008, Bundesministerien 2009 forthcoming),

the framework conditions for private equity and venture capital are rather unfavourable, and competition in certain service industries should be enhanced.

This list of stylised facts on the Austrian economy suggests that there are strengths that must be further deepened, but that there are also deficits that need to be addressed if Austria is to embark on an innovation led growth regime. A frontrunner strategy aims at positioning as many Austrian firms as possible on the technological frontier in their fields of competence that allows them to stay competitive by creating lower cost, higher quality products while keeping or improving the high Austrian social standards. The evidence presented in this section suggests that the first and foremost priority for the Austrian National Innovation System must be the improvement of education and scientific research. This is not only an important precondition for expanding the research activities by Austrian firms, but it is also an important source for new enterprises. Unique research capacities, crucial competencies and excellent reseach facilities are also important factors that attract foreign research intensive firms. The R&D support system has achieved its goal (related to the imitation led growth strategy in place since the 1990s) to support the upgrading of technological capabilities, and now new ways need to be found to foster excellence, and to increase the quality of firm creation.

Appendix

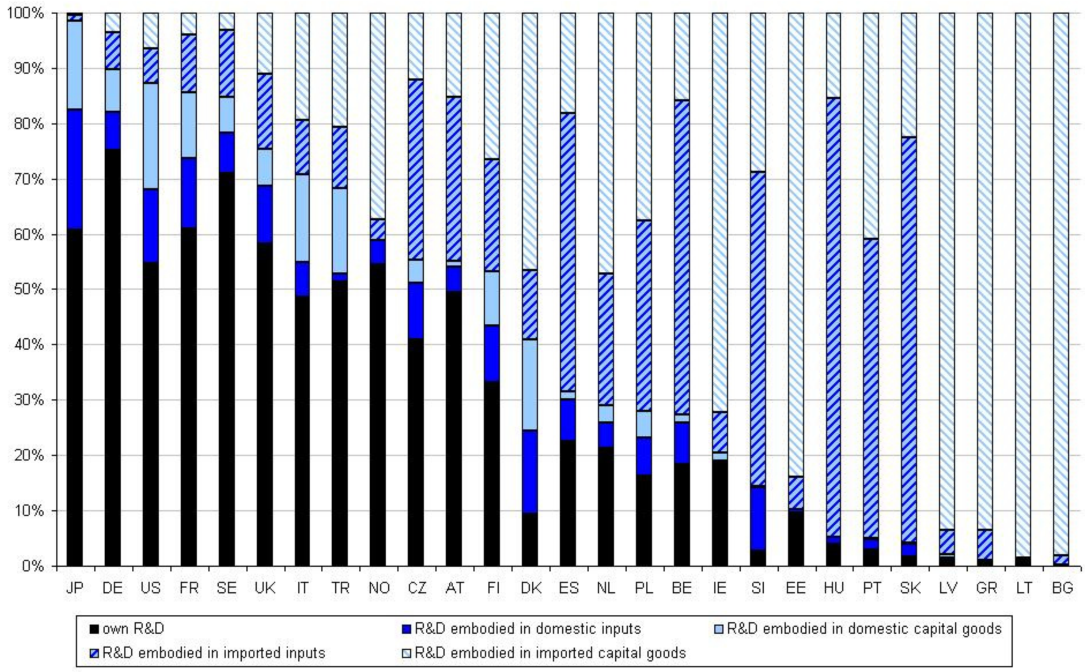
Table A2.1

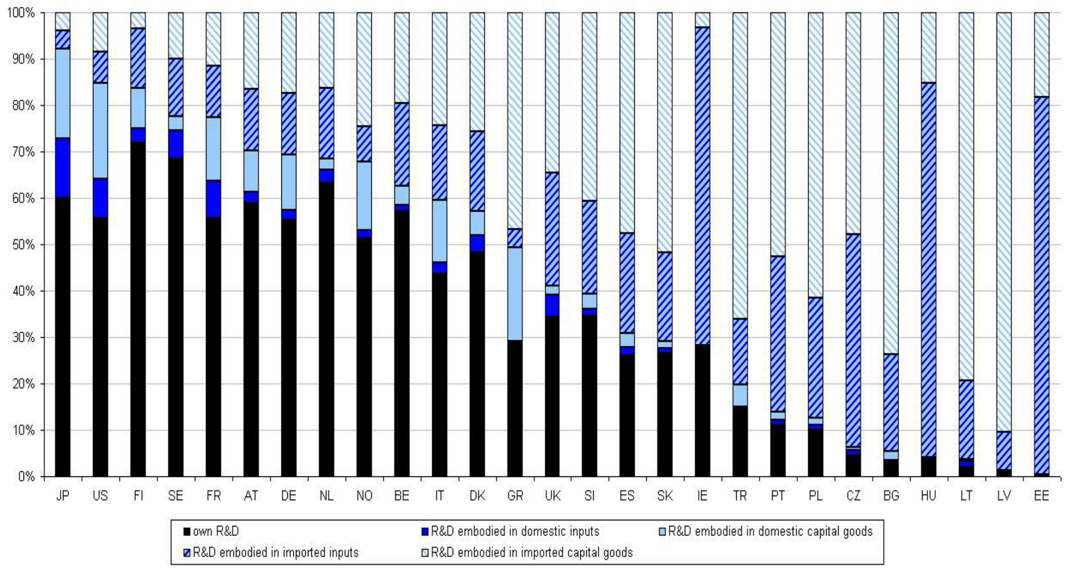
Country abbreviations

AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LT	Lithuania
LU	Luxemburg
LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom

Figure A.2.1: Shares of direct and indirect R&D investment in the automotive and ICT equipment industries

Automotive sector (NACE 34)





ICT equipment (NACE 30, 32)

Source: OECD ANBERD 2006, OECD Input-Output tables 2006, Eurostat Input-Output tables. Knell 2008. WIFO representation.

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3. New Results in the Studies Commissioned

3.1 Strategic Governance: Gabriele Gerhardter, Markus Gruber (convelop)

Over the past few years, Austria has achieved success in terms of the Lisbon 3% target and developed an extensively matured national innovation system (NIS). In the process numerous changes were accomplished within the STI policy system. The economic and social requirements on problem solutions by research, technological development and innovation, however, are increasing and require comprehensive measures coordinated across policy levels, institutions and subjects.

This report analyses the current STI policy governance regime in Austria and the associated processes of policy formulation are outlined in the following, so that recommendations for the future design can be given. Simultaneously, this is a critical evaluation of the policy so far: in terms of the quantitative-focused catching up phase in the Austrian STI policy, it has created an elaborated supporting structure and achieved considerable success. Now it is essential to develop this policy further to meet the challenges of a "frontrunner position" coupled with broad innovation performances.

Challenges

In respect of current and future challenges, the present problem solving mechanisms have to be evolved to a new stage. The challenge is to overcome the status of entropy in the STI policy system and to create mechanisms which support an evolution towards "smart governance".[17] For the Austrian research promotion system "smart governance" means a new understanding of steering, adjustments in the area of tasks and functions of protagonists and a new culture of cooperation and joint system learning.

Main Results

Entropy as Description of the status of Austrian STI Policy

The STI policy in Austria is affected by increasing entropy[18] which in the following will be characterised on the basis of five areas of perception.

(1) System persistence in dynamic environments: The environments of the STI policy system have substantially changed in following areas: (i) the extension of content of the field of activity, on the one hand towards science and on the other hand towards innovation and

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[17] The term "smart governance" was taken from *Willke* (2007).

[18] 42 central protagonists of the FTI policy in Austria contributed to this conclusion based on guideline-oriented interviews.

Entropy designates the lacking permeability of the system for information from the environment. In that, entropy above all is described as the degree of change. The higher it is, the more time-consuming and complex it is for the system to eliminate the lack of information.

market, (ii) the differentiation as multi-level policy, and (iii) the enhancement by protagonists and (iv) the increased consideration of the policy framework. In the STI policy system in Austria, the shifting focuses are currently noticed in individual areas, however, are not adequately received for the overall system yet and cause "uncertainties" in the STI policy system. They have not yet lead to adaptations in adjustments at the strategic level. Due to lacking common visions and targets result in the present preferences and orientations are maintained.

(2) Lacking normative orientation in the STI system: Currently, the Lisbon 3% target has an exclusive leading STI policy orientation function in Austria. However a commonly shared content driven goal or vision of the STI policy is missing. Formulating strategies only in subsystems such as ministries, Austrian Council for Research and Technology Development may lead to a fragmentation[19] of the system and sub-optimal solutions are found. The lack of a shared reference system results in external inputs (information, measures, programs etc.) overstraining the system, since information cannot be received selectively.

(3) Programs as the predominant intervention logic: The research promotion system above all effects interventions by programs. STI policy measures, however, are not per se configured as programs and future challenges require a comprehensive mixture of instruments. For normative gaps, increased inward orientation, input and clientele relation, the STI policy interventions concentrate on "approved patterns of action" and familiar paths. The following six mechanisms provide for the "program machinery" being maintained:

A lacking overall orientation performance of the STI policy results in the fact that a program does not need to prove its legitimation towards a comprehensive strategy, but justifies itself (in respect of subjects, community, etc.).

Programs are "trophies" of the ministries: the internal, informal reward system promotes the emergence of programs; they signify visibility and make possible additional funds.

Community building: numerous programs aim at the establishment of a research- and subject-related community then will ask for "its" own programs.

Structural character requires a long-term basis: some parts of the programs are mainly aiming at improving the research structure – which, however, cannot be achieved on a short term basis.

Only new programs have a media effect – and program inaugurations and events more and more often are used for public relations purposes of the ministries.

In Austria, there is no culture of ending programs.

The increase of entropy in the STI policy system is an essential cause for the concentration of the STI policy interventions on programs – and the reason for the continuation of the same course of action. If there are no normative orientations and structural openings of the overall system, the logic for action and implementation will remain the same.

[19] Overall orientation in the system reduces complexity and fragmentation.

(4) System paralysis – Cooperation as the exception: In Austria, STI policy, mainly at the ministerial level, is heading for a partial "deadlock". Decisions requiring horizontal or vertical coordination are frequently blocked. However, to remain capable of acting, there is a concentration on (fragmented) individual events and thus an extensive loss of the systemic overall view. Cooperation occurs only in rare cases and by personal connections or informally. I.e. the system paralysis promotes the strength of the informal[20] in the STI policy system because it makes it possible to provide functionality within a certain period of time. Inter-ministerial competitive behaviour promotes informal, fragmented solutions and requires a great deal of negotiation resources.

(5) *Learning instruments, but no systematically supported system learning:* "Learning" in the Autrian STI Policy scene occurs in co-evolution between experts and representatives of the ministries and agencies. In this way successful developments have been achieved. But *learning above all takes place informally. There is a distinctive evaluation culture which is* mainly to be found on the individual program level. This allows adaptations and development steps mainly at the program level. Institutional, reflexive learning with respect to the whole STI-system is not implemented systematically.

Multi-level System: Programs as Strategy

The Austrian research promotion policy is integrated into a multi-level system between the European Union and provinces. For the NIS, the role of the federal state remains dominant mainly due to the funds. In Austria multi-level governance is not standard practise. This drawback can be noticed especially in the area of strategies, agenda setting and cross-policy outline conditions. However, at the research program level there is a "well-rehearsed" approach – due to the fact that in Austria mainly programs are used as research promotion instruments.

In respect of STI policy programs, the well-rehearsed mechanisms work perfectly: the area of European programs is characterised by a (successful – 117% in RP6) "reflux mentality". The innovation policy measures of the regions rarely overlap with those of the Federation or there exist co-financed programs as well as mechanisms of the individual solutions by province lobbying.

In the area of strategic coordination, integration and further development of the NIS which above all concerns agenda setting and the creation of innovation-stimulating outline conditions, there is demand for action in the multi-level system:

At the interface to the European level: above all in the active co-design of the STI policy in the European Commission

[20] Here, "informal" refers to a group of experts above all from management, research, consultation and individual persons from FTI policy institutions, who outside the official negotiation arenas are able to implement new strategies. It does not mean individual interventions with particular interests (lobbyism, interventionalism).

At the federal level: integration of further policies like educational, health, environmental and further policies for comprehensive problem solutions and design capability in the NIS

At the interface to the provinces: this level requires here a reorganisation of the one-way communication from the federal state to the provinces towards a two-way exchange of information and joint learning in terms of an enriched innovation system at the federal and state level as well as possible support from cross-state activities.

Summary

The future design of the governance structures substantially depends on the political responsibility for science, research, technology and innovation in Austria, i.e. the participation of the federal government, the federal ministries with research agendas and also all ministries partially or indirectly contributing to the outline design of the Austrian innovation system. These institutions will determine whether the Austrian innovation system focus on the requirements of the future and decide about the structures needed to achieve this.

The reforms mandated address the steering of the process beyond the discussion of small improvements. Modifications in steering issues are necessary and important for the future STI policy. They demand a more strategic multi-level policy, a better understanding of the roles of stakeholders, multi-protagonist policy, policy learning and a policy changing process of the Austrian innovation system.

A coherent and effective research promotion system needs a systemic steering logic and types of steering with visions and strategies as well as the determination of corresponding outlines, the specification of targets and result control as well as more freedom in the implementation of target achievement.

Multi-level Policy

On the basis of a coherent objective, an active design in selected policy areas should be pursued at the European level as well as in the international area to achieve a transition from a mentality orientated by program refluxes to a strategic co-design in relevant areas. This must be linked with respective organisational measures – especially personnel development in order to introduce an active STI policy at the EU level and to offer persons successfully working here (also with part-time employment in the EU Commission or other institutions and facilities of the EU) promising career opportunities in Austria. Organisationally speaking, this above all means the strengthening of an inter-ministerial EU service facility (as it already exists in the BMWF *[Austrian Federal Ministry for Science and Research]*), which is informed about procedures and decision-making processes of the EU, provides its knowledge and experience to other employees of ministries and enables exchange-based learning.

Coherent objectives also form the basis for a target-oriented coordination performance with the provinces. Information about the strategic orientation of the Federation, STI policy developments and the projects create orientation for the provinces (keyword: context steering). It might become the task of the Federation to more strongly support cross-state initiatives within the scope of the regional clusters.

Multi-protagonist Policy

Austria has – as is common practice internationally – enhanced the STI policy system by stakeholders (councils). At this, however, insufficient attention was paid as to which function they are to fulfil in the STI policy system. The task of stakeholders is to observe the overall system on the basis of current developments and to motivate it to optimal and matching solutions with the question: "Why choose this way and not another?" Stakeholders enable new contents, subjects and an adaptive policy design, but they are not integrated into formal, financial or decision-making processes. The issue of legitimating of activities, too, cannot be delegated to them. The function of the Austrian Council for Research and Technology Development is to be inspected in this respect and the role, tasks and also the personnel structure are then to be adjusted in a "new council".

Policy Learning

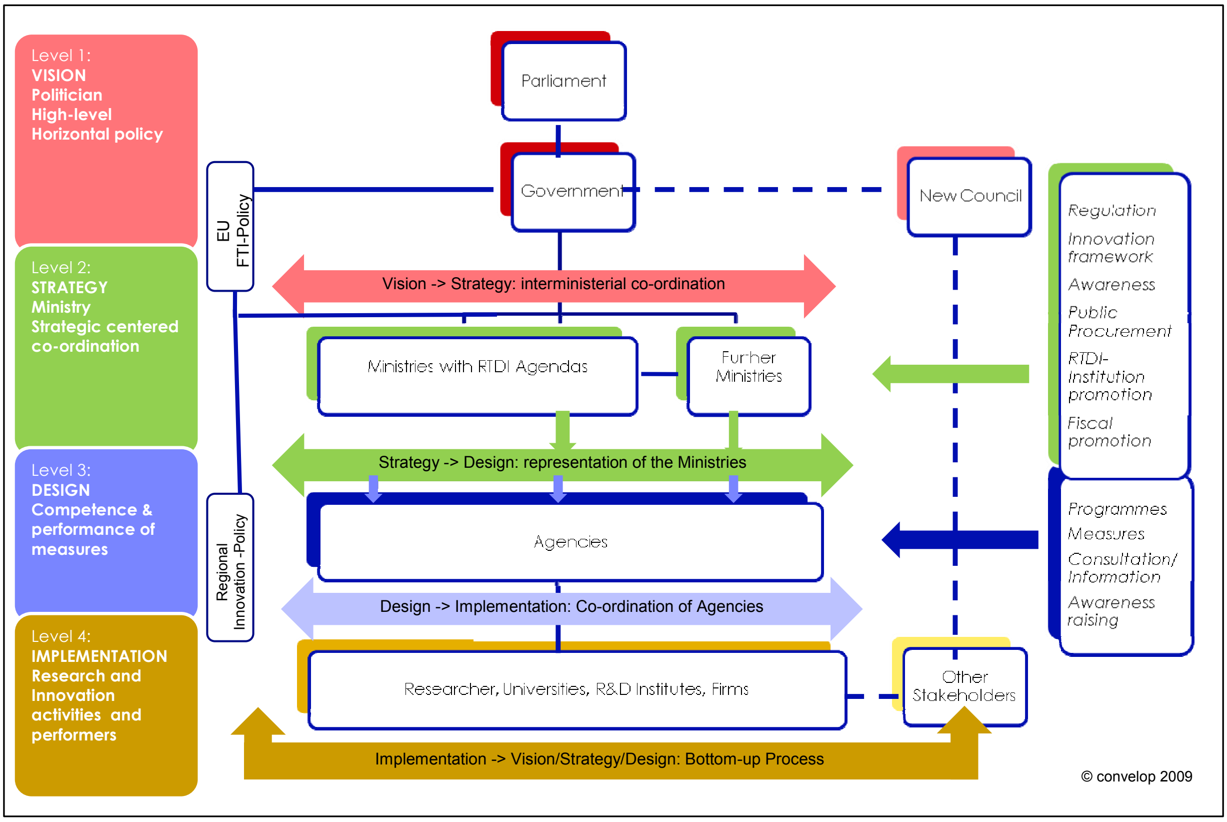
STI policy steering means continuous reflexion and learning at various levels and in intercommunion with different protagonists. The path towards being a frontrunner, mission orientation and a broad innovation base has to be treaded anew; correspondingly instruments are required, which allow for corrections and provide new solutions. For that, exchange and new learning cultures must be established in particular inter-ministerial, between ministries and agencies, in respect of the overall system by discourses with experts and STI implementers and also by evaluations. Evaluations and the responsibility for them are to take place at two levels: i) measure-related evaluations: these concern subjects or instruments of the ministries which are partially implemented by themselves or by the agencies. Measure evaluations are assigned by the ministries (inter-ministerial) and examine the implementation of their strategies. ii) Evaluations of the overall system: these concern the state of implementation and the further development of the NIS and the STI policy system in terms of the developed vision and are to be assigned by a "new council".

Government regime

The strategic steering in the STI policy governance system requires comprehensive organisational changes and development of new management techniques in the ministries with research agendas which above all are positioned transverse to the present normative-cultural perception of the tasks and therefore include a longer-term implementation perspective. The organisational (e.g. in respect of steering capacities and inter-ministerial problem solutions) and personnel development (e.g. permeability in the career development) in the ministries therefore represents a success-critical factor.

This shows that without the integration and responsibility of the political level which secure the coherence and effectiveness of the measures and the overall sustainability of the national innovation system, no new structures and cultures of cooperation can be achieved here.

Figure 3.3: "Smart Governance"



Source: convelop 2009

Table 3.1: Smart Governance Regime: Functions and Protagonists

What...	**... these protagonists...**	**... should do**
VISION	Federal government	Opts for and is responsible for a vision, participates in the process for the generation of the vision, must comment on the annual report of the council. The vision is assessed at the beginning of a new legislative period.
Monitoring	Council for Science, Research and Innovation ("new council")	Monitors the implementation of the vision in the NIS; Drafts an annual report. Commissions evaluations at the system level.
	Parliament	Enacts vision presented by the government, comments on the annual report of the new council.
SUB STRATEGIES from vision	Ministries with research agendas. Political level (minister, cabinet, head of section department or "new competence units")	Are responsible for a strategy and its implementation; other ministries are involved. Account for agenda setting in the multi-level system.
Implementation and delegation	Ministry employees	Are in charge of strategic steering of multi-level system - EU/provinces – above all via design of framework conditions, but also through regulations, awareness, public procurement, etc. Assign evaluations of agencies' interventions (target achievement, etc).
Controlling – public research funding	Federal Ministry of Finance	Checks the efficiency of overall public research funding in terms of the new service agreement (Austrian Federal Budget Act 09/13) or "new competence units"
	Representation of the ministries towards agencies (see Report 3)	Shape the Framework for financial promotion regulations; supervision of agencies. Determine targets, subject areas and output measurement in terms of strategy. Multi-year service agreements with the agencies (on the basis of the strategies).
INSTRUMENTS/ MEASURES	Agencies (see Report 3)	Design appropriate measures which enable the target achievement of the strategies in the area of research promotion. Monitor these measures; reflect on target achievement and learning processes.
	Inter-ministerial work groups including respective experts	Shape framework conditions, guidelines, etc. to strengthen the NIS
SYSTEM LEARNING	Associations and interest groups, civil society (beyond STI policy), subject-related associations	At the strategic level, they take on the role of sparring-partners w.r.t. knowledge, learning, reflexion and implementation and thereby contribute to flexibility of the system; in particular they have a stake in agenda setting at European level
	Research community, universities, research facilities, companies	Make sure that needs of target groups, match the intervention measures; stimulate fields of activities – at level of interventions
	STI policy experts	Provide systemic evaluations and reflexion on the design of the NIS – at the level of vision, strategy and measures

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3.2 Governance in RTDI – Relation between Ministries and Agencies: Sabine Mayer (coord.) et al. (KMU FORSCHUNG AUSTRIA)

Introduction

Dealing with questions on the governance in the field of STI policies in Austria is neither a newly emerging issue nor an outdated topic. Analyses conducted both in the past and recently have shown that several challenges are inherent to the Austrian political system, a system that comprises a diversity of coexisting, differing understandings of governance, political steering and approaches on how to cope with the requirements of a modern system of public support for STI both in companies and research institutions.

This part of the evaluation of the Austrian system of STI support is primarily dealing with the relations between the federal ministries (i.e. the three ministries responsible for the majority of the federal STI policies and the respective budgets – the Federal Ministry of Economy, Family and Youth, the Federal Ministry for Transport, Innovation and Technology and the Federal Ministry of Science and Research) and the funding agencies (i.e. Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Austrian Economic Service (AWS) and Christian Doppler Research Association).

Against this background, the report summaries the main findings on the system's overall structure, the communication, coordination and steering processes as well as insights into the governance culture. Derived from that analysis, the core challenges of the current governance of the Austrian STI support system and respective policy recommendations will be presented.

Challenges

The relations between ministries and funding agencies in a system shaped by developments referring to agencification, create a set of challenges both inherent to the process itself and to national specific characteristics. The main target of agencification is to provide for professional and flexible administration in the sense of an increased alignment to criteria such as flexibility, change and innovation. Therefore, the main characteristics by which the system can be measured are effectiveness and efficiency of the administration and implementation of STI policies.

To develop an understanding of the actual challenges which have an impact on the overall question, whether or not the system fulfils the hopes for an increasingly efficient implementation of STI policies, it is necessary to analyse institutional structures and (communication, coordination, etc.) processes. Although both aspects contribute to the identification of the system's shortcomings and challenges in an interdependent manner, they cover two separate issues. However, the institutional framework defines the conditions under which an organisation may use different processes.

Methodologies

The report is based on quantitative and qualitative research methodologies that have been used in order to cover all aspects of the topic and to be able to balance their particular disadvantages.

The ground for the analyses has been laid by an extensive examination of scientific literature, reports on the issues covered, legal texts and databases. The actual data were collected from a variety of in-depth interviews with stakeholders and members of the organisations of the STI system, from an online survey as well as a social network analysis.

Main Results

The division of labour between ministries and agencies is quite clear as it is laid down in the corresponding legal documents. Similarly, most of the interview-partners consider the division of responsibilities and operational tasks well-defined. However, on the level of agenda setting and the development of strategies, the different roles seem to be blurred: Individual interpretations of roles, tasks and future warranted changes differ. On the other hand, there is a widely shared belief that the "system functions quite well".

Analysing communication as the basic linkage between organisations, the main result is clearly that the players and organisations are very well linked with the majority of the links being rather close. Therefore, the networks can be described as very stable. This can be an advantage of the Austrian STI system but has certain risks. Networks of closely linked individuals tend to become self-referential and to exclude information from outside the network or hinder the systematic access of this information to the system. However, there are no clear signals for a distinct tendency towards social closure except from the fact that communication rests upon a rather small group of only 10 people.

Formal communication networks dominate the system both in number of links and diversity of organisations participating. Pressure groups and other external stakeholders such as individual scientists and entrepreneurs are involved quite strongly, indicating that they have at least the chance to incorporate views from "outside" into the communication system. However, they are also part of the informal communication network which raises the question whether the necessary degree of transparency is still guaranteed in these communication links. Informal networks are vitally important to the functionality of the Austrian STI system and therefore should not be suppressed. However, they might exclude certain organisations and opinions and result in a lack of transparency. Therefore, important interfaces have to be identified and the communication or coordination taking place there will have to be transformed into formal and transparent relations.

Analysing the contents of the communication between agencies and ministries, the authors have observed that, as a rule, questions of the operative program management are rather an issue between ministries and agencies. This has been a striking result since it had been expected that operational issues mostly occur in the realm of the agencies. The more strategic a topic, the less frequent are the links between the two mentioned organisation types and the more frequent are the links between ministries. Besides, the involvement of other organisations is increasing. Interestingly, pressure groups and stakeholders are also involved in issues of the operative program management. The numerous links between AWS / FFG and their respective parent organisations reflect their very intense interdependence.

Coordination as the harmonisation of activities aiming at a defined goal in general is appreciated but in some cases, it is practised too extensively, while in others it is not practised enough from the agencies' or ministries' point of view: As a rule, the coordination referring to the operative execution of funding programs is rated as being too extensive. On the other hand, coordination in the area of strategies tends to be rated as rather too low, especially by the ministries.

In general, communication and coordination are reviewed best where similar underlying rationales can be assumed (i.e. between ministries and their affiliated agencies; FWF and BMWF, AWS and BMWFJ etc.) and, not surprisingly, in cases with only little demand for communication / coordination. In addition, the rating for communication is slightly more positive, which refers to the fact that coordination is bound to some sort of result while communication is not, at least not by principle.

However, if asked about the actual influence the ministries are having in different phases of the implementation process, not a single agency stated that the ministries concerned have a (very) strong impact, not even in the area of strategic developments or the definition of new funding priorities. On the other hand, the ministries seem to assess that the agencies are exerting higher influence. Even in the areas mentioned above they credit the agencies with a (very) strong influence at least regarding to some of the activities included in these phases.

To understand both the difficulties of the ministries to govern effectively and in a strategic way and the resistance of the agencies against being governed, one has to take a look at the actual steering mechanisms. The Austrian STI system, foremost the funding of STI by FFG and AWS, is dominated by the coexistence of two parallel governance principles. Being the owner of a funding agency, the respective ministries have, of course, the right to determine the basic principles under which the agency is operating, their management board, budget, human resources etc. However, the actual budget (for non autonomous funding) goes along with associated governance mechanisms and is connected to individual funding programs and individual concepts of how to govern.

As we have stated for coordination issues, the need for a coherent STI strategy is as widely accepted as its absence is regretted.

Summary

Since a coherent Austrian STI strategy is missing, the Austrian federal government should develop a vision that includes all aspects of STI policies and is aligned with neighbouring policies, e.g. education policy, economic policy, etc. It can avail itself of external experts, but the vision is in property of the national government. The ministries in charge of STI policies are then to develop respective sub-strategies for implementing the vision into their areas of competence. In order to establish the necessary publicity and transparency, the parliament will have to be included as the arena of discussions of both the vision itself and the implementation progress, preferably on an annual basis. The federal government, ministries and an advisory board / council will have to report to the parliament and respond to each other's statements.

In order to establish a more systematic approach to STI policies, the two main advisory boards (the Austrian Council for Research and Technology Development and the Austrian Science Board) should be merged into a single organisation. The newly found board would then be based on a bicameral system with respect to the differing issues of basic research and applied research including joint consultations when feasible. Thus, the Austrian Council for Research and Technology Development would enhance its status due to the increased importance of science and scientists (represented by the former Austrian Science Board) while the Austrian Science Board's importance for the political system as such would be stronger and more transparent to the public.

Due to the internal diversity of issues covered, the Austrian STI system as a whole suffers from the relatively low importance of STI budgets and agendas within the ministries in charge. Very likely, a merger of (parts of) federal ministries being responsible for STI policies would contribute to a decrease of coordination cost and a clearer funding portfolio. Moreover, the STI-budget's share in the ministry would increase, thus, STI policy might gain weight within the respective ministry. However, the findings suggest that without an equal change in political and governance culture this would not be an enduring and sufficient solution.

Once the vision is established, the system needs to revise its working principles as for the division of labour between ministries and funding agencies, the former strengthening their function as owner / supervisory authority of the agencies in a more strategic way. Therefore, the future system should rather be based on agreements on the actual goals and output of the agency's work (adding output indicators to input and performance indicators). Hence, a monitoring system needs to be established.

The process described as "earned autonomy" (see figure 3.4) aims at a step-by-step consolidation of the autonomous and assigned areas and budgets of the funding agencies to solve the problems caused by the existence of two parallel steering mechanisms. In consequence, the autonomous areas / budgets will be included in the performance agreements and therefore be subject to strategic goals. At the same time, the assigned budgets will be included in a quasi-autonomous area, also being governed by performance agreements. Not only would this empower the ministries to develop strategies, govern their field of STI policies and the implementation of these strategies, but the agencies would also benefit as they could make use of their knowledge gained from (program) management and their experiences with direct contact with the target groups.

Figure 3.4: Earned autonomy in the Austrian STI policy

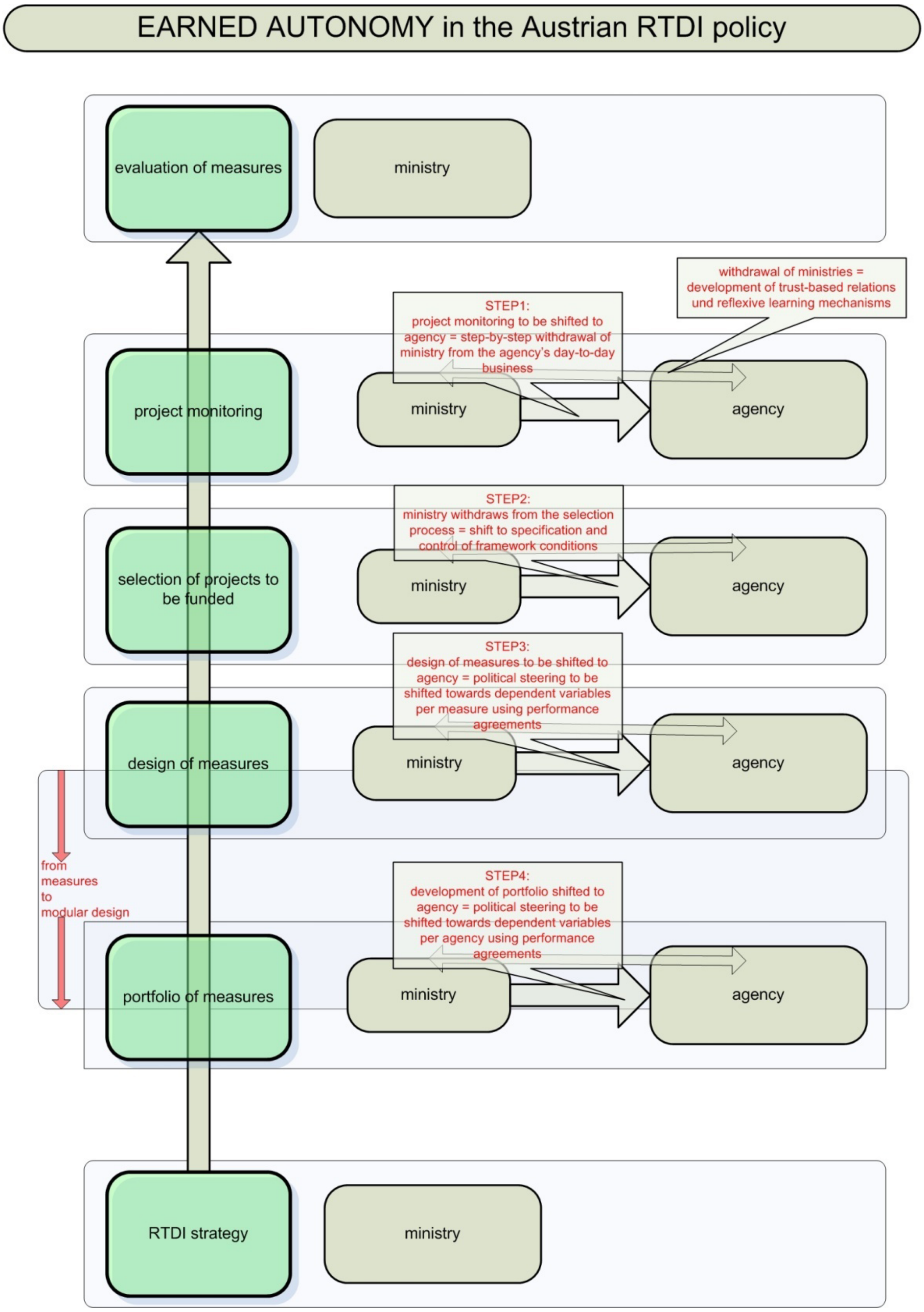


Diagram by author, KMFA.

However, the process proposed recognises the fact that a modern agencification-based administration of STI policies in the interplay of ministries and agencies has to be based on trust which needs some time to develop. Next to a sufficient timeframe for the implementation of the proposed processes, there is also the need for permanent revision of the progress made and for feedback loops to allow adjustments where necessary. In order to consolidate the trust, it must be made possible to revoke certain steps in case of underperformance. The basic structure of a political system that comes with agencification has one major trade-off: information asymmetries between the agencies and the ministries. Therefore, ways have to be found to secure a steady, institutionalised and open exchange of knowledge. Overall, these structural reforms cannot be implemented without an accompanying change of governance and political culture that should be based on a prior normative discussion about the positions on and understanding of the division of labour, governance and STI policies as such.

3.3 Tax Incentive Schemes for R&D: Rahel Falk (WIFO)

In Austria, special tax treatment of R&D expenditures was introduced as early as 1980. It has been continuously developed and refined ever since, the most fundamental changes arising from the introduction of Frascati-based tax incentive schemes in 2002. This change in tax funding legislation came as an immediate response to the Barcelona/Lisbon Challenge the Austrian government had committed to in the same year. Increasing emphasis on tax instruments to promote R&D is very much in line with recent trends in other EU member states, as well as with EC and OECD policy recommendations.

Challenges

In Austria, recent debates on the pros and cons of tax incentives for R&D proceeded with surprisingly little hard evidence on (i) the usage, (ii) the acceptance, and (iii) the effects of tax funding. Report 4 of the current System Evaluation is concerned with these questions, starting with a thorough presentation of the current structure of tax incentive measures. The main purpose of this report is to set the stage for subsequent discussions on the interplay between measures of direct RTI funding on the one hand and tax funding on the other. For either scheme, effects of funding on economic and RTI performance measures must take into account simultaneous usage of the other scheme. Otherwise, the analysis would suffer from an omitted variable bias. This long overdue, stand-alone assessment is, however, instrumental in assessing the extent to which tax funding addresses some structural deficits in current RTI performance.

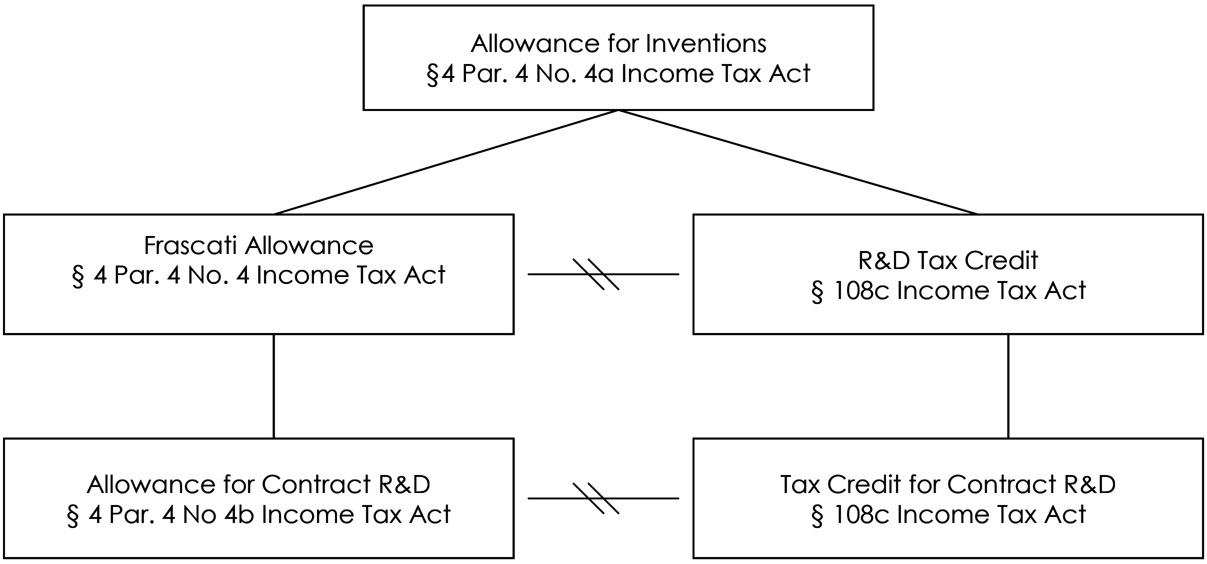
Main Results

Complexity of the system

The current system of tax incentives is quite complex and can best be understood when seen in a historical context. The Austrian Tax Code has granted tax incentives for expenditures related to inventions "valuable to the economy" since 1958. Since 1980 a volume-based allowance could be claimed on such expenditures or on expenditures relating to inventions protected under patent law. In 2000 an additional incremental-based allowance scheme was introduced: qualifying expenditures exceeding the moving average levels of the last three years can be deduced at a higher rate.

More fundamental changes in the structure of R&D tax incentives occurred in 2002 when the so-called Frascati allowance and a Frascati tax credit were introduced. These schemes focus on R&D according to the definition of the OECD Frascati Manual: basic research, applied research and experimental development. Though the same R&D expenditure cannot be claimed twice under different schemes, a company may claim some expenditure items via the allowance for inventions and other expenditure items via either of the Frascati-based instruments. However, companies cannot claim both of the Frascati-based schemes in parallel.

Figure 3.5: Present Structure of Tax Incentive Schemes for R&D



Source: Federal Ministry of Economics and Federal Ministry of Finance (2008)

The 2005 Growth and Employment Act introduced preferential tax treatment of contract R&D to the Frascati-based schemes. This scheme mainly addresses small companies that do not have the technological capacity to conduct R&D internally. The most recent change in legislation took place in 2007. At that time tax incentives were restricted to respective expenditures that accrue to plants and establishments located within the EU or the EEA (European Economic Area). At present, the Austrian tax code offers three different types of allowances and two types of tax credit for R&D-performing firms which may be claimed in parallel to some extent (Figure 3.5).

Fiscal Cost[21]

The Austrian system of indirect research subsidies is surprisingly cost-efficient. Cost in kind of reduced tax revenue for assessment year 2005 (the last year for which complete data exist) is estimated at 277 mill. €. Estimate costs of the tax credit pertaining to the most recent disbursement year 2008 are undoubtedly higher, viz. 340 mill. €. However, the latter approach is imprecise by construction and leaves much scope for speculation. If the tax authority credits the cash value of fiscal funding to number-one R&D-player in Austria on 31st of December, disbursements for that year increase by approximately 45 mill. €. If the credit is delayed for a single day, respective disbursements pertain to the next year. Whatever the

[21] All figures of this sub-section are given in nominal terms to simplify verification.

most appropriate basis for respective calculations may be (cost measurement at disbursement or at assessment years, at constant or at current prices) - nobody disputes that fiscal costs fall far below the estimates of the Court of Audit (418 mill. € for 2005 and 458 mill. € for 2006).[22]

Costs over time skyrocketed between 1999 and 2000, when volume-based allowance rates for expenditures relating to economically valuable inventions increased and, in addition, the incremental-based scheme was introduced. These changes in tax legislation involved additional cost of 79 mill. €, in other words: cost doubled within a year. Though R&D-expenditure of the business enterprise sector developed dynamically (+9%), they fell far behind the dynamics of cost. In 2001, the last year before Frascati-based schemes came into effect, cost of fiscal funding added up to 179 mill. The cost increase between 2001 and 2005 was 54%, while R&D-expenditure rose by 49%. In summary, the cost-benefit assessment of the more fundamental changes of tax legislature in 2002 and thereafter indicate better cost-efficiency of tax incentives as compared to earlier legislation when claims were exclusively based on economically valuable inventions.

Generosity of Tax Funding

Over time, rates of tax subsidies increased until 2004. After that, the fall of the corporate income tax rate made allowance-based schemes less advantageous (Table 3.2). More specifically, before 2005, each € of R&D expenditure was subsidised by 8.5 cents (volume based schemes). Since 2005, public funding has been only 6.25 cents. The generosity of tax credits does not depend on income tax rates. Currently the tax office refunds 8% of eligible R&D expenditure and thereby generates the highest possible volume-based benefits (as far as incorporated entities are concerned). Benefits accruing from incremental expenditures relating to economically valuable inventions are still higher, but less relevant in practice.

For allowance-based schemes, the rate of tax subsidisation depends on income tax rates. While corporate entities currently face a flat rate of 25%, companies liable for income taxes face progressive taxation. If their taxable income falls short of € 10,000 per year, their tax debt is zero. In this case fiscal incentives for R&D come only through the tax credit. If, however a non-incorporated company makes more than the critical benchmark of €10,000, its tax benefit accruing from any of the allowance schemes is higher than would be the case if it were run as a corporate entity.

The relative attractiveness of R&D-activities vis-à-vis non-R&D activities carried out in Austria used to be clearly above European and OECD-average before 2005. Now it is EU-average, or slightly below. In Austria, the relative attractiveness of research activities as compared to non-research activities has definitely lost ground. This decelerates structural change towards knowledge-intensive activities and thereby dampens the long-run perspectives of economic growth.

[22] Österreichischer Rechnungshof (2007).

Table 3.2: Rates of Tax Subsidies for € 1 R&D Expenditure

Firms liable for Corporate Tax[1)]

	Allowance for Inventions					
	Volume-based component	Increment-based component	Frascati Allowance	Allowance for Contract R&D	Frascati Tax Credit	Tax Credit for Contract R&D
2002	8.50%	11.90%	3.40%		3%	
2003	8.50%	11.90%	5.10%		5%	
2004	8.50%	11.90%	8.50%		8%	
Since 2005	6.25%	8.75%	6.25%	6.25%	8%	8%

Firms liable for Income Tax[1), 2)]

Taxable income in €						
10,000 and less	0%	0%	0%		8%	
Above 10,000	9.58%	13.42%	9.58%		8%	
Above 25,000	10.9%	15.26%	10.90%		8%	
Above 51,000	12.5%	17.50%	12.50%		8%	

Note: [1)] For the allowance schemes the rates of R&D subsidisation are calculated by multiplying the allowance rate by the (*marginal* income) tax rate. [2)] The table displays the situation prevailing since 2005.

Source: Statistic Austria: Corporate Tax Statistics and Income Tax Statistics - Wifo calculations

Aspects of administration

Administering fiscal support for R&D is a delicate but crucial issue which is inherently related to the effective basis for claims. The allowance for economically useful inventions focuses on innovation output ("inventions") and on economic output ("economic usefulness"). The Frascati-based instruments, on the other hand, address the input side and examinations of such claims occur ex post. Auditing of eligible input items seems to be very difficult in practice, at least for non-specialised tax auditors.

Claims on the basis of the allowance for economically useful inventions are closely examined ex ante (the invention issue is dealt with ex post). The Ministry of Economics is in charge of certifying these claims. Roughly three out of four companies asking for a certificate filed a patent application in the past and base their current claims on further developments thereof. As for such "further developments", we note that these are extremely hard to trace. In principle the company has to disentangle sunk research cost from research expenditure that contributed to economic success, since only the latter qualify for fiscal support. In practice, it seems that claims are rather decided in the affirmative if applicants are economically successful plus innovative in some unspecified way and that there is greater emphasis on "economic usefulness" than on the invention issue.

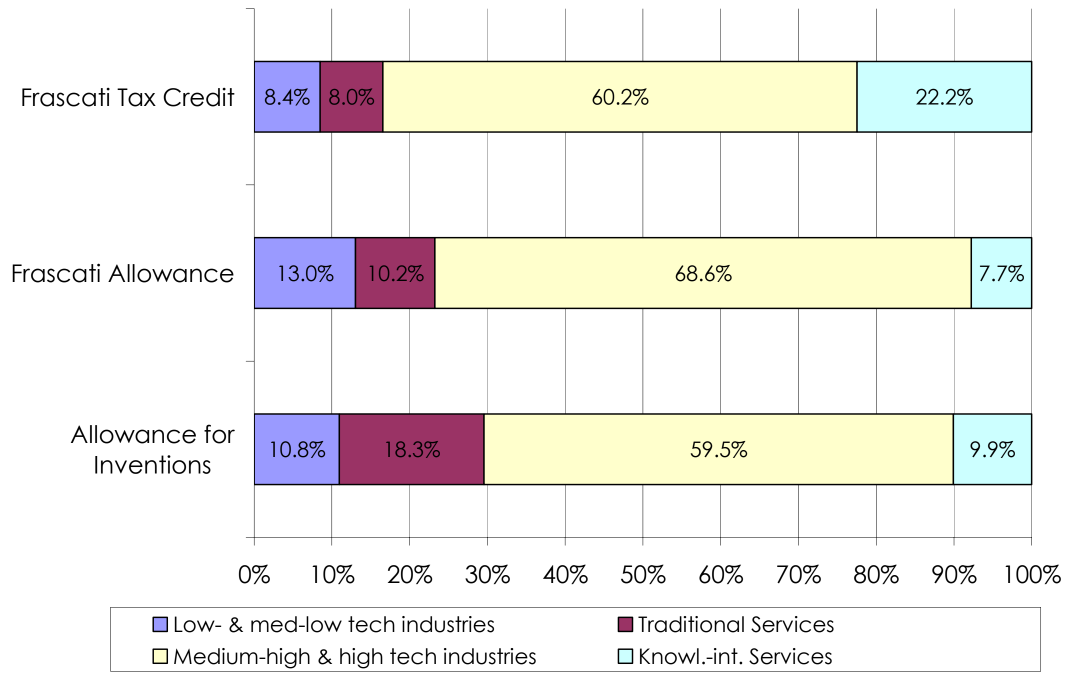
Scope and quality of data

The statistical basis for a thorough evaluation of Austrian tax funding turned out to be insufficient in many respects. There are severe deficiencies in the coverage of relevant information on the one hand, and abundant amounts of very detailed but useless information on the other. In parts, the statistics misrepresent evidence on the use of tax incentives. Access to a unique and potentially very valuable firm-level database on the usage of allowances for inventions was denied since data privacy laws apply. The Ministries of Finance and Economics eventually provided aggregate data. Empirical evidence based on micro-data would have been much more reliable and explicit. Above all, the search for data tied up far too many resources and could hardly have been accomplished by evaluators from abroad. Such data should in future be made readily available.

Structural effects

The structural effects of the tax funding system reflect the overall structure of research expenditures quite well. A between-scheme comparison of sectoral user profiles reveals some interesting findings (Figure 3.6).

Figure 3.6: Sectoral Distribution of Tax Funding in 2005 — by Funding Scheme



Source: Communication from the Ministry of Finance - WIFO calculations.

In 2005 22% of tax credit funding is absorbed by knowledge-intensive services, and 60% falls on medium-high and high-tech industries. This sector profile qualifies the tax premium as the tax funding instrument that is most suitable to enforce structural change in the direction of knowledge-intensive sectors. While the allowance for inventions covers the service industries to a similar extent, it addresses more traditional services. This supports the concern that this allowance does not only target inventions, but, more generally, also rewards activities "valuable to the domestic economy".

The number of firms making use of R&D tax incentive schemes is increasing over time, especially the tax credit is boosting this development. In 2001, only 835 companies claimed the allowance for inventions, the only tax incentive instrument by that time. In 2005, the estimated number of tax funding recipients ranges between 2,400 and 3,100, and quite many of them are comparatively small companies. It seems that the former bias of the system in favour of (very) large undertakings has been tackled.

Summary

The current Austrian system of indirect research subsidies is complex and characterised by several inconsistencies. It distinguishes between:

the basis for claims: expenditures relating to inventions valuable to the economy vs. expenditures as defined by the OECD´s Frascati Manual

the focus of interventions: the "old" allowance scheme focuses on the economic *results* of RTI activities and thereby it classifies as an ouput-based measure, whereas the Frascati based schemes classify as input-based measures.

the timing of close examination: the output-based scheme is largely audited ex ante, while the input-based scheme is audited ex post

the eligibility for support relating to contract R&D: cap vs. no cap

the type of benefits: tax allowances reduce the tax base, while tax credits reduce the tax liability by a certain share of the qualifying expenditures.

the calculation of the allowance: volume-based schemes vs. incremental scheme

corporate structure of companies: the subsidy component is different for incorporated vs. non-incorporated companies

the authority in charge of administration: ministry of economics vs. tax authorities

This system is hard to explain to outsiders, especially to those who are not familiar with the German language. Current information material of the stated-owned agency in charge of promoting the business location Austria is heavily directed towards German companies. This strategy will not suffice in future times. Firstly, because Germany is seriously thinking about the introduction of tax incentives for R&D; there is tough pressure not alone from the side of industry, but also from scientific advisory bodies. The chancellor and her party are campaigning the introduction of R&D tax credits. Secondly, and more importantly, Austria should make strong efforts to attract *and maintain* top R&D players from all over the world. At present, multinational firms increasingly relocate headquarters or R&D-competences.

The intensity of fiscal subsidisation has decreased over time. While the relative generosity of R&D tax treatment in Austria used to rank top by international comparison, today it is only average or even slightly below. Decreasing comparative advantage are attributable to lower corporate tax rates in Austria which reduces the attractiveness of allowance-based schemes. At the same time, other countries increasingly rely on tax funding schemes for research.

The structural effects of tax subsidies across industries or size are low. This is comes as an immediate reflection of their "neutral" design, i.e. the content and character of R&D projects is immaterial for access to funding as long as the general eligibility criteria ("R&D-investment") are met.

The fiscal cost of tax funding pertaining to the last year for which complete data exist, vis. assessment year 2005, amount to 277 mill. €. This falls far below the estimates of the Court of Audit (418 mill. €).

3.4 Direct Public Funding: Sabine Mayer (coord.) et al (KMU FORSCHUNG AUSTRIA)

This report analyses the range of direct public STI funding on the federal level. Subject of the analyses are 77 different funding measures which were offered in the period 2002-2007 by the Austrian Research Promotion Agency (FFG, 39 programmes), Austria Wirtschaftsservice (AWS, 18 programmes), the Austrian Science Fund (FWF, 19 programmes) and the Christian Doppler Gesellschaft (CDG).

Challenges

The report at hand sketches a theoretical background for direct public STI funding and analyses the requirements the funding system has to meet. It should be able to address the challenges of market failure as well as the more complex challenges of system failure. Different ways of knowledge production need to be considered for the purposes of the funding goals. STI funding should allow for a sound and flexible STI basis on the one hand and on the other hand foster excellent R&D which is competitive on an international level. This means increasing the number of companies that conduct research systematically and on a regular basis, increasing the scientific basis, enforcing the transformation of knowledge into innovation and growth, providing more incentives for radical innovation and high risk STI activities with high potential for economic growth. Moreover, the ability to contribute to mission-oriented strategies that address societal challenges or foster specified technologies or disciplines of future importance is a further requirement.

As a consequence, the analyses dwelled on the following aspects:

Integration of the different goals and strategies of the funding schemes in these requirements

Resources and target groups

Interplay of thematic priorities or mission oriented funding and "bottom up" funding

Methodology

The report is based on a mixture of quantitative and qualitative research methods. The ground for the analyses has been laid by a systematic examination of the official documentation on the different funding programmes (e.g. programme documents), complemented by an extensive questionnaire and data sheets addressing the funding agencies including issues such as target groups, resources, goals etc. The analysis of these data pointed to one of the methodical challenges of this project: the lack of comparability of the data received from different agencies. Partly, this is to be attributed to different funding logics related to different monitoring systems. However, in this context also path dependency plays a crucial role.

In addition, the two surveys that were carried out among companies and research institutions in the course of this evaluation also provided useful data for the report.

Main results

Aims and strategies

First of all, analyses show that there is a need for a set of various instruments to be able to address the different needs and target groups in a suitable way. STI-starters could be induced to more and more systematic STI with other measures than those suited to stimulate STI professionals for more risky and more ambitious R&D projects. But there are also overlaps, resulting to a large extent from different funding logics: funding measures that do not have scientific standard as a main focus will still address partly the same target group and partly also the same activities as do other funding schemes due to other logics. However, similar instruments are used and activities are addressed – e.g. with and without thematic focus. These overlaps are primarily owed to different funding perspectives and intervention logics. Altogether it became obvious that a "logic of development" along the support measures is noticeable: companies as well as scientists are supported to develop respective competences on a broad basis which could further generate promising - excellent - research at an internationally competitive level in "Pasteur's Quadrant". These competences on a broad basis do not only refer to technological or content-specific knowledge, but also e.g. to the companies' ability to adopt new innovative technologies/processes, skills referring to STI management, cooperation abilities. Reasonably, they are not only developed towards certain topics or industries. Concerning research funding on the researchers side, it became obvious that funding of FWF mainly refers to the persons themselves and not the institutions behind them which results in the fact that the structural challenge is not embraced and cannot easily be addressed. On the other hand, enterprises or research institutions are the main focus of application oriented STI funding so that the development of human resources is usually regarded as an "intended side product" of funded activities.

Resources of direct public STI funding and target groups

The majority of public means for research funding in the analysed period (2002 - 2007) (based on the data of the four promotion agencies that were analysed) are mainly assigned by FFG and FWF.

When analysing the target groups of the funding measures, the profiles of the agencies become obvious: FFG addresses mainly enterprises, universities and research institutions, and only to a smaller extent researchers; FWF addresses primarily researchers and to a clearly smaller extent enterprises, but also universities and other research institutions; AWS focuses on enterprises (SMEs, start-ups).

Almost half of the funding granted is allocated to enterprises (mainly by the FFG), about one third to universities or researchers at universities - primarily by the FWF, and at least almost 20% to research institutions (including competence centres). Service innovations are funded to a comparably small extent, their share in general funding ("Basisförderung" of FFG) is rather low, the access to structural programmes of the FFG and to thematic programmes is better but still at a low level in absolute numbers.

Furthermore, direct research funding can bring new actors into the system: while those at STI entry level orient themselves more towards funding schemes with a lower threshold such as feasibility studies, general funding, but especially the new innovation cheque in the general programmes of the FFG; more ambitious funding programmes (e.g. COMET) attract rather research experienced target groups willing to engage in more ambitious STI co-operations; a result that is also reflected in the characterisation of the users of the various programmes that were included in the survey (see report 7)

Top-down and bottom-up approaches

Funding without thematic priorities basically draws on existing interests and abilities, and it has the advantage of allowing for new topics – however, the latter raises considerable demands on the selection processes. Funding measures building on arguments of system failure and using top-down elements in funding (e.g. specifications with regard to co-operations) apart from thematic/content specifications complete a broad bottom-up funding while still using market signals; this is also true for measures trying to create critical masses and enlarge main topics on basis of existing potential ("strengthen strengths") without prescribing these ex ante. Results of the analyses of FWF funding compared to stand-alone projects, priority research programmes and programmes for applied research lead to the conclusion that funding in those programme categories of the FWF are largely granted to already strongly represented areas.

In programmes with thematic priorities, funding of the FFG has shown that at the beginning new players (first-time applicant) are attracted by such new funding schemes, but with time a more or less defined clientele develops and the share of initial applicants decreases. There are technology areas that are exclusively represented in "their" thematic programmes, but also such areas that are receiving more funding from measures without thematic priorities than from funding with thematic priorities. Finally there are indications that in some cases calls with thematic priorities and/or with high funding intensities or high funding budgets, respectively, may lead to a migration of target groups from other funding schemes.

Summary

A broad basis, with Quality Requirements

Public direct STI funding on a broad basis without explicit thematic priorities is an essential element of the federal funding portfolio. However, this does NOT mean that quality is not taken into consideration, on the contrary: selection criteria considering quality as well as the funding goals (theoretic rationales of public STI funding) are key for direct funding. Hence, it has to be made sure that the funding provides an impetus for structural change and upgrading: e.g. carrying out STI on a regular and systematic basis, with higher ambition, more cooperation etc. The focus on change leads to the relative concept of the selection criteria (expected relative improvement).

Selection criteria have to consider the relevance of the proposed activities for each applicant and in the light of the funding goals.

Both, the relative improvement ("Qualitätssprung/Innovationssprung") for the applicant / the market and the level compared to others is crucial for a funding decision (always consistent with the specific goals of the funding measure).

For companies conducting R&D on a regular basis, especially large enterprises, selection processes should not only focus on the specific project itself but also on the R&D portfolio of the company in general, aiming at identifying those parts of the STI portfolio where funding would provide for the highest effects and additionality. Such measures should not be limited only to a specific funding scheme (e.g. general funding in FFG).

Towards a broader concept of innovation

A broader concept of innovation (based on the Oslo Manual including organisational and marketing innovation) will provide for better opportunities also for service innovation; it raises the following challenges concerning the selection procedure and the funding management:

Ensuring that selection panels are able to cover different target groups and a broader concept of innovation.

The definition of goals of STI funding schemes should better take into account the specific aspects of service innovations. This also holds true for the indicators that are defined to measure the success of a funding scheme.

Consideration of these aspects in advice and monitoring of funded activities by the funding management.

Thematic and non-thematic public STI funding

Non thematic funding responds to individual signals of particular markets and allows for the bottom-up development of new topics and new combinations of interdisciplinary STI. This poses considerable challenges for the selection process. It has to be open for new developments while maintaining quality standards, fairness and transparency.

However, mission oriented funding or thematic priorities are a relevant means e.g. to create knowledge concerning a specific societal problem (e.g. ageing society) or to foster competences in a specific technology considered to be of high importance in the future. The implementation of such schemes should be limited in time and explicitly consider different measures that can be adopted (see below).

Incentives for more funding of (high-) risk projects

The risk of innovation projects covers multiple aspects, such as the technological feasibility and market risks

Funding for higher risk projects is to balance between the legitimization of public funding (being risk and public goods characteristics of R&D) on the one hand; on the other hand taking high risk may lead to the majority of funding being awarded to failing projects, thus, investing public money ineffectively.

Providing incentives for more funding of higher risk projects / STI activities has implications on the selection processes (selection criteria considering both aspects of risk as outlined above; risk aversity of selection panels, monitoring processes etc.), but also on the topic of governance: performance/output indicators of funding agencies vis a vis the responsible ministries need to consider the risks of failing projects.

In addition, it should be kept in mind that risk is not a general concept but will vary between applicants and differ in different markets.

Evaluation and monitoring of direct public STI funding

Despite a standardised request on data the possibility to compare public funding figures of the individual funding agencies is limited. For that reason it would be useful to develop an integrative and comprehensive funding data-base on the federal level.

Comprehensive means covering STI funding of all responsible agencies, ministries, project categories on the basis of selected and compatible assessment standards. However, there might well be no "one fits all" standard that is applicable for the whole set of funding, ranging from basic research to innovation. But where funding logics are aligned, monitoring logics might be alignable as well.

This could be the basis for strategic governance on the one hand, but also for evaluations concerning not only single measures but broader funding portfolios on the other hand.

A broader concept of measures, strengthening the horizontal character of STI policy

In many cases critics towards the strongly differentiated systems of direct research support have been mentioned relating to the immediate introduction of new programmes as soon as evidence of a newly suggested topic exists. Thus, the number of programmes rises continuously, the administrative work seems to be inflated compared to the programme budget, the complexity increases and high-publicity measures are necessary to achieve sufficient attention for more and more new programmes. Moreover, the findings suggest that this complex landscape of programmes with different funding intensities and funding amounts provide competing instead of coordinated incentives vis à vis the target groups.

Alternatively, approaches could be introduced into the system, where new topics or missions are fostered by measures of stimulation (consulting, management, partnering, awareness) and the monetary support of resulting projects could be handled with already existing instruments. This alternative should be seriously considered, especially when the capacity of a new initiative is unclear, when the clientele is rather small and when there is a rather minor differentiation towards already existing programmes.

A further deviation from the existing exclusive programme logic should contain the following steps:

Definition of various **measures** being reasonable and necessary for the respective objectives. This can, depending on the objective or the problem, either be a selection, a single or all of the following activities: direct monetary STI funding; advice, consulting and guidance associated with direct monetary funding; dissemination of information for target groups related to the specific objectives; awareness and stimulation measures; community building; co-operation with other policy areas, usage of other instruments such as public procurement.

For each of these measures it has to be considered, whose strategic **responsibility** they are and who should be responsible for the implementation. Possible role conflicts on the one hand and synergies on the other should be considered: while the knowledge gained through the management of STI funding schemes can be key for creating suitable information tools for the target groups, too, a close interrelation between funding agencies / policy level and target groups, which may arise through community building, may raise legitimate concerns about transparency and unbiased fairness (considering selection processes, controlling). For the detailed implementation of these measures, various **modules** could be defined, such as standardised project types for monetary STI funding etc.

The **allocation** of measures to funding agencies on the one hand and to responsible ministries on the other hand has to be developed along this sequence: the funding agencies would therefore be responsible for the implementation of the monetary funding modules as well as for consulting and monitoring of funding; the transition would be questions of awareness and stimulation. Community building should not (primarily) be located at the support agencies due to the above mentioned potential role conflict - the ministries could use other institutions and expertise (which is already done in some cases); the co-operation with other policy fields clearly is a matter of the ministries (policy level).

Moreover, a kind of **experimental** approach (pilot-calls, learning experiments) for new policy measures can be recommended. After the "experiment", the next step would have to be a "stop-or-go"-decision based on ex ante defined success criteria.

3.5 Effects of Block Grants on Research Institutes and Universities: Michael Astor (prognos)

This study aimed at answering two core questions:

What is the impact of basic funding on the general research behaviour of R&D institutions? How does basic funding influence the acquisition of project and program based funding?

Basic funding of R&D institutions allows the researchers to carry out their work with a significant amount of freedom. Therefore, basic funding decreases the direct influence of politicians and companies and fosters the independence of research. It reduces the researchers' need to strive for goals not related to science and coming from external actors. Furthermore, basic funding backs up the role of knowledge as a public good and hence broaden the general base for new research.

Basic funding enables researchers to carry out projects even if they are risky and market or profit potentials are not yet known. Research does not depend on the sole focus on direct utility and researchers can select its topics and goals without taking into account economic needs.

The question, how much freedom R&D institutions should be granted in basic funding matters is a controversial issue.

As in most other OECD countries, the structure of the financing of R&D institutions in Austria has changed. Especially in the case of universities general basic funding without an explicit focus on single projects has lost parts of its ground to the financing through project and program based funding. The latter of the two forms is also referred to as competitive research funding. The general goal of competitive and hence performance-oriented funding of research is to allocate the scarce public resources in a more transparent and efficient manner.

Not only has the share of basic funding decreased, but its characteristics have changed, too. In order to counterbalance the lack of an incentive structure first steps have been established to introduce performance-oriented elements such as, for instance, performance agreements or a formula bound budget for universities.

Challenges

The amount and structure of basic funding of R&D institutions have an impact on the behaviour of the institutions' researchers. However, this impact is not the only relevant factor of influence; many other factors have to be taken into account as well. The intrinsic motivation of the researchers and the management of the R&D institutions are two of them. The diversity of the general research environment represents another challenge. The level of diversity is determined, among other factors, by the big number of knowledge and technology areas, the different modes of research (such as basic, applied, and experimental research), and the distance of the research areas to the technology frontier. Different actors within the general research environment need different levels of funding. Besides, the influence of the structure and the amount of basic funding are not the same in all institutions.

The research design of this study takes these challenges into account. In order to extract the different forms of influence, we have studied the specific context in which research funding is carried out. More than 50 interviews with professionals and experts allowed us to trace the functional chains of ways in which basic funding influences the research behaviour of academic and non-academic research institutions in Austria. Our findings were backed up and complemented by a paper-based survey. Monte Carlo simulations have enabled to guarantee a high information-quality of the findings.

Main results

The structure of basic funding has impacts in different ways. The awarding of basic funding to universities and non-university institutions both, in direct as well as in indirect ways, depends on the performance indicators of the individual institutions. Performance agreements are made with all Austrian universities and with most of the non-university R&D institutions. In general criteria and instruments for the controlling of the agreements are established in a similar way. Especially in the case of universities, performance-orientation plays an important role in the allocation of basic funding. In addition to performance agreements there are the following options: a division of budget into a basic budget and a formula-bound budget; balances of knowledge; performance reports; and, in addition to a comprehensive reporting system, statements of accounts.

As a result, the performance-orientation of the basic funding of universities has already been able to generate a variety of impulses. The professionalization of the instruments, used for supervision and monitoring, has allowed to back up and to modernize the internal controlling. The performance-orientation of basic funding has made many universities rethink their organisational structures. Similar to the situation in a cascade model, requests for performance are often passed on to subordinate units.

The research behaviour of R&D institutions is mainly influenced by the amount of basic funding these institutions receive. An increase of the basic funding leads to a significant increase in the scientific output. It can be observed that a comprehensive endowment with basic funding per researcher has a positive impact on the institutions' ability to acquire project and program based funding. This is particularly true for funds from the so-called program support ("Programmförderung").

The acquisition of project and program based funding allows the institutions to perform additional research and hence to generate additional research output. In particular the participation in publicly financed project-funding, such as the "Austrian Science Fund FWF" ("Forschungs- und Wissenschaftsfonds") correlates with a higher output, as this output is a condition for, as well as a result of, a participation in this funding scheme. The interviewed professionals and experts have described how the amount of the available funds influences the research output as well as the acquisition of additional funds:

The creation and maintenance of an actor's own knowledge base is a key prerequisite for a successful acquisition of projects with direct research funding. In most cases, this knowledge base grows and develops in the course of time. Therefore, prior research projects, in particular publicly funded ones, play an important role for the acquisition of outside funds ("Drittmittel").

Universities, seeking to put new emphasis, may apply to the program called research Infrastructure IV and Preference-Professorships 2007/2008 ("Forschungsinfrastruktur IV und Vorziehprofessuren 2007/2008"). However, the coverage of these programs does not meet the demand. The influence of the basic funding on the creation and maintenance of the knowledge base shall not be underestimated. The interviews have shown that basic funding creates relative autonomy and opportunities for self-defined research activities in particular for key factors such as professors and heads of institutes. They have the opportunity to update their knowledge, to extend it, to develop research designs, and to access important knowledge from the networks of the scientific community.

The importance of the basic funding for self-defined research activities was met with differing evaluation. Many of them considered the possible scope of activity as too small.

Another important function of basic funding is to enable the co-financing of R&D projects. Although overhead lump-sums are included in the calculations of the program support they are in the opinion of various experts too small to cover the actual overhead costs. Apart from that, companies involved in publicly financed project- and program-based funding projects may face financing shortages as they have contributed a part of the money through their own funds.

The acquisition of new technical equipment, too, is made possible partly due to basic funding. However, this is in most cases not true for expensive instruments. They have to be financed through other budgets. In a number of cases the acquisition of technical equipment is also possible through publicly provided project- and program-based funding. If the project period is shorter than the depreciation period of the equipment, the remaining costs have, in most cases, to be provided through basic funding.

Basic funding plays an important role also in the maintenance of the infrastructure. As in the case of the creation of the basic infrastructure (that is, for instance, laboratory material), fewer additional sources of financing are available. In particular, universities are facing financing shortages in this realm.

In summary it is stated that a performance-oriented basic funding does not conflict with an acquisition of funds through outside program funding. In the contrary, the performance-based funding builds a base for the outside funding.

Disincentives through a too comprehensive basic funding have neither been observed in the case of universities nor for non-university research institutions.

The observed hurdles for R&D and other innovation activities are not caused by the way of financing but rather, they are problems of the management of the R&D institutes as well as of sub-optimal opportunities for HR and career development of the researchers. The way of financing, therefore, should not be debated any more. Beside these general findings for the R&D institutes, some findings are valid only for universities or non-university research institutions.

Universities

The proportion of basic funding is higher in the case of universities than in the case of most non-university research institutions. The proportion of university funds used for R&D ("HERD": Higher Education Research and Development) has declined from 83% in 1993 to 70% in 2004. This budget is used to finance the lion's part of the R&D of the universities, in particular the labour costs and the costs for accommodation.

The importance and the volume of entirely basic-funded research differ between the departments of universities. The importance of basic-funded research depends most of all on the demand for financing of experiments and infrastructure as well as on the application-relevance of the research results. The importance of basic-funded research declines with increasingly expensive research projects and with an increased application relevance (which opens opportunities for the acquisition of project and program based funding). It has been observed that basic funding plays a less important role in the realm of mathematics & science and in the realm of engineering. Departments with comparatively low costs of research such as, for instance, the departments of law, do not need any additional funding on top of the basic funding.

An important issue to be tackled is the relation of sharing costs between research and teaching:

As there is no admittance limitation to Austrian universities and as all enrolled students have to be taught, there is only little room for influencing the costs for academic teaching. If the number of students increases quickly, an additional need for financing and for university employees arises in short term.

The need for additional teaching can influence the research activities, as the budgets for these two activities are not separated. The basic funding means for research therefore act as a residual fund of the teaching.

One characteristic of the field of the universities is that the need for a renovation of the technical infrastructure is high. Instruments that are already entirely depreciated are in most urgent need of renovation.

Non-university research institutions

Non-university research institutions are heterogeneous; this is specifically the case for the amount of basic funding. An example for this is Joanneum Research. This institution does not receive any basic funding from the federal government. It receives a share of its operating costs from the province of Styria.

On the contrary, the Austrian Academy of Sciences ("ÖAW") receives a comprehensive basic funding. Together with the different means of financing significant differences in the role, function, and research potential exist. It is the task of the ÖAW to support science and, in particular, basic research in all fields and regards.

Varying controlling systems represent another difference between non-university research institutions and universities. The control systems of the first group are much less sophisticated than the ones of the second group. But many non-university research institutions plan to establish controlling systems in the near future. The ÖAW, for instance, is supposed to settle a performance agreement which is supposed to be similar to the ones of universities. Agreements on goals exist also between the Federal Ministry of Transport, Innovation and Technology on the one side and Joanneum Research on the other.

Compared to the sophisticated controlling instruments of universities, the controlling instruments of non-university research institutions are still poorly developed. Many of them are still in the first implementation phase.

The agreements that have been settled so far should reach a higher level of specification in order to make the target achievement measurable. Likewise, more precise goal and performance agreements are necessary to more precisely define the tasks of the institutions in national innovation system.

Scope of basic funding

The technical equipment of the universities requires new/additional sources of financing. Although there is a program called “Forschungsinfrastruktur IV and Vorziehprofessuren 2007/2008” (Research Infrastructure IV and Preferred-Professorships 2007/2008) that offers funding of 50 mill. € for the determination of foci and development of profiles thus promoting research infrastructure. It can, however, only fund a fraction of the required infrastructure.

The technical equipment of R&D institutions requires new/additional sources of financing. The investments in infrastructure should represent on average at least the amount of the write-offs. Basis infrastructure and new technical equipment should be treated equally.

There is little evidence indicating that basic funding may have negative effects. Significant correlation between negative effects and an overly high amount of basic founding could not be observed. Institutions with moderate basic funding do not report to be facing more or higher hurdles than institutions with a higher public funding. There are no visible correlations, only tendencies at best. In addition, hardly any correlation of significance could be found between the level of support demand and the proportion of basic funding. These results were backed up through interviews with experts and other stakeholders. Negative effects that are caused mainly by basic funding could therefore not be observed.

On the contrary, we observed that institutions with a high scientific output also receive a relatively high basic funding and vice versa. In addition, the endowment of the R&D personnel through a global budget correlates with the attraction of project and program based funding.

The basic funding of R&D institutions can help create and extend knowledge bases enabling R&D institutions to acquire project and program based funding. In addition, basic funding allows R&D institutions to maintain and renew research infrastructure. Additionally, the financial scope is of key importance for the co-financing of R&D projects. However, the financial scope of the R&D institutions is often relatively small, as essential shares are bound through fixed costs. Therefore, only a limited amount can be allocated variably and flexibly. The financial freedom of R&D institutions, in particular of the universities, should be increased.

Summary

Basic funding of R&D institutions is playing an important role within the Austrian Innovation system. The performance-orientation of basic funding does not conflict with the acquisition of additional sources of finance. On the contrary, the first fosters the latter. A sufficient basic funding provides an important component for the realization of the Front Runner Strategy.

Although the share of basic funding has decreased over the last few years, it still is the most important source of financing for the majority of R&D institutions. The answers to the key questions on the positive and negative effects of basic funding can be summarized to seven key aspects on two levels.

Basic funding could not finance the larger share of ambitious research activities. Acquisition of project and program based funding and the participation in program funding should remain mandatory.

The chosen way of increased project and program based funding of academic and non-academic research has not contradicted a substantial scientific output. However, the scope of the financial freedom which is provided by basic funding shall be maintained or even extended.

On the level of the organisation and governance of basic funding the following key aspects came up:

Extension of the controlling instruments of non-university research institutions

increased output orientation

increased assessment of the research output from the perspectives of scientific and technological goals

separation of universities' budgets of research and teaching

The impact of the basic funding amount on the research behaviour can be summarized in the two following key aspects:

the importance of the financial freedom of action for the scientific output of the R&D institutions

the importance of the financial freedom of action for the technical equipment of the R&D institutions

3.6 Public RTDI Funding – The Users Perspective: Sabine Mayer (coord.) et al. (KMU FORSCHUNG AUSTRIA)

User satisfaction and target group behaviour are, from a system point of view, always to be seen in context, especially with results of other aspects of this system evaluation (efficiency, effectiveness, rationale for public intervention, frontrunner strategy). The satisfaction and the behaviour shown by the target groups are not the main indicators to evaluate the system's effectiveness in reaching its goals. On the other hand, taking this into consideration when interpreting the data, we can get valuable insights into how the system is perceived, and find answers to the following questions:

(1) Are the requirements of the target groups in terms of transparency met?

(2) Is there a lack of support from the users' perspective?

(3) How are the funding schemes accessed by different subgroups of users and does this relate to the intended target groups etc.?

(4) Are there any information bottlenecks?

Challenges

Against this backdrop we specifically investigate:

The perception of the Austrian STI funding system by the research institutions and the companies, specifically considering patterns of user's satisfaction (concerning information, process, decisions etc.) with different measures as well as assumptions about the relevance of specific interventions or portfolios.

The impact of the existing system of STI funding on the target groups' behaviour e.g. in terms of adaptation of STI strategies.

The study is mainly based on two surveys of companies and research institutions with experience of the Austrian system of research support and financing. The analysis focuses on firms and institutions which had submitted a proposal for direct funding and/or claimed tax incentives (in the case of the companies). This sub-group is referred to as "system users".

Main results

About 80% of the **companies** surveyed have actively used the support system of public STI funding provided in Austria during the past. These companies either claimed R&D tax incentives or applied for direct public funding. The majority of these "system users" are small and medium sized enterprises (SMEs; 83% of them employ fewer than 250 employees). Micro enterprises with less than nine employees account for a considerable share (34%) of these system users. These data comprise firms having applied for the innovation voucher.

Although nearly all sectors and industries are covered by the participating companies, most of the companies operate in technology and knowledge-intensive sectors. Micro companies tend to run their business predominantly in the knowledge intensive service sector, largescaled companies in the user group operate more often in the medium high and high technology industries.

As the main barriers hampering innovation activities by the system users (companies) we find: The lack of financial sources (61%), administrative and approval issues (for 58%) and the lack of qualified personnel (54%). These results are in line with the findings from similar studies, with the exception that administrative and approval issues are more stressed as barriers to application in Austria. In the group of the system users, 85% of the companies stated to have applied for direct public funding by one of the finding agencies, while 64% claimed R&D tax incentives. The larger the company (in terms of employees), the higher the probability that it claimed tax incentives.

From the **research institutions** surveyed, 90% have used the Austrian system of STI funding. The majority of them are university institutes (60%). Non-university research institutions and governmental institutions account for 35%; only few universities of applied sciences were covered by the survey. The survey targeted especially research institutions doing research in the area of technology, natural sciences and medicine. Regarding barriers hampering STI activities, the research institutions are most of all facing problems of insufficient financial resources, infrastructure and limited (qualified) human resource capacity.

Applications for direct public STI funding on the federal level are often **combined**: the majority of companies submitted proposals in more than one agency. The most important single funding scheme is the “Basisförderung” (general funding) of FFG, for which around two thirds of the companies submitted at least one proposal, while 27% focused only on this funding opportunity. For the period from 2005 to 2007, half of the user companies filed one or two applications in early 2008, 32% submitted 3 to 6 applications and 12% submitted even 7 or more applications. Research institutions (or their individual researchers) combine different funding schemes even more extensively than the companies: while 67% filed at least one proposal to FWF, only 15% focused exclusively on FWF funding and only 21% filed for only one single funding scheme, compared to 16% that submitted proposals for 7 and more schemes between 2005/07 – about a third submitted 7 or more proposals.

User satisfaction with aspects such as the clearness of the instrument portfolio, access to relevant information and the quality of advice for both direct STI funding and tax incentives is generally reported to be high among all companies. These findings cast a new light on the current discussion about a perceived “funding jungle”, as it indicates that STI active companies are well in touch with the system´s offerings. However, small companies are rather less satisfied with aspects regarding R&D tax incentives.

Administrative burdens and the lack of transparency regarding funding decisions are considered to be the primary barriers for STI active companies when using the system of public STI funding. This holds especially true for SMEs. Potential actions in this regard have to be balanced against (i) the necessity to get proposals that can be subject to meaningful evaluation, (ii) the positive effect of self-selection processes (e.g. learning effects gained from developing proposals, also if funding is not granted) in application based funding. Users from research institutions are, on average, quite satisfied with key aspects of the Austrian system of direct STI funding: the clearness of the instrument portfolio, the access to relevant information and the quality of advice receive highest ratings among the various STI system features. On the other hand – similar to the results from the company survey – administrative efforts and the lack of transparency regarding the funding decision are critically assessed by the research institutions.

Asked about the **importance of specific services** in general the user companies rate direct public funding as very important for their STI activities. In contrast, tax incentives are seen to be less important. However, the relevance of tax incentives increases with company size. The satisfaction with direct public STI funding is, on average, lower than the satisfaction levels with tax incentives for STI.

Regarding the research institutions, direct funded research personnel and the funding of material and other investments are to be considered as important; support in this regard is considered to be unsatisfying by the surveyed research institutions.

The target groups' behaviour in the funding system

The (expected) chance of getting an application accepted, and the amount of funding rank highest for the user companies. For the research institutions, thematic fit is crucial besides these two aspects.

70% of the research institutions are seeking information about funding on a regular basis, which indicates the high relevance of direct STI funding for the research institutions.

For the user companies, domestic university institutes and SMEs are the most frequent STI cooperation partners. About 60% of the companies stated that at least one of its science-industry co-operations has been initiated through direct public funding. About 40% of firms carrying out STI co-operations with another company, holding or group, reported that (at least) one of these activities resulted from direct public funding.

Regarding the general strategies of user companies in case (direct) public research support is not granted, 16% of the user companies stated that planned undertakings can generally not be carried out at all without (direct) public research support; pure windfall gains (the undertaking is carried out without any change/modification) are also recorded at 16%. For the remaining companies, the answers indicate an impact of the support system on the STI behaviour: if (direct) public research support is granted, the STI projects can generally either be carried out faster, started earlier, done on a larger scale or with higher technological ambitions. A third of the user companies generally redraft an application trying to get funding by the same or another funding agency.

Summary

The report presents key data on the perspective of the target groups of the Austrian STI funding system. Summarising the findings presented above, the following crucial aspects can be identified:

- Human resources are a crucial bottleneck, both for research institutions and companies. This relates to the findings and recommendations of almost all the reports of the system evaluation: link STI policy more closely and systematically with other policies – in this case education policy; conceiving STI policy as a horizontal matter and make use of joint measures deliberately.
- For research institutions, especially for universities, maintaining their R&D infrastructure seems to be a challenge, let alone financing new research infrastructure.

  In this context the balance of institutional funding and project funding will have to be discussed. Competitive mechanisms and quality criteria will have to be applied either way.

  In addition, a shift of focus in the FWF funding from the current focus on individual researchers to a broader view considering the institutional background (eligibility of overhead costs; organisational structures of the universities, etc.) might enhance the opportunities of FWF's funding to contribute to a positive development of the universities (see also report no 5 on the topic of direct STI funding in Austria).

  The non-university sector depends largely on third party funding (including public STI funding); thus, especially the lack of predictability of funding schemes hampers long-term strategic planning in this sector. A systematic approach, based on the experiences with performance related institutional funding for the universities would allow for those institutions to perform better on the basis of longer term strategies.
- The system users' satisfaction with the funding portfolio per se has been high in most cases. Critical remarks are reported concerning administrative burdens connected to direct public funding, transparency concerning the evaluation criteria and the funding decision, and the predictability of funding schemes. These aspects are of special importance to small companies. Small enterprises show a more critical attitude towards R&D tax incentives than towards direct public finding. If service innovation is to be addressed by public funding of STI a broader concept of innovation should be applied.

  The findings concerning administrative burdens and lack of transparency are consistent with a number of comparable evaluations. Proposals have to undergo a meaningful evaluation during the selection process; however, when implementing funding processes these aspects should be taken into account in terms of adequacy of the requirements.

  Transparency of the processes how public funds are invested in STI can be considered an inherent value. In addition, funding agencies and applicants as well can benefit from transparency in terms of mutual learning – e.g. discussing the reasons why funding was not granted may foster learning processes on both sides.

The aspect of predictability of the existence of funding schemes is crucial: if public direct STI funding is to exert influences on the longer term behaviour of the target groups, it has to exhibit elements of continuity in terms of the funding schemes and incentives.

- The target groups move more flexibly in the system of direct public funding than would be expected when analysing the different rationales of the programmes themselves. In addition, there seems to be a group of "professionals" with multiple proposals submitted between 2005 and 2007. There are only low shares of firms and an even lower share of research institutions that focus only on specific funding schemes. However, there are some smaller subgroups submitting proposals only to specific funding programmes.
- The findings indicate an impact of the funding system on the strategies of companies: In case funding is not granted, projects are generally carried out later, with a lower budget, within a shorter period of time or technologically less ambitious. Depending on the type of funding different aspects weigh differently: while the more complex funding schemes seem to foster higher technological ambitions and STI projects can generally not be carried out without funding to a higher share, programmes with a lower threshold allow for STI projects to be larger and to be started sooner.

  STI co-operations are initiated by direct STI funding to a considerable extent both for companies and research institutions; and new thematic topics are accessed via public funding by approx. 20% of the companies doing R&D in this field.

3.7 Coherence of the Instrument Mix: Rahel Falk (WIFO)

Introduction

Sound research, technology and innovation activities of the business sector are of key importance in enhancing national STI-performance. To that effect, government measures to stimulate RTDI undertakings on a company level address the external environment under which companies are operating. The most relevant policy areas identified in Report 1 of the current System Evaluation include competition and (de)-regulation policies, patent protection, innovation financing and tax policy. In a more narrow sense the government provides for a research-prone, favourable business setting by paying close attention to educational policies and by funding universities as well as research performed in public laboratories. A broad and sound base of highly qualified human capital is a prerequisite for excellence at the top; scientific knowledge gained from academic research in turn generates positive knowledge spillovers and thereby facilitates private business R&D and fosters productivity of the corporate world. Arguably, such framework conditions are the most sustainable way to enforce companies' RTDI capacities and to promote adoption and diffusion of related activities. More focused intervention measures involve tax incentives for R&D or direct financial transfers to the private sector via grants, subsidized loans etc.

The System Evaluation comprises the first comprehensive and detailed empirical assessment of the structure, the usage and acceptance of fiscal support for R&D in Austria (Report 4/work package 4). Hence, so far, joint assessments of indirect tax measures and direct funding measures were confined to quite aggregate levels of analyses.

Challenges

The underlying hypothesis of the System Evaluation is that the overall systemic effects of governmental intervention cannot be assessed by simply adding up the effects of the various kinds of individual intervention. Rather, if we want to understand the effects on the system level we must examine the interaction of individual interventions, their complementarities and contradictions. Report 8 (work package 12) of the System Evaluation is an assessment of the combined effects of the interventions on the system level. A key concern is to find out if incentive mechanisms are compatible when tax funding and direct funding target the same actors or groups of actors.

Main Results

Scope of incompatibilities

By definition, tax incentives for R&D address R&D only. In principle therefore, potential incompatibilities of the two instruments concerned are confined to the extent to which direct transfers address so-called technical innovation activities, i.e. research and development as defined by the OECD Frascati Manual: basic research, applied research and experimental development.

Though R&D funding constitutes the main business of RTDI funding agencies, they provide other sorts of support to companies as well, e.g. advisory services, funding for networks, brokerage schemes, awareness measures, etc.

Innovation in the services sector and in lower technology segments of manufacturing relies less on investments in formal R&D and more on non-R&D inputs such as creativity, cooperative efforts, technology diffusion, or organisational change. The economic importance of non-technical innovation is increasing. For instance, dynamic branches such as film, music, design, software, and media are highly innovative industries, which usually consist of small- and medium-sized enterprises. These enterprises are largely excluded from tax incentive schemes for R&D.

This said, it seems that tax incentives in the form of an allowance for economically useful inventions – the "old" allowance scheme – are granted to companies which made an invention in the past and are economically successful in the present plus innovative in the sense that former inventions are characterised by technological progress. While the scope of technological advancements is as wide as it is blurry, economic usefulness is defined in terms of an applicant's contributions to GDP, employment, and other indicators of economic performance that positively impact the domestic economy. Since large companies with dynamic employment prospects and output growth are economically valuable per se, they have more bargaining power to argue the economic usefulness of their innovation activities as compared to small innovative companies.

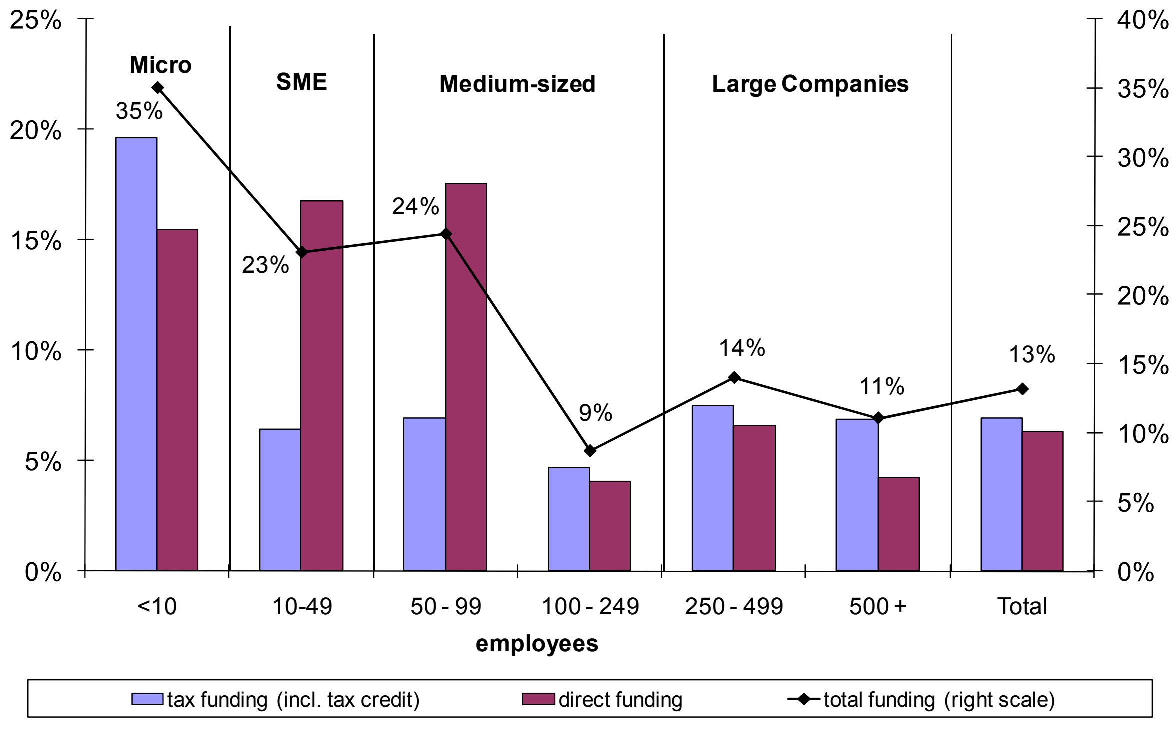
Cost

The fiscal cost of tax incentives for R&D involved cost in kind of reduced tax revenue in the amount of € 277 million for assessment year 2005. By contrast, gross direct transfers from the public to the private sector came to € 428 million in 2006. This sum includes € 156 million tax credits for R&D. Though tax credits qualify as an indirect measure to promote R&D, they nevertheless involve direct transfers of public money and as such they show up in the (direct) R&D funding statistics. When tax credits are subtracted from gross direct transfers, we arrive at net public transfers to the business sector in the amount of € 272 million. Hence, public R&D-funding to companies via either of the two channels takes place in about the same order of magnitude.

Access to Funding

Fiscal incentive schemes are more accessible to companies than direct support measures, which invariably involve an element of selection and hence competition. Companies that qualify for fiscal support widely make use of these measures; in fact the analysis suggests that all of them do so: the tax statistics count more users of tax incentive schemes than there are R&D-performers as reported in the most recent R&D-statistics of the federal statistical office. This inconsistency in data is due to sampling effects. The R&D survey is based on a full sample of companies with 100 or more employees. Smaller companies are covered only to the extent to which they pertain to R&D intensive industries. Also, if funding agencies grant direct R&D support to a small company, then this company is included in the survey. The R&D statistics report that every third R&D-active company draws on direct public research funding, i.e. 778 out of a total of 2123 companies.[23]

Figure 3.7: Direct and Indirect Funding Intensities[1)] by Size of Firms (2005)



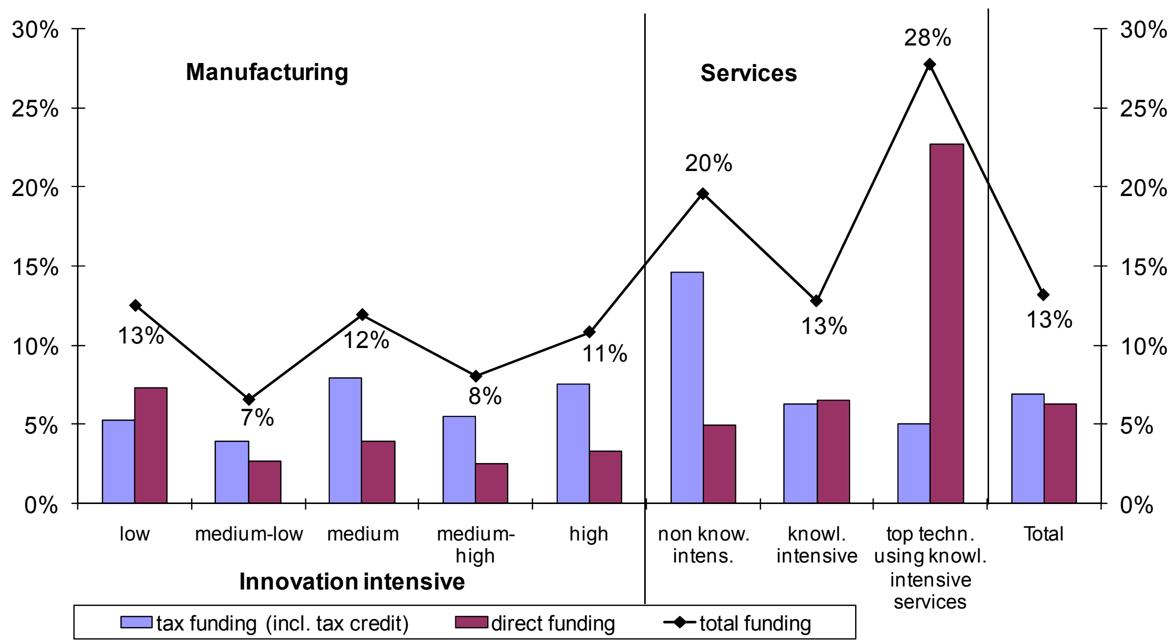
Source: Federal Statistical Office, 2004 and 2006; The Ministry of Finance provided all data on tax support – Wifo Calculations. – [1)] ratio between government funded R&D and total R&D performed by the business sector; direct funding intensities are calculated as (2004-2006) averages.

[23] These figures relates to the reporting period 2004 (Schiefer, 2006, p. 1030). In 2006, the share of directly supported companies came close to 50 percent (1211 out of a total of 2407 companies). However, in the 2006 report, users of the tax credit are classified as recipients of „direct funding“ (Schiefer, 2008, p. 1012). The sharp increase in the number of funding beneficiaries between 2004 and 2006 can be attributed to this change in methodology.

Funding agencies apparently make some effort to address the needs of smaller R&D-performers with less than 100 employees. Nonetheless, so-called micro companies with less than 10 employees get more indirect financial support than direct financial support for R&D, i.e. their "indirect funding intensity" exceeds their "direct funding intensity" (Figure 3.7). The same applies to very large enterprises with more than 500 employees. These findings support the notion that firstly, relatively low barriers to fiscal support schemes are advantageous for very small companies. Secondly, the availability of fiscal R&D incentives might indeed have a positive impact on R&D location decisions made by large multinational companies.

Nearly half of the direct R&D transfers to the business sector are geared toward the so-called co-operative sector which comprises highly knowledge-intensive organisations; the majority is affiliated with branch 73 ("research and development") and some of them are assigned to branch 74 ("business services"). Most of these units are non-profit service organisations that carry out R&D projects by order of or in cooperation with conventional companies. These conventional profit-maximising companies in turn are merged in the so-called "company-internal sector" within the business sector. For the latter, direct support intensity (excluding the tax credit) amounted to only 3.6% in 2006.

Figure 3.8: Direct and Indirect Funding Intensities by Branches (2005)



Source: Federal Statistical Office, 2004 and 2006; Ministry of Finance – Wifo Calculations. – [1] ratio between government funded R&D and total R&D performed by the business sector; direct funding intensities are calculated as (2004-2006) averages.

Figure 3.8 depicts direct, indirect and aggregate support intensities for different segments of manufacturing and service industries of the total business sector. The very high direct funding intensity of the top-technology using knowledge intensive services (comprising branch 72 "computer, software consultancy and supply", as well as branch 73 "research and development") reflects to a large extent the industrial structure of the co-operative sector. Hence, quite a few direct funding sources support R&D performers only in an indirect way – to the degree that they have access to the research facilities of the co-operative sector.

At the same time, direct funding puts some emphasis on broadening the research community by funding companies in more traditional, low innovation-intensive segments of manufacturing.

Companies in the not so knowledge-intensive services appear to benefit a great deal from tax incentives for R&D. To some degree this finding constitutes a statistical artefact, since the corresponding branches are not well-covered by the R&D statistics. Second, NACE 75-93 branches enter as non-knowledge intensive services, though three of the sub-branches therein clearly qualify as knowledge-intensive, i.e. education, health and culture. However, to some extent, the finding of extremely high fiscal funding intensities for traditional services also reflects quite high shares taken by "wholesale, retail trade and motor vehicle repair" in 2005 which supports the notion that the old allowance scheme does not necessarily target only inventions, but, more generally, also rewards activities "valuable to the domestic economy".

To gain some insight into the interaction between direct and indirect funding measures at the company level, a survey was launched which entailed a number of detailed questions on the use of particular funding programmes and instruments. As expected, companies which benefit from fiscal funding usually draw on bottom-up funding. However, companies which do not benefit from fiscal funding also draw on bottom-up funding in the majority of cases.

If we take a look at the clients of various programmes we find that the share of fiscally funded companies is quite neutral across programmes. In other words, about the same share of projects supported by FFG bottom-up funding fall on fiscally funded companies as proves true in case of EU-funding schemes. Against this overall finding, two programme groups stand out, i.e. CDG-Laboratories and top-down thematic programmes. With respect to the former, overlap is somewhat more common, with respect to the latter, overlap is somewhat less common.

This said, direct funding programmes that address "excellent" RTDI or projects which focus not only on applied research, but beyond (top-down thematic funding, top-down structural programmes, EU funding and CDG-Laboratories) prove to discriminate highly against small companies, i.e. larger companies face far higher chances to get in than smaller RTDI-active companies. Bottom-up funding schemes (regional funding, FFG base funding and tax funding) feature less selectivity in terms of company size. In particular, RTDI-active companies with 50 employees face the same chances to benefit from fiscal research incentives than companies with 500 or more employees do.

Furthermore, the survey results support the well-known finding that the current design of tax incentive schemes is incapable of addressing the relevant RTDI-activities of service companies. FFG bottom-up funding does not discriminate against services as much as tax funding does, but still: knowledge-intensive services show a statistically significant lower probability of getting access to such measures compared to the benchmark of high-tech manufacturing industries. Selected lines of direct agency funding do grant preferential access to knowledge-intensive service companies – the top-down approaches. However, companies engaged in top technology using segments of knowledge-intensive services find it no easier to select in *any* of the direct funding schemes as compared to the high-tech segments of manufacturing industries.

Effects of Funding

Effects on growth of RTDI-expenditure and turnover. Micro-econometric evidence shows that, in general, neither tax funding alone, nor agency funding alone help to improve the growth performance of RTDI-active companies, at least when seen from a short-term perspective and benchmarked against RTDI-active companies with no public support. Only companies with above average growth performance are able to transform funding success into advancements of research expenditure and output growth – this holds true if and only if such companies tap both of the funding sources, i.e. tax incentives as well as direct financial transfers. In this sense, the concern relating to the compatibility of both schemes is answered in the affirmative. Tax incentives and direct funding seem to go together and cannot be substituted for one another. Even more, a problem arises as long as companies do not access both schemes, because in this case funded RTDI-active companies do not perform better than non-funded RTDI-active companies. Medium-term analyses based on sectoral data suggest more distinctive effects of funding. However, such analyses are confined to descriptive statistics and give no clear evidence regarding the direction of causality.

Effects on innovation output. RTDI funding is instrumental in increasing radical innovation output, i.e. in developing products and services that are new to the market. Again, funding effects materialise only if companies are "double-treated". On the other hand, funding is not instrumental in raising levels of new-to-company or incremental innovations. Non-funded RTDI-active companies prove to be no less successful in this sense.

Additionality. Since most companies that benefit from direct RTDI funding measures do at the same time draw on tax incentives for R&D, recipients of indirect and direct RTDI-funding react in a very similar way when the funding agency denies financial support for a particular project. Out of the companies claiming tax subsidies only, 14% report in a recent survey that projects could not be carried out when direct funding was denied, i.e. "full project additionality" applies. By contrast, 28% of the companies that rely on direct funding only "usually" realize full project additionality.

Given that a company experiences "partial additionality" (i.e. the design of the respective project is changed), 71% of the tax-funded companies report additionality in scale – i.e. the project was run on a smaller scale. In case of agency-funded companies the respective share is 68%. Moreover, there is likewise hardly any difference between different types of funding with regard to the timing of rejected project, nor the scope.

3.8 Intervention Logic – Interaction between Institutions and Actors: Michael Astor (prognos)

This part studies the interplay between the system of innovation and the system of intervention as well as the role of different approaches to public funding. Based on the partial analysis of instruments of direct and indirect research funding as well as on a study of the structures of governance and the mechanisms of basic funding of selected research institutions and universities a procedural method of system analysis that derives from the scenario analysis approach was chosen. The scenario analysis investigates individual elements and influences on the system level and looks at the influences' immediate interrelation beyond the borders of partial systems. As a result, we identify a system dynamic with the selected influence factors and their individual importance for the system as a whole. In this way we obtain indicators to which extents some system phenomena may be suitable to compensate for certain problems – or to develop certain strengths – and to identify suitable parameters to influence and govern the overall system.

Challenges

The approach of system analysis is not only an integration of the results of single reports. In fact it is based on a holistic view of the innovation system which integrates different areas of innovation policy and possibilities for intervention on the system level. The task of the system evaluation was to examine whether the main challenges of the system and market failures are addressed by the intervention system of Austrian innovation policy.

Not all questions mentioned above will be answered by this chapter which is based on a holistic view on the innovation system. The analyses of the different mechanisms of intervention – direct funding, indirect funding, general funding of universities and research institutes – make a contribution to answering these questions. For this reason we have to refer back to the other reports.

Main Results

When assessing the functionality of innovation systems, one can see that human resources factors and education factors have the greatest impact on the governance of the overall system. They prove to be active levers which allow enduring changes of the overall system. At the same time, they appear to be subject to only few interdependencies with other factors of the innovation system. Even if the system evaluation study did not focus on this subject, this insight represents one of its key findings. The relevance of human resources factors for the future development of the innovation system is not to be addressed by the existing portfolio of governmental intervention.

In addition, the system analysis shows that incremental improvements in single fields of action are possible. However, these will have a small impact on the system architecture. Based on the findings of the analyses of the partial systems governance, of direct and indirect R&D

funding as well as basic funding of research, the following profile of the strengths and weaknesses of the Austrian innovation system can be presented:

Strengths of the innovation system

Until the beginning of the economic downturn in 2008 there was a consensus among Austria's politicians that R&D in general as well as R&D activities in businesses and science in particular needs to be intensified. This is the only possible way to create a knowledge-based economy able to compete globally. Accordingly, the realisation of the Lisbon goals received high priority on the political agenda and the relevant indicators reflected a positive trend.

This development is confirmed, for instance, by the ERAWATCH-Report.[24] Today's discussions about suitable instruments of crisis intervention, however, seem to lose track of these goals. In the last years, a comprehensive set of tools of public research funding has been developed which addresses nearly all customer needs. For the individual target groups specific tools have been developed that seem to satisfy the needs and requirements of the customers. Although a few details have been criticized, the comprehensive funding portfolio seems to successfully offer suitable programs for actors looking for support.

The strong focus on bottom-up funding in the public funding scheme guarantees flexibility which enables companies and researchers to work on different topics and technological subjects. Only few hurdles and knock-out criteria exist, so that the different innovation focused target groups can operate in different fields of innovation.

Weaknesses of the innovation system

The broad portfolio of bottom-up funding, however, has got not only strong points but also a few weaknesses because few strategic foci are defined. Also, there is no evaluation of the public funding activities concerning their economic or research-policy-related importance. In addition, the applied definition of the term 'innovation' focuses too closely on technology development and puts too little emphasis on the innovative opportunities of services as well as on the role of public discourse. The public funding portfolio itself is not yet subject to innovation policy. The "Förderdschungel" (jungle of funding) therefore results from a certain intervention attitude. This attitude considers the launch of a new program as the only possible way to react to newly identified needs for action. Existing program structures and elements are not questioned because funded target groups, but also agencies and departments administering the funding, often voice their ongoing interest in existing programs.

Innovation funding is widely defined by inputs (e.g. an increase of investments) and hardly focuses on the output of funded or unfunded R&D activities. Seeking to fulfil the Lisbon goals does not necessarily lead to an increased innovation output. First of all, it only ensures that more money is pumped into the system. The example of the universities shows that higher budgets do not necessarily create a larger scope for action. Large shares of the allocations

[24] European Communities (Ed.) (2009): ERAWATCH Research Inventory Report for Austria, p. 5.

are tied in fixed costs and there is no division of the budgets for research and for teaching. This continues to create problems in particular for the creation and maintenance of a sophisticated and efficient technical infrastructure.

The process of so-called 'agencification', i.e. the handover of program administration to agencies, should have clarified the roles of all actors in charge of these programs. This handover is not complete. The government departments still interfere all too frequently in the operational governance of the programs.[25] The role of the innovation systems' actors that receive basic funding also remains unclear. Occasionally, developments seem to enhance rather than decrease the ambiguity, i.e. when universities of applied sciences increasingly engage in research. The universities, universities of applied sciences, institutions of applied research as well as the co-operative sector have no defined profiles and roles, so that fundamental research and applied research are mixed.

The interfaces between single actors/groups of actors of the innovation system are not sufficiently defined due to the high amount of institutionalised panels (see the text on Governance). As a result, actors cannot seize their roles more prominently. The same appears to be true for the co-ordination of the departments dealing with public innovation policies and hence also for the co-ordination between direct and indirect funding. Until today both partial systems of R&D funding have been operating independently. Therefore, improvements in one system are not synchronized with the other and measures are not interlocked.

At the same time, long-term budgets are missing. These would help especially the scientific community to achieve a greater autonomy in their research activities. Funding agreements at universities and the fixing of budgets over three years are first steps towards an improvement. As mentioned before, large shares of the allocation are still tied to fixed costs and continue to restrict the recipients. In addition, the universities' allocation budget (Formelbudget) includes a complex model of indicators which offer not only incentives for excellent research but also for other activities and, again, lacks a defined set of priorities.

On the whole, the innovation system is a widely differentiated but closed system in which a limited number of actors determines the general settings. The resulting inertia renders reorientations and changes rather improbable. The system responds to new needs by enacting new programs without questioning the system itself. Also, the mechanisms of reflexion and system learning are limited in a way that maintains the structures without scrutiny.

Overlap of instruments

At large, there is a differentiated system of direct funding. This system includes bottom-up funding, structural and thematic programs. The institutionalization of different types of co-operative research – K-centres, Christian Doppler laboratories etc. – establishes organizational structures which should close the gap between basic research and applied research for

[25] European Communities (Ed.) (2009): ERAWATCH Research Inventory Report for Austria, p. 5.

future applications in industry and services. Instruments and targets of the different funding instruments are often closely connected with single target groups and stakeholders. The main problem does not result from the tool box of intervention in itself, but from the singularity and the small reach of occasionally too specific funding instruments.

The system evaluation cannot recognize priorities or a strong emphasis on single fields of technology, research, applications or branches. So it is not clear, in which fields Austrian innovation policy intends to set priorities. This lack of reference and evaluation criteria leads to a problem for the valuation of the portfolio of innovation funding. We have a broad range of instruments but a lack of priorities. The portfolio ranges from innovation vouchers for newcomers in R&D to the funding of single projects which are limited in time to co-operative research in K-centres or Christian Doppler-laboratories which make a mid-term strategic approach possible. So the different instruments include the whole value chain of the innovation process.

Gaps within the system of R&D funding

Basically, we have identified four topics resulting from the system analysis which are not being addressed by the set of the established funding instruments. These are:

missing self-reflexion of the system as a whole and of its actors

missing willingness to define an overall innovation strategy

consideration of companies on the verge of innovation

lack of interlocking with educational policy

Furthermore, the system analysis has looked at the overall societal innovation climate and the role of public procurement as factors that can either foster or hinder innovation. These topics seem to be underrepresented in the discourse of the strengths and weaknesses of the system as a whole.

Interplay of measures and instruments

Companies using direct as well as indirect instruments of innovation funding rank their level of innovation behaviour higher than companies which use only one instrument. This self-perception is a first, but quite weak indicator for the complementarities of the different funding schemes. The multitude of funding programs leads to a high confidence by the different target groups. Evidently, each target group is able to identify at least one funding program that supports its innovation activities. From the customer's point of view the funding system does not show any contradictions.

From the analytical point of view, the greater number of programs indicates the lack of setting priorities. Even though we cannot identify any contradictions, we do not see an interlocking between the different instruments and strategies. The different programs exist in parallel without a strategic element of interplay.

General funds and project funding, too, have to be regarded as complementary sources of financing R&D in the academic and non-academic research sector. General funds guarantee the basic technical infrastructure and the basic human resources. This is a precondition for all activities in allocating competitive project funding.

Connectivity of innovation actors

The different instruments for financing co-operative research support the strategic co-operation between science and the corporate sector in a mid-term perspective. This is a major advantage compared to a selective co-operation in funded projects limited in time or single measures in technology transfer. The mid- and long-term character of co-operative research strengthens the co-operation on R&D-projects as well as the general awareness for the different rationalities of R&D-institutions and entrepreneurial R&D. In general, we have to assess a positive impact on the institutionalization of co-operative research but we have also to stress two critical aspects:

Which party has the negotiating power in creating new structures and defining research topics? Is there a balance of power between entrepreneurial actors and research institutes / universities? Do both sides benefit from the results of research?

What will happen when public funding will be phased out? Will companies and research institutes find new forms of strategic co-operation which strengthen the connectivity of the innovation system as a whole?

These questions have to be answered by a specific evaluation of the impacts and long-term sustainable effects of co-operative research.

Summary

Especially in the area of science and research institutes the role of actors is not defined clearly enough. The Austrian Academy of Science and universities are focussed on questions of basic research. Simultaneously they participate in different forms of co-operative research which should fill the gap between basic research and industrially applied research. In comparison to Germany we cannot identify any actor in Austria that takes the role of the Fraunhofer society. The R&D activities of Fraunhofer have a strong focus on applied research and are very close connected to industrial applications. There is a mix of funded R&D and contract research. Fraunhofer institutes are well integrated in networks of excellence with scientific institutes and universities on the one hand and go deep into projects of product and process development with industrial R&D-partner. For Austria we need a definite role model for Joanneum Research and ARC Seibersdorf as the most prominent non-academic research institutes.

Austrian innovation policy of today is based on the target of reaching the 3% goal of the Lisbon strategy for 2010 and the national target of the Austrian government of 4%, as well as the target of 2% for basic research. Especially for universities, ÖAW and non academic research institutes we find a lack of planning reliability. Lacking continuity – in case of proven fulfilment of performance criteria – is a key barrier for the development of research strategies and the implementation of new research topics. The budgets define the scope of action but we have to consider a lack of autonomy in realizing mid- and long-term strategies. A strong commitment to the front runner strategy needs also a commitment to financing an effective and efficient R&D infrastructure. Innovation policy must enable researchers and the scientific community to overcome path dependencies and to identify new paths for future development.

Karl Aiginger, Rahel Falk, Andreas Reinstaller

4. Policy Conclusions: An Agenda for a New Policy

4.1 Preamble

The ministries commissioning the System Evaluation set two main project goals:

- understand the rationale and the actual functioning of public intervention in the Austrian research, technology and innovation system (RTI), especially on the systemic level, not on the level of individual interventions and programmes and
- suggest major and minor improvements for the innovation system in general, and the current RTDI funding system in particular.

The nine special reports briefly summarised in the preceding sections tackle the first objective and provide the main basis for the policy recommendations drafted in this chapter which is tackling the second objective. The recommendations are also based on the findings of past (evaluation) studies of the Austrian Science and Technology system. Last, new results of the innovation literature were taken into account as well as the challenges Austria is facing in the globalising world economy and in the current economic crisis.

The evaluation proved to be no easy task for three reasons:

Firstly, any assessment of a subsystem of economic policy, such as the innovation system, crucially depends on the ultimate goals of the socio-economic system as a whole. The objectives of a society or an intervention system cannot and should not be defined by researchers, but by society at large and its legitimate representatives (politicians). Unfortunately, there is no generally accepted and politically sanctioned strategy for the Austrian Innovation System. This system is complex in nature and characterised by many opaque interdependencies to other sub(systems) – a trivial statement, which however gives rise to some rather non-trivial implications as far as the choice of an appropriate benchmark for strategy formulation and hence policy recommendation is concerned.

Our approach was formed by recent advances in economic theory of innovation, which establishes that an economy that is close to the technological frontier is essentially driven by science, technology, innovation and education. The final goal of the innovation system of a high income country such as Austria should therefore be to promote scientific discovery and technology development rather than the absorption and improvement of know-how and technologies developed elsewhere. We have called this a "frontrunner strategy". In order to render this guiding principle operational for the current purpose of evaluation and strategy formulation, chapter 2 of this Synthesis Report elaborates on the critical factors conflicting with the pursuit of a frontrunner strategy. This puts the findings from the nine special Reports into frame. By reflecting these findings against the established benchmark we arrived at the policy conclusions.

Secondly, the terms of references of this System Evaluation were such ambitious and broad in scope that they certainly challenged any expert's day-to-day business. We opted for the "pooling of experts"-approach and deliberately set up a rather heterogeneous consortium. Quite a number of researchers from different scientific fields in different institutions and from different countries worked on the System Evaluation offering a broad variety of methods and rich results. In principle, the team arrived at a common understanding of the functionality of the intervention system, owing not least to inspiring as much as challenging feedback from the external experts and a wider circle of clients and other stakeholders. Also, there is overall consent with respect to the directions future policies should take and the consortium partners agree to most of the more specific lines of policy conclusions drafted in this chapter. At the same time it remains true that whenever two people agree they each place emphasis on about three different aspects.

Thirdly, the quality and availability of relevant data proved to be far worse than expected (and these expectations were already low at the outset). It is a well-known fact that in general output indicators for all types of research and development activities are difficult to find. However, also data on direct and indirect support were either unavailable or proved to be of low quality or inconsistent - not only across agencies, but sometimes also within agencies across programmes. These problems should be tackled in a decisive way to base empirical work on reliable and robust data and allow for evidence-based policy making.

4.2 Recommendations for Policy

Introductory Remark: Coherence in Policy Targets all Relevant Fields

(§0) Recommendations normally address the client. In the current context it is important to distinguish between innovation policies in the narrow sense, referring to measures and institutions directly involved in research, innovation and technology policy, and innovation policies in the wider sense, most noteworthy policies directed at the formation and attraction of human capital. Innovations depend very much on framework conditions, like regulation, the incentive and reward system of individual researchers and the openness and mobility of an economy. The evaluation commissioned refers primarily to the innovative system in the narrow sense; given the crucial importance and path-dependencies in the wider system for the performance of the system calls automatically for a broader view.

The Point of Departure: Favourable Position Based on Past Achievements

(§1) Basically, the Austrian economy has been performing well. The long-run growth differential (including an appreciating currency) has put Austria into the group of the top 3 countries in the EU-27 as far as GDP per-capita is concerned. Merchandise trade is broadly balanced and the current account is in the surplus. However, long-term as well as short-term success over the past five years has been based more on a favourable relation between costs and productivity and on markets dynamics (in Eastern and southern Europe) than on the growth drivers which usually define the competitive edge of high income countries. A number of relevant indicators is lagging far behind the leading countries, for instance, the numbers of research departments in firms, the number of patents in the triad, Pisa ratings, expenditures for basic research, or the number of university departments. The same holds for vertical mobility in education, the share of persons engaged into life-long learning activities, gender equality and investment in pre-school activities.

Standing Still is a Step Backwards

(§2) Competitiveness and economic dynamics of rich countries depend on many "growth drivers" or "decisive" (cutting edge) factors. Firstly, they depend on a number of crucial inputs like research and development, education and life-long learning. Secondly and equally important is the efficiency of such expenditures, the incentives provided, the institutions supporting innovation and the matching of innovation policies with the need of innovation players (firms and research organisations) and society at large. Thirdly, competitiveness and dynamics depend on systemic conditions such as the coherence of the innovation system with the educational system, where education ranges from Kindergarten and school to universities. Finally, economic dynamics depend on the mobility of individuals as well as on the domestic and international transfer of knowledge, on the co-operation of firms and institutions as well as on the openness of the economy and its subsystems.

It is our understanding that economic dynamics do not stand for economic growth only, but also for the pursuit of broader societal and economic goals. The welfare function includes social goals, e.g. risk coverage by a solidary society, environmental goals including sustainability, as well as health, security and other intangible goods. By the same argument, competitiveness is not based on low wages and prices, but refers to the ability to provide goods and services satisfying national or international preferences under conditions of a high income level

The Point of Reference: the Frontrunner Economy

(§3) As has been argued elsewhere (see *Aiginger* et al., 2006) Austria has completed its technological catching-up process during which physical investment and incremental innovations were important to foster productivity growth. Austria has become one of the leading countries as measured by per-capita income. Also the political and economic environment has changed: Austria has joined the European Union and its borders to central and eastern European countries have been opened. This development has offered many opportunities to the country´s economy, but it has, at the same time, put pressure on the innovation system.

(§4) Innovation systems look very different (i) for countries with low wages and low productivity (catching-up countries); (ii) in middle-income countries, still lagging as compared to the leading countries (followers) and finally (iii) in the countries with top income and productivity (frontier countries). Austria is now part of the group of the "frontier" countries as far as per-capita income is concerned. Therefore, the innovation system should also be changed from a system relying on imitation and incremental innovation to a frontrunner strategy (see *Leo et al.*, 2006). In this respect there is still much room for improvements as can be shown by analysing the industrial structure, the type of services supplied, the low share of knowledge intensive industries and many other indicators.

(§5) Countries at the technological front differ from follower-countries in several respects:

- the relation between radical innovation and gradual, stepwise innovation,
- the share of high-tech or knowledge intensive industries in total employment, value added and exports,
- the excellence in complementary production-related and quality-increasing services,
- the share of output in the highest quality segment within industries,
- the share of output in fast growing industries and industries with quality competition,
- the excellence in technological niches,
- knowledge creation as measured by the number of patents, specifically high-tech and triad patents
- the share of basic research in GDP
- the leading role of human capital for innovation,
- co-operation and research networks between firms and between firms and universities.

Frontrunner strategies can, to some degree, be different across countries, excelling in some of the listed characteristics more than in others; but excellence in the majority of these lines defines countries at the technological frontier.

We recommend:

Shifting to a frontrunner strategy

We recommend shifting from a follower towards a frontrunner strategy decisively and quickly. A frontrunner strategy necessitates changes in the organisation, finance and careers of universities and non-university research. It implies changes in many different subfields of innovation policy, but above all it calls for a deepening of the interaction between the innovation and the knowledge system, as well as between innovation and educational policy. It necessitates lower barriers for mobility on all levels: national/international, vertical/horizontal, private sector/public sector.

To make this strategy operational, the number of firms innovating has to be increased (this is the base), then the type of innovation in firms has to be changed (every firm has to "climb up the innovation ladder"), and finally the depth of innovation has to be intensified. On all steps, but specifically at the highest level, the interaction between firms and universities and between applied research and basic research has to deepen.

Addressing the Bottleneck: Human Resources

(§6) The future performance of the Austrian innovation system very much depends on giving top priority to educational policies. Without addressing the bottleneck "human capital" in its various forms, a further upgrading of Austria's innovation system is doomed to failure. It is very difficult to boost competitiveness through additional R&D expenditures by firms if at the same time universities do not provide well-trained graduates in science and technology. Top-level research is not only an important source of new knowledge, but excellent scientists are also often involved in the foundation of new firms. The quality and the quantity of excellent human capital define the capacity of technical innovation, while the quality and the quantity of broad, innovation-relevant skills matter for diffusion and absorption of innovation. This highlights the importance of policies targeting insufficient knowledge transfer or focussing the interface of basic and industrial research. Single measures taken to increase innovation inputs and outputs will only have a low impact and diminishing returns, if they do not go along with other measures to improve the educational system. Whereas the broadening of the base requires that more people successfully complete secondary education and graduate from higher education institutions, shifting towards the technology frontier calls for an upgrading of the quality of teaching at universities by better funding of the teaching at universities and by raising the quality of research at universities. A coherent policy tries to implement measures in all relevant fields and it does not rely on single measures, but on both, complementary and mutually enforcing policies and instruments. The design of a forward-looking and growth-oriented innovation policy therefore needs a thorough analysis of the educational system, basic research and labour market performance, tax incentives and the involvement of the public sector in innovation policies.

We recommend:

Removing the Bottleneck in Human Capital

There are deep interactions between the innovation system and the educational system. Without appropriately qualified employees and researchers, it is difficult to develop or adopt innovations. Innovation activities in general, the level of R&D-expenditures, diffusion and absorption of knowledge and technologies, start-up activity and firm location decisions are to a large extent influenced by the quantity and the quality of available human capital. Reforming the educational system, from kindergarten to universities, is of key importance. Specific attention should be paid to gender aspects, the integration of migrants and the attractiveness of Austria for highly-qualified researchers. These tasks fall within the remit of various ministries and therefore require a co-ordinated approach.

Furthermore, the relation between basic research and applied research has to be addressed. In particular, it is necessary to define the distinctive role of (i) universities, (ii) universities of applied sciences and (iii) non-university research institutions.[26]

[26] §41 ff. deals with the details.

Government Commitment: Ambitious and Long-Ranging

(§7) The EU Lisbon agenda has proclaimed the goal of raising R&D expenditures to 3% of GDP by 2010. This has been criticized from two different perspectives. Some critics underscore that such input goals say little about innovation output performance of the EU member states. Others have pointed out that higher research expenditures are far more important for more technologically advanced countries than for catching-up economies. So far the Lisbon agenda has had little impact. When pooled across member states, R&D expenditures as a share of GDP have not increased; actually the quota even dropped slightly because of the accession of the new member states, but also due to a stagnation or slight decrease in the large economies. The Austrian government has acknowledged the necessity that a high-income country should have a higher R&D quota and that the upward dynamics in research expenditures should be continued. Accordingly, it set the goal to reach 4% by 2020. This target should be pursued despite the current crisis.

(§8) In the current crisis a more restricted access to financial means has quickly become a critical constraint for firms, in particular for small, newly established and innovative ones. R&D is highly pro-cyclical, and declines in profits and cash flows imply that firms focus their R&D activities more on development and less so on research. High-risk projects are more likely to be abandoned in favour of projects with relatively secure returns. As consumers buy less expensive goods, firms react by becoming more reluctant to introduce innovations because it is more difficult to reap a price premium. Moreover, as banks reduce credits, process innovations that could reduce costs (e.g. energy-saving equipment) are more difficult to implement as they imply capital investments. In addition, new entry is limited due to declining market prospects. Especially in the high-tech segment, the shortage of venture capital will curtail the expansion of existing and the entry of new firms. It is therefore not only necessary to strengthen the capital market, but also to increase expenditures on R&D in a counter-cyclical way.

(§9) In recent years public financing of S-T-I-R-D is increasingly based on short run commitments and sources vary from year to year. This is a big drawback since agencies and institutions face a severe problem of long-term commitment. The current situation is particularly delicate owing to the late enactment of the federal budget for 2009. As of April 2009 contracts had not been signed and pending funding decisions had to be further postponed. Terminating structurally important (basic) research projects due to short-time finance constraints entails first and foremost large sunk cost.

(§10) Given an assumed starting level of R&D-expenditures of 2.6% to 2.8% of GDP in 2010 the growth-path to the 4% goal for 2020 requires an increase in publicly financed R&D expenditures of approximately 8% per year on average. The required amount of public money will be the lower the more effective funding is in stimulating private R&D (i.e. the greater input additionality). However, the "necessary rate of increase" to reach the 4% target could also be higher, since in Austria a rather large part of the R&D expenditures comes from abroad. The contribution of foreign financed R&D expenditures could go down in the future, firstly in the aftermath of the financial crisis, secondly because of the growing trend in off-shoring of R&D activities of multinational enterprises to emerging countries. These off-shoring activities primarily comprise product adaptation and new product development as well as applied research and to a lesser extent basic research.

We recommend:

Confirming the 4% Goal for 2020

The commitment of the Austrian government to reach the 3% goal of research expenditures in GDP by 2010 has been crucial for the boost of R&D expenditures over the past years. We also welcome the new commitment of the Austrian government to set the target at 4% by 2020. A rich country should have higher ambitions than the average of the EU-27, and the dynamics of research expenditures – rising considerably faster than nominal GDP – should be maintained.

An expenditure goal is a mere input goal; on the positive side, however, input goals are easier to promote and to monitor. Similarly, a 3% (or 4%) target is no goal as such but an input benchmark which is instrumental in underlining current and future importance of R&D. Such targets are necessary in order to track the priority given to the goal, if output cannot be measured easily or if the output effect of inputs comes with a long time lag.

In Face of Crisis: Keeping up Dynamics

It seems extremely difficult to reach the 3% goal in a period of a severe recession, since firms - domestic and even more the multinational ones - tend to reduce investments in bad times, specifically those with a long-run effect. Alternative sources like private funds or funds of the Austrian National Bank, appear to be less reliable sources of finance in a recession and interest rates for commercial loans are especially high. Nevertheless, it is important to keep the impetus in the face of crisis. The case of Finland overcoming its severe recession in the 1990s may serve as a prominent example. Inevitably, public incentives and direct funding have to be increased in a recession. The view that R&D quota goals can be reached more easily as the denominator (nominal GDP) declines is naive or cynical (depending on the expertise of the person in question); it's a fallacy by all means. International evidence shows that R&D expenditures are cyclically declining in periods of low demand and high interest rates. This is specifically risky for Austria, since a large share of R&D is financed or performed by multinational firms (60% to 70% according to *Hanisch und Turnheim*, 2007).

On the political level the strong commitment to the Lisbon goals should be confirmed.

Ensuring longer-term planning perspectives

The amount of financial resources available for public funding should be guaranteed over a longer period of time. Ideally institutions/agencies should be able to base their funding decisions and strategies on three year contracts which are renewed one year before termination. Not least the innovation actors in academia and business need a stable framework for planning and realising R&D projects and hence a long-run development path of public support is of key importance.

Growth paths of resources consistent with defined goals

Since a frontrunner strategy places high emphasis on basic research it seems advisable that funding thereof appreciates higher priority; in other words funding of research institutions should grow faster than the overall trend.

Commitment to a Vision: Defining Mission and Goals

(§11) Currently, there is no explicit and commonly shared innovation strategy in Austria. It is necessary to develop such a strategy at the highest level of policy i.e. federal government; the ministries responsible for innovative systems should be involved in the formulation of the strategy and then base their work on this strategy; agencies and institutions defining the national innovation system must understand their specific role in promoting the implementation process. Such a strategy or "vision" should also be communicated to and supported by the scientific as well as the economic community and the other layers of government. Several attempts that were made in the past to achieve a consensus have shown little success.

(§12) A strategy change cannot be enforced without political commitment at the highest political level. The operationalisation of a strategy needs massive support by all ministries and all levels of the government. This is specifically true for a small country, for a country with a rather low share of tertiary educated people in the workforce, for a country with deficits in basic research, and where a large share of applied research is done in multinational firms with headquarters in other countries. This strategic realignment of the innovation system should become self-sustaining and endogenous in the long run; it has to be initiated top down, but then it should become an intrinsic goal of stakeholders, agencies, firms, and university departments.

We recommend:

Establishing and implementing a strategic vision

We recommend that the Austrian government commissions the drafting of an innovation strategy ("the vision") which defines the mission and the goals of the innovation system, its relationship with other fields (above all with educational, but also societal and economic goals such as social cohesion, sustainability, health...). Some necessary inputs for such a strategy are already available (Forschungsdialog, Crest monitoring, Forschungs- und Technologieberichte, Strategy of RFTE, System Evaluation).

The strategy should be based on four pillars:

(i) linking innovation to all levels of education,

(ii) broadening the innovation base,

(iii) drafting sub-strategies for excellence and technology leadership in some niches,

(iv) and attaining high market shares in some growth industries and technology lines.

The strategy should be commissioned by the government and devised by a group of national and international experts. Then it should be discussed in several feedback loops with government representatives and stakeholders and finalised. The final strategy or vision has to be enacted and "owned" by government. All ministries and levels of government should commit themselves to the strategy and parliament should put it into legislation. It should set quantifiable sub-goals and be evaluated and revised after five years.

Sustainable Commitment to the Vision: Building up Strategic Intelligence

(§13) Developing a strategy is by no means a one-off activity. As environments change, policy has to change as well necessitating continuous effort to check whether current policies are still appropriate. Independent and strategic intelligence at the system level is key to the dynamic alignment of the system. High level advisory bodies should reflect on achievements of objectives and remaining challenges and – if necessary – recommend changes in the strategy.

(§14) For the time being the existing advisory bodies, namely the Austrian Council for Research and Technology and the Austrian Science Board, fulfil similar tasks - except that the first one focuses on applied research and the second one focuses on basic research. It is very important to have a strong and highly respected advisory council which (i) monitors the strengths and weaknesses of the innovation system as a whole, (ii) increases the awareness for innovation, (iii) and reflects on the progress and implementation of the vision. Having two councils lessens the importance and reputation of each of them. Moreover, having one for applied research – working closely together with stakeholders of applied research – and having a different one for basic research – working closely together with academia – aggravates existing borderlines between basic and applied research.

We recommend:

Forming a comprehensive Austrian Council for Science, Research and Innovation

We recommend setting up one comprehensive Austrian Council for Science, Research and Innovation (smart solution). A joint Council for applied and for basic research is preferable to the current split to maintain coherence with respect to the basic design of the new innovation policy outlined before. Moreover, the boundaries between basic research and applied research are becoming more and more blurred ("applied basic research"). The soft solutions would entail merging the two existing Councils step-by-step: allowing for cross memberships, establishing a bicameral system, organising joint annual sessions or awareness campaigns etc. If advisory bodies cannot be reformed immediately in the smart way, then at least a future date should be fixed for such an undertaking. In the meantime merging should proceed in two steps.

Either way, the members of the new Council are nominated by government, where stakeholder groups may propose their favourite candidates. To combine the elements of continuity and change in an optimal way, half of the members and the president should be appointed by every new government.

The primary role of the new Council is to give advice to government and other actors of the innovation system. The new Council surveys the implementation of the vision and reflects on past achievements of objectives and remaining challenges. Theses reflections are published in an annual report. If necessary, the new Council recommends changes in the vision/strategy. The annual report is open to public; it is debated in parliament and discussed with the federal government. A second and more general task of the new Council relates to promoting public awareness on the overall importance of research, innovation and science.

Vertical Alignment of Innovation Policy: Coordination over different territorial levels

(§15) Since Austria joined the EU it is part of a larger European research area. Today, Innovation policy takes place in a complex setting: there are different actors at the European, national, but also at the regional level (Länder), there are different target groups and policy fields which sometimes run across all those different layers. To that effect innovation policies have become a typical multi-level policy area as regards agendas, budgets and institutions; resources and competences have become increasingly dispersed across territories and governance levels. Such a setting calls for extensive coordination efforts, viz. horizontal coordination among various policy fields, as well as vertical coordination across the different territorial governance levels – regional, national and supranational (European) governance in STI.

(§16) For the time being similar tasks are often performed on the national level, on the regional level and on the international level (European Union). The strategy developed for each intervention by a federal or regional agency should be aligned with respective European programmes as much as possible. The recommended policy shift is mostly about increasing coordinated efforts (vertical cooperation) to improve the efficiency of innovation support actions at all levels. Building upon comparative advantage and on the principle of subsidiarity, are key to this approach.

We recommend:

Enforcing coordination and agenda-setting on the European level

Austria is very successful in participating *in* and getting research money *back from* European programmes. However, it would be at least as important to influence European agenda setting. The Austrian research promotion policy should be redesigned into a multi-level system between the European Union and the regions. Deficits in co-ordination and especially in agenda setting and cross-policies should be tackled. Demand for action exists

- at the interface to the European level: above all in the informal phase of active co-design of the STI policy in the European Commission;
- at the federal level: integration of further policies like educational, health, environmental and further policies for comprehensive problem solutions and design capability in the NIS;

- at the interface to the provinces: this level requires a reorganisation of the one-way communication from the Federation to the provinces towards a two-way exchange of information and joint learning in terms of an enriched innovation system at the federal and state level as well as possible support from cross-state activities.

On a more practical level, combining regional, national and European support should be made as easy as possible. The least that should be done is to provide relevant information, e.g., by referring to respective programmes at a higher/lower governance level. The national agency should offer to do the selection of projects also for the regional programmes. Furthermore we recommend earmarking a specific part of each programme's budget for activities that connect the funding seekers with the international scientific community and with international high-level research programmes.

Horizontal Alignment of Innovation Policy: Coordination over different Policy Domains

(§17) Establishing a vision and setting objectives are good starting points for policy but not sufficient by themselves. It is of key importance to outline how the overall goals are broken down to more operational targets, which measures are to be used to achieve these sub-targets, how these measures are going to be implemented at the different layers of the innovation policy system, who is going to be responsible for the overall coordination of efforts and how the resulting developments are to be evaluated.

(§18) Beyond the task of drafting the innovation strategy, some more co-ordination of research policy is strongly recommended. For the time being, programmes constitute the predominant tool for policy intervention. Nearly each new thematic or structural priority recognized by government, administration or the firm community results in a "programme", i.e. a certain amount of "ordinary funds" or out-of budget sources are sidelined to respond to the newly perceived challenge. Consequently, a multitude of programmes (co-)exist and many of them are endowed with little financial means. The resulting plethora of programmes primarily reflects severe deficiencies in the governance of STI. STI-agenda setting increasingly takes place at the European level. At the national level, there are few commonly shared visions and targets beyond mere quota goals and inter-ministerial competitive behaviour is rather the rule than the exception. When vertical and horizontal policy co-ordinations are doomed to failure or take too much time, the scope for successful and prompt policy action is increasingly confined to individual intervention. To overcome some distinctive barrier to innovation, the staff of either of the three innovation ministries regularly comes up with a well thought-out measure that is tailored towards the needs of a specific target group - which is often closely involved in the design of the programme. Taken by itself, the new programme might be smart. However, such kind of fragmented policy response does not necessarily promote the functioning of the overall national innovation system. Seen from a systemic perspective, the new line of action too often is not linked up to other piecemeal intervention. Moreover, allocating financial resources in homeopathic quantities and not paying attention to overall funding portfolios is aggravating the scope for further policy fragmentation from which eventually severe inefficiencies arise. The effects on the system level accrue through the interplay of individual interventions, their complementarities and contradictions. Coherence in strategy and action and compatibility of distinct intervention measures require first and foremost a commonly shared vision and co-ordinated policy making to fulfil a multitude of tasks.

We recommend:

Establishing a High Level Coordination Commission across Ministries

A smart version of a renewed governance approach provides for a permanent high-level government commission which presses ahead with the implementation of the strategy. Ideally, the three ministers mainly responsible for the innovation system take on the role of a steering group. The chair should rotate between the three ministers. The steering group meets two times a year to review which goals of the strategy need special attention or measures and which strategy lines should be intensified. The chancellor, the vice chancellor, and the minister of finance attend every second meeting of the steering group. If necessary, other ministers in charge of a specific part of the comprehensive innovation strategy are invited as well.

Regular input to the steering group meetings should come from the team drafting the strategy, from the renewed Council for Science, Research and Innovation responsible for outside monitoring and from the parliamentary committee on Science, Research and Innovation (the latter is also a merger of two currently separated bodies).

Concentration of Innovation Competences at the Strategic Governance Level

(§19) The segregation of competences between four or five ministries has often been complained about. This problem will be less aggravating once a vision and a high-level co-ordination committee are established. The coordination of innovation-related activities would improve and the division of labour between the ministries would be more clear-cut.

The very new budget procedures add to the disentangling of competences in strategic innovation governance. Budgets are defined over a longer period and with more leverage for the individual ministries and agencies.

We recommend:

Radical reform: Locating innovation competencies in two ministries

A radical reform would concentrate the innovation activities in two ministries, e.g. a Ministry of Research would be in charge of basic research, including research performed in universities and a Ministry of Economics and Technology would be responsible for applied research and innovation activities of firms. However, a Ministry of Economics and Technology does not exist in Austria; for the time being, competencies on framework conditions for firms and industries are split in two ministries (at least). Furthermore, a split between basic and applied research is not completely in line with the view that innovation is created in a systemic, non-linear process. Concentrating research agendas in just two ministries will become less important once innovation policy is based on a commonly shared vision, and a permanent high-level government commission is set up to co-ordinate all tasks related to innovation policies.

Realistic reform: Restructuring the competencies of three ministries

A realistic reform takes into account the fact that the current split between the two ministries in charge of applied research and innovation is hard to overcome. It accepts the current division of labour, but improves the division of responsibilities, fosters common strategies and similar governance procedures. It restructures historically grown competencies according to the new vision, for instance at the start of a new legislative period, when shifts in competences are quite common. It develops common management tools and competencies relevant to the steering of research and innovation in an administration.

There is Plenty of Work to Do: Separating the Tasks

The Ministry of Economy, Family and Youth focuses on the following strategic RDTI-issues: cooperation between industry/SME and science; start ups; innovation and RDTI-capacity; internationalisation; human ressources). In this sense it aims at the broadening and widening of innovation. It puts core emphasis on framework conditions related to the financing of innovation - especially of innovative start-ups - and attracting foreign direct investment - especially in knowledge intensive industries. Further fields of responsibility include the commercialisation of innovation, and deregulation policies. Main indicators for successful policies of this ministry include, first, an increase in the innovation base ("more firms are engaged in innovation activities"); and second an increase in the number of firms establishing innovation activities as regular parts of their business activities ("firms are more engaged in innovation activities"). In this regard the Ministry of Economy, Family and Youth will in practice be mainly concerned with innovation in small and medium sized firms. Knowledge transfer through co-operation in innovation are key (business-to-business as well as between business and co-operative research centres or Universities of Applied Sciences). Fields of action relating to larger companies include the worldwide marketing of Austria as a research location.

The Ministry of Transport, Innovation and Technology focuses on the upgrading and excellence of innovation. Its overarching strategic mission is to promote the shift to the knowledge and technology frontier. On this account the Ministry of Transport, Innovation and Technology should be primarily concerned with the needs of firms that already do research. For instance, community building and branding of emerging key technologies are key measures to enhance innovation performance; especially the performance of small research firms with limited own capacities in this respect will benefit. Further prime task of this Ministry include the cultivation of a competitive profile in selected technology segments, promoting co-operations between industry and the scientific community and providing an attractive location for international research centres. The latter first and foremost relies on sufficient amounts of high-skilled labour; it is a sine qua non. The restructuring of competences thus involves co-operation with the Ministry of Research and with labour market policies in order to attract the best researchers available.

The Ministry of Science and Research is responsible for basic research, universities and Universities for Applied Science. More specifically, it is responsible for the knowledge transfer from and to universities, for an ideal mixture of bottom-up and top-down research and for the monitoring of extra-mural basic research.[27]

Enforcing the Process of Agencification

(§20) Management literature suggests to rely on the principle of agencification to fulfil such complex tasks as the public support of innovation. An agency is a body (agent) which is operationally independent from the public administration. It works under different framework conditions (labour law, own management, autonomy) and mostly deals with a very specific, if not single purpose activity - such as implementing public support for innovation. The main advantages of agencification relate to professionalisation, increased efficiency and flexibility. On the other hand, agencification may lead to an uneven distribution of knowledge (asymmetric information) between the agency and the principal. The latter suffers from informational deficits as regards the need of the target groups, the functionality, effectiveness and efficiency of some support measure etc. giving rise to classical principal agent problems.

(§21) Agencification has been started but has not been fully implemented.

A full implementation would imply

that specific tasks are delegated to an agency, not only an amount of money plus request for routine administration,

that the overall goals and the indicators on progress are fixed ex ante,

and that the agency develops an operational plan (operation strategy) on how to perform the task.

The core idea of agencification relates to the division of work. On this account the principal (originator of the task) does not intervene in any details of task fulfilment; instead it only controls targets achievements of the agency according to pre-specified schedules and rules to which the agency should obey to. The agency is responsible for making decisions on the type of support, on eligibility criteria, on members of the jury and acceptance/rejection of proposed projects. These jobs can only be accomplished if agencies provide excellent human capital, internal structures, mobility and adaptability; recruiting of personnel including the top level must follow best practice and monitored by recurrent external control.

[27] §41 ff. deal with the details

We recommend:

Let agencies earn more autonomy

The process of agencification should be revived, reshaped and reinforced. This requires clearly defined roles for both, the principal and the agent. The use and transfer of knowledge in both directions are key to the well-functioning of innovation governance, as is development of mutual trust between the different levels of innovation governance. Increased agencification should occur step-by-step so that the extent of "earned" responsibilities and non-responsibilities, respectively, shift gradually along a process of earned autonomy leading to more operational freedom of the agencies and more room for strategic governance on the side of the principal.

Defining a clear division of labour between principals and agencies

We strongly recommend a more pronounced division of work between the strategic level and the operational level of governance. The principal (ministry) has to set the strategy and the goals. It should neither be allowed to, nor be forced to interfere at the micro level. The originator of some policy measure should certainly have no voice in nominating jurors and experts and accepts eventual funding decisions or rejection of proposed projects. Agencies decide on the operationalisation of policy objectives and are responsible for proper administration procedures which go quite into the details, e.g. applying uniform cost schedules. Agencies monitor the measures they implement for fulfilling assigned tasks, they reflect on target achievements and learning processes – and they share their gained insight into the functionality or dysfunctionality of intervention measures with the strategic governance level. Consistent reporting and building of mutual trust are key to this model of earned autonomy.

Once the gradual process of agencification is completed, only the accomplishment of assigned tasks matter. The agency is continuously controlled by a board and should be evaluated every now and then. In these evaluations an agency's decisions can be investigated, but not changed ex post. If the number of wrong decisions is large and the instruments are chosen badly this will have consequences for the management of the agency.

Implementing Tools of Steering

The agencies' assigned budgets will ultimately be included in a quasi-autonomous area, being governed by performance agreements. The agencies' autonomous areas / budgets should also be included in strategic performance agreements and therefore be subject to strategic goals. Existing framework contracts between ministries and agencies (such as the "Rahmenvereinbarung" between FFG and BMVIT/BMWFJ) can form a basis for the performance agreements. The process as such will have to include a permanent revision of the progress made and feedback loops to allow adjustments where necessary. In order for the ministries to be able to effectively govern (and therefore, control) the process, to provide incentives for the agencies to perform their tasks as agreed and to consolidate the necessary trust, a mechanism to revoke certain steps in case of underperformance has to be developed in parallel. Furthermore, one of the main problems in the relation between agents/agencies and principals/ministries needs to be tackled: the information and knowledge asymmetries. We therefore recommend establishing mechanisms and procedures that allow for a steady, transparent (thus institutionalised) and open exchange of knowledge between agencies and ministries. These mechanisms should be obligatory for all participating organisations.

Upgrading of management skills

The new governance structures require specific knowledge and capabilities on both sides. On the side of the ministries, strategic capabilities and experience in professional controlling should be increased and fostered. On the level of agencies the capabilities must change from operating very detailed programmes at very different, but narrowly defined rules, to a more strategic, independent approach. Similarly, instead of spending money for pre-specified programmes, agency staff should be able to design and pursue operational strategies.

Specifying the Roles of the Agencies

(§22) Three agencies are currently of utmost importance for implementing the strategies of the three ministries involved in innovation policy: FFG, AWS, and FWF. All three of them are publicly owned and constitute legally separated entities. The fourth funding agency in federal public ownership is the *Christian Doppler Research Association* (CDG) which supports cooperative research projects of the scientific and the corporate world. All of these agencies fulfil partly different and partly overlapping task. FFG and AWS evolved from mergers of smaller agencies. In fulfilling their tasks they build on different types of contracts for individual programmes and activities. AWS concentrates on the financing of smaller firms and funding is not restricted to innovation. Among other things, the AWS finances firms which suffer from credit constraints – an important role in the current crisis. The AWS is currently applying for a full banking concession. In contrast, FFG is concentrating on the financing of innovation projects: partly it engages in general bottom-up programmes (basic programmes, "*Basisprogramm*"), partly it engages in sophisticated structural programmes and partly in thematic programmes. FWF is financing university and non-university research mainly on the basis of a bottom-up strategy, without prior definition of thematic priorities by a ministry.

We recommend:

Streamlining of Operational Governance and Allowing for Specialisation

The current ownership structure of agencies is appropriate if the mission of each agency is aligned with the responsibilities the "vision" assigns to each ministry. In this case the strategy of the ministry defines focus and scope of tasks, some of which may be delegated to agencies. These tasks should be clearly defined in terms of their aims and required outcome. Drawing on the funding expertise of any of these agencies should follow similar rules, but there is still some scope for remaining differences. Assignment of tasks to either of the agencies should draw on the principle of specialisation and comparative advantage.

Harmonising procedures over all agencies

All procedures, forms and statistics should be brought in line across agencies as far as possible. The forms should be based on modules, which are partly similar across all product lines and agencies. Reports should also be similar and compatible with the requirements in the reports to Statistic Austria. Post project statistics have to be provided for at least five years or the firms can allow the statistical office to transmit their reports as required by law to the agencies if they want to prevent additional reporting. All records should be transmitted to the Austrian Statistical Office, which then allows agencies as well as universities and research institutions to make use of the micro material anonymously.

(§23) The roles for the three agencies should be stated in the vision with a clearly defined general task and a streamlining of the current division of labour.

We recommend:

FWF: well-balanced funding of bottom-up and top-down approaches

The FWF should give more room for developing thematic areas focusing on societal priorities and on broad technologies in which Austria strives for international excellence. Scholarships and awards should also be more closely linked to priority areas. While the very missions or priority areas are defined top-down in the vision, the specific research lines and topics should develop from a bottom-up approach. Whenever the dominating bottom-up approach leads to spots of excellence, the FWF should further such fields of research and make a report to the ministry, which will then decide whether additional measures should support the strength of this field.

The support of excellence, internationalisation, and cooperative research in science should remain the principal goals of the FWF. Excellent researchers coming to Austria should be supported specifically. To increase the internationalisation of research an extension of the D.A.CH agreement to other countries should be enforced

FFG: less thematic programmes and more bottom-up approaches

It is recommended to strengthen the role of FFG as the central research promotion agency pressing ahead with a frontrunner strategy, particularly in the area of applied research. The current programme lines with their very specific funding logics should be brought to an end. New and more flexible support measures should be developed. The following measures should be taken immediately and independently on later decisions regarding the continuation of specific programme lines.

The number of thematic programmes should be reduced (not the amount of money spent). Within all programmes there should be more bottom-up approaches, less stringent a priori definition of programme lines and less pre-specification of the instruments to be applied. The differences in procedures stemming from the time before the merger process setting up the FGG should be eliminated. The personnel of FFG should be more mobile across the programme lines. FFG should become the agency promoting excellence and bringing firms nearer to the technological frontier in the applied sector. FFG should try to increase cooperation with FWF, specifically looking for the creation of similar clusters and excellence spots in applied and basic research.

Current basic programmes should be upgraded. Funding should specifically support service firms facing severe difficulties in tapping indirect funding. It should draw more attention to risk taking and projects in the pre-competitive stage. The support for individual projects should be increased and money given for longer periods to allow for the development of human capital and, more generally, to enable behavioural additionalities to emerge from support.

Structural programmes should be evaluated every fifth year, again according to ex ante known criteria. Structural programs in the area of cooperative research have to be dissolved at the latest after 10 years, since only this will put pressure on persons and firms to go into the market phase (making profits). Structural programmes as well as thematic programmes should be fixed in three years performance contracts (with an evaluation after two years). The room for choosing instruments should be larger. The bottom-up approach should dominate within structural and thematic programmes.

AWS: Encouraging the access to venture, seed capital and innovation entrantss

The role of AWS could be defined as a bank on the one hand, and as an agency supporting the start-up of companies on the other hand. For start-ups and innovative new firms they should provide and encourage the access to venture and seed capital and offer and promote the innovation check. This task includes counselling, networking, project management and change support. Functions related to deeper innovation may be shifted to FFG. AWS should also be in charge to support firms that have not engaged into innovation so far to develop primary innovation capabilities and to integrate respective activities in day-to-day business. As the innovation voucher supports innovation newcomers, it should be moved to AWS. It may also be worthwhile to consider delegating operational responsibility for the Headquarter Programme to AWS.

New Goals: Focus on Output

(§24) To some extent, output goals have entered both, the strategic level of innovation policy as well as its operational level. More recent programme documents list a number of targets and related output indicators or spell out to-do-lists on the basis of which funding recipients may tick off supposed output of some support measure item by item.

The general performance of the innovation system might be assessed with reference to the number of patents and publications, the speed of technology diffusion, competitiveness in high-tech industries and in the highest quality segment of individual industries. More specifically, output goals for a scheme devised to promote innovative start ups may be defined in terms of the number of firms entering a market, the dynamics of employment in new firms, the growth of firms after five years, the number of firms developing new products or innovating continuously. Output goals for a strategy to deepen innovation may be given by the number or size of innovations new to the market, the number of firms which realise successful innovations in an emerging key technology, the number of newly initiated research co-operations with (foreign) universities, the share of patents in the triad (USA-Japan-Europe), revenue accrued from licenses, etc.

Any attempt to specify the ultimate goal of intervention is very much appreciated for they offer more orientation with regard to contents of innovation policy and gear more towards the efficient allocation of public money than mere input goals would. It is also in line with the new budget law. Above all, output indicators stimulate increased action and put issues on top of the agenda. At the same time, however, we note that in many cases it is simply impossible to attribute well-defined, observable, and above all meaningful output indicators to discrete measures of intervention; this holds true at least at the programme level, and certainly at the level of national innovation policies. On the other hand, the "to-do list approach" simply measures what is measurable. At best, this might be a device for internal bureaucratic control, but it is certainly not rather conducive to efficient output steering of the NIS.

We recommend:

Adding output goals wherever feasible

Lacking efficiency of current expenditures in Austria is indicated by the fact that Austria's position in innovation output indicators is less favourable than its position for input indicators. This may not be surprising after a prolonged phase of rapidly increasing R&D investments. However, political representatives should not ignore this development. Steering the innovation system mainly by input goals tends to lead to inefficiencies. For this reason, we recommend to include output measures in the formulation of policy goals and the implementation of specific instruments whenever possible. Public interventions should therefore be assessed on a mixture of output goals, administrative guidance and provided inputs.

In particular, beneficiaries of direct funding should be aware that their post-funding performance will be increasingly benchmarked against output-based indicators. In light of the difficulties to define universally valid output indicators that apply to all funding beneficiaries, it is suggested that applicants themselves specify their output targets along a list that varies between individual intervention measures. As currently the majority of policy instruments still follow an input-based funding logic, the change towards steering by output goals whenever possible introduces some cultural change to current funding practices.

Direct and Indirect Support: Separating the Tasks

(§25) The analysis of the Austrian innovation system indicates that the innovation base is not broad enough and that innovations are not sufficiently profound for a high-income country. Broadness of the innovation base can be defined by the number of innovative firms, and by the number of firms innovating on a regular base (instead of casual innovations), or the share of firms with research personnel or research departments.

Excellence of innovation activities may be indicated with reference to applied technology levels, e.g. respective projects are based on off-the-shelf technologies, on technology beyond the normal operating window or on next generation technology. The depth of an innovation may also be assessed by its distinctiveness, or service features.

Whatever the definition of high-value innovations might be, they are often based on basic research and certainly on high-skilled labour. Both, increasing broadness and excellence (depth), equally require human resources and financial incentives. Different instruments should be used to fulfil the two goals.

(§26) *Direct* support measures involve the direct transfer of financial means such as grants, subsidies, or conditional loans, but also non-financial support, e.g. access to information and advice, brokerage schemes, or funding for networks. The distinctive feature of direct support is that specific measures are granted for well-defined projects. Support depends on some commission's discretionary case-by-case decision where pre-specified funding criteria and selection rules apply. The budget allotted to agencies and programmes is predetermined and often varies from year to year.

By contrast, claims against tax liabilities – via allowances or a tax credits – are subsumed as *indirect support*. They allow companies to reduce their tax payments as a reward for carrying out research activities. There apply no prior selection criteria.

(§27) The final mission of direct measures is to channel support to those activities which generate the highest social returns. By focussing on excellence, direct support is the right approach to promote the deepening of innovation. By focussing on areas of high societal importance it is also instrumental in offering solutions to problems beyond the narrow sphere of the immediate beneficiaries of support. Furthermore, direct support enables learning processes, provides information and induces a certain degree of consulting.

(§28) The mission of indirect support is to foster R&D in general and to make investments in research more attractive than investments in other activities. The rationale for this kind of support is derived from the importance of R&D for the growth of firms, for the competitiveness of the economy and the creation of external benefits connected with research. Firms and institutions should know that indirect measures make all expenditures related to research and development cheaper than if paid at market prices. It is advantageous for setting up research departments in Austria, if research incentives are high and reliable. Structural effects within the research expenditures are not intended and do in general not exist (with the exception of low support for innovation in the service sector).

We recommend:

Broadening the base and deepening the scale for innovation

Broadening the innovation base and an upward level shift can be best supported by indirect support mainly via tax incentives. This holds primarily for increasing the number of firms which engage in innovation-related activities on a regular basis, for setting up research departments or attracting foreign firms to locate research facilities in Austria. The tax credit is a very efficient instrument because it provides incentives for firms not yet profitable and it induces a cash effect in recessions (as opposed to tax allowances).

However, for new start-ups and for firms with no experience in innovation at all, some additional direct project funding including a service and a consulting component is essential in addition to or instead of tax funding. More generally speaking, "changing the track" – supporting innovation entrants, and encouraging the deepening of innovation and the transition from imitative activities to innovation activities at the knowledge frontier - can be better accomplished through direct project funding. Both the scale and the scope of such projects regularly call for a high concentrated subsidy component. In particular, direct funding should focus on radical/new-to-the-market innovations, on risky projects, on research co-operation with universities and other firms and on broadly defined thematic priorities. Direct funding may also be instrumental in removing major structural deficits of the innovation system.

For broadening plus level shift we propose a simple and generous tax credit for research. For deepening and changing the track we recommend substantial reforms in the governance of funding (mainly) applied innovations of firms and changes in funding of basic research, university- and non-university research. We furthermore recommend to continuously measure the degree of additionality of public funding, to monitor the degree to which the deepening of innovation occurs via direct funding and to regularly assess the impact of tax credits on innovation, on the use of human capital, on research output and economic performance at the firm level.

Increasing complementarities, reducing overlaps

The dichotomy between direct and indirect funding is well-founded and should be continued. Both of these basic funding approaches meet distinct objectives and follow different funding logics which should be made more complementary to each other. Direct and indirect funding instruments are no substitutes for one another – far from it. There is strong evidence that funding effects materialise only if companies make use of tax incentives and also rely on more challenging measures of direct support. This applies especially to successful introduction of true market novelties. In this sense both measures work complementary and complementarities should increase through the reforms.

The role of indirect support is to further the width of innovation and to facilitate complex continuous innovation activities which cannot be easily divided into individual projects. Firms should be able to rely on public support independent of the decisions of agencies, their shifting priorities and annual funding budgets.

The role of direct support is to differentiate between firms and projects according to the priorities of the vision or the ministry designing a programme, and to give support in cases of extraordinarily high expenditures (core projects, start of a new phase) and high risks (radical innovations). Thematic priorities – as defined in the vision- supporting successful clusters, or concentrating research on certain areas as to gain international leadership should be a priority task for direct support, too. Support for research in the precompetitive phase should be strengthened. Structurally important projects should build on reliable and dynamically increasing sources of finance and not on irregular ones. Similarly, the short-time (non-) availability of public money should not have an effect on stop-or-go decisions of such projects. Tying the funding of basic research to unstable sources (e.g. to the National Foundation) involves some unpleasant side effects once the flow of these funds falls below prior notice and funding slows down or ceases. Breaking ongoing research projects off first and foremost entails sunk costs.

It is very difficult to predict the future use and hence the cost of indirect funding instruments (and the cost of public funding as a whole). Recent projections of the Ministry of Finance proofed to be highly overrated. Direct funding needs a continuous, foreseeable perspective of increasing funds to pursue the frontrunner strategy and to contribute to attain the 3% goals in 2010 and the 4% goal in 2020. On this account the practice of trading direct funding budgets off against (over)estimated expected costs of indirect funding undermines (if not damages) respective statements of the current government programme. Furthermore, basic research does hardly benefit from indirect funding provisions.

Reform of Direct Support

(§29) Throughout the last years a comprehensive set of intervention measures has been developed, where the programme-approach is dominating. As has been argued in §16 the resulting plethora of programmes primarily reflects severe deficiencies in the governance of STI. These programmes meet all kinds of specific needs of target groups and, as a consequence, the recipients of (direct) support are not overly critical of the current system. On the contrary, the customers are quite content. They do not get lost in a funding jungle, but deliberately pick from the best offers of a funding supermarket. The strong orientation towards customer satisfaction dampens the readiness and willingness to change, even more when the direction of change by itself is controversial. On the other hand moderate performance in innovation output puts severe doubt on the overall effectiveness and efficiency of the current system.

(§30) Today, a typical programme is administrated partly by an agency and partly by the originator (a department in a ministry). The originator of the programme is still able to intervene or at least to co-determine in detail how the money is invested and what funding criteria apply. While such control does, in principle, comply with the division of work between the strategic and the operational level of governance, the level of intervention and the driving force for intervention are in dispute. Agencies informally complain about micro interventions, i.e. in-detail control of funding guidelines and specifications of programmes. Similarly, agencies themselves voice their continued interest in established programmes. Sure enough "cosy relations" between the originator/implementer and the target group of interventions are very much appreciated by the beneficiaries. However, without discrimination between projects, industries, technological content etc. the structural effect – the very objective of direct support – cannot be fulfilled. Now and again, interventions are necessary in order to achieve a structural effect – the ultimate objective of direct support.

We recommend:

Improving Governance will put an End to the Plethora of Programmes

In general the number of programmes should be substantially reduced, but not the money spent. The objectives of each intervention – the broad tasks – should be clearly stated. Ideally these tasks are derived from the vision or at least they should be based on the sub-strategy of the ministry delegating some task. Tasks are defined as broad issues, e.g. "building a cluster or a community for a certain topic". We recommend reversing the burden of proof for initiating new programmes. Whenever a new policy goal (task) comes up it has to be investigated first whether there are other options for policy response than building on the familiar, yet mostly little sustainable programme-logic. This approach involves tight co-operations with policy areas outside the sphere of innovation policies in a narrow sense; fields of action include the formation and attraction of human capital, intellectual property rights, standardisation, (de)regulation, public procurement and probably much else besides. Ministries meet regularly to co-ordinate tasks and to prevent overlaps in the assignment of tasks remaining in the responsibility of agencies.

Mitigating Role Conflicts and Benefiting from Synergies

In fine-tuning the provisions for direct support and assessing the role of various steakholders, it is important to pay close attention to potential role conflicts and synergies. While the knowledge gained through the management of RTDI funding schemes can be key for creating suitable information tools for the target groups, a too close ("cosy") relation between funding agencies/ministry staff on the one hand side and target groups on the other hand side, raises some concern on issues such as transparency and unbiased fairness and, above all, on the coherence of the intervention system as a whole.

We recommend shifting (or leaving) responsibility for the implementation of monetary funding modules to agencies; agencies should also be in charge of information brokerage, consulting and monitoring of funding. Community building on the other hand should not primarily be located with the support agencies due to the above mentioned potential role conflict. In principle, the same argument applies to ministries. However, once ministry staff sticks to strategic governance and agenda setting, this role conflict becomes less severe. In the meantime the ministries could commission community building to other (private) institutions and expertise.

A Need Test for each New Programme

When tasks are delegated to agencies, there should be a strict need test before implementing a new programme. In particular, it has to be investigated which programmes become redundant after the introduction of a new one and whether assigned tasks can be fulfilled via existing programmes (taking into consideration the aggregate programme portfolio of all agencies). For instance, new policy issues or missions could be fostered by measures of stimulation, consulting, management, partnering, awareness etc. (which may be specifically customised for distinct target groups), while monetary support could draw on existing instruments and measures. This approach seems particularly reasonable when the capacity of a new initiative is unclear, the target group is small, and when the features of the new initiative are not very distinct from available measures.

In view of the long time it takes to design new measures, experimental approaches (pilot-calls, learning experiments) are encouraged, especially if there remains uncertainty on the capacity and scope of a new initiative. After the "experiment" has come to an end, the next step involves a "stop-or-go"-decision based on ex ante defined success criteria

Phasing out Existing Programmes

In order to increase the structural effect of direct support we recommend not only defining the broad objectives of each programme or task more explicitly, but also specifying the criteria by which success or failure of some support measure will eventually be evaluated. Indicators defining the success or failure of an intervention have to be developed ex ante and a set of "exit" criteria should be defined which build the basis for any decision concerning the closure of funding programmes. Each programme should be evaluated according to these pre-defined criteria after five years, and terminated after six years if the specified task could not be fulfilled. (There may be arguments for longer or shorter time spans). Above all, if there is no structural effect the financial resources spent for direct support lose their most important justification. The findings of positive evaluation reports should be reflected and fed back to the potential restart of the programme in concern. In particular, updated objectives induce new strategies for operationalisation.

Defining Top-down Areas

(§31) While it should be no longer possible to establish narrowly-defined thematic programme lines, nor programmes for narrowly-specified technologies, it can and should be possible to define broad priority areas in the vision. Agencies should determine the details of implementation. Agencies should carry out periodic calls to support the development of scientific and technological capabilities in areas of social interest and to promote strategic technologies defined in the "vision". Given the urgent challenges many advanced economies like Austria face (e.g. Kyoto Targets and global warming, ageing of population, health issues, security issues) research funding should also support societal goals. It is evident that a small country has to economize on scarce resources and will achieve leadership only in small areas and niches. The first argument in favour of top down programmes is that markets not always provide scientific or technological know-how to fields of societal concern ("mission argument"); the second argument is that top down programmes can contribute to make production and research more effective by bundling resources ("scale argument"). On the other hand it is well known that the information level of the government on prospective future developments and on chances for success in a competitive environment may be insufficient. This is even more the case if basic research and radical new fields are involved. Due to this uncertainty governments of advanced innovation systems tend to pick programme lines for similar new generic technologies (or "future technologies"), or they focus on similar societal goals irrespective of grown domestic capabilities and specific domestic needs. Moreover, often thematic programmes result from extensive lobbying of interest groups with little reference to research areas of national strength, nor mission arguments.

One solution to this problem is to determine a few broadly defined themes and strategic technologies in specific domains of application on which Austria should concentrate either on the basis of prospected excellence or on the basis of policy preferences (societal needs). All these priority areas (top-down priorities) should be clearly stated in the vision, including the very reason for choosing whatever priority area of intervention. It is further necessary to outline criteria by which both success and termination should be assessed.

We recommend:

Defining Priority Areas in the Vision

In the vision focus should be directed on a small number of priority areas aiming mainly societal goals (including ecology, health etc.). The rationale for identifying some priority area of action should be made explicit and the motivation for intervention should reflect a wider social consensus. It is important to define thematic programmes on a broad basis and avoid subdividing money according to narrowly defined programme lines or pre-defined instruments. Specific research topics within the broader thematic areas should not be specified but follow from a bottom-up process. Additionally the agencies should try to identify hot spots or topics which are defined by a cluster of bottom-up projects. FWF as well as FFG should co-operate and work out framework conditions for successfully strengthening an existing or newly created cluster of competence. These are to be reported annually and the ministries in charge of the agency can decide if there are measures to be taken to further encourage a centre of excellence with measures in the realm of their political sphere.

Seed finance and Start-ups

(§32) One of the most pressing deficits in the framework conditions for innovation in the Austrian innovation system refers to the undersupply of venture capital. This shortage of risk capital is related to the specific medium-tech profile of the Austrian business sector. More generally, information asymmetries are hard to overcome despite intensive screening of the projects as managers of technology firms and start-ups have always better information on the actual quality of their business plans and the technologies they develop than potential investors. Investors are prone to herding such that their investments are concentrated in a few sectors and as a result, not enough variety is supported by the capital market. Private venture capital investors tend to focus on the less risky late stages of the start-up process such that not enough private capital is available for the early phases of business creation. Finally, also the classical argument for the support of R&D is valid for start-ups as start-ups may underinvest into R&D if returns cannot be completely appropriated.

(§33) In Austria a number of policy instruments have been developed to support early stage financing needs and other support measures for start up firms. These programmes are administered by two different agencies. The AWS provides financing instruments, research, consulting and certifying services, and guarantees for venture capital funds as well as venture capital intermediation services. The FFG in turn offers instruments to support business start-ups by academics (AplusB programme), innovation vouchers and thematic R&D funding programmes accessible to start-ups. Thus, start-up firms are able to access a large number of programmes; however, the fragmentation increases the administrative burden to firms. The proposed instrument could also be adapted to promote the building up of research and development capabilities by innovation newcomers.

We recommend:

Simplifying Support for Start-Ups and Focusing on very Early Stages

Public support for start-up financing should be simplified in order to reduce the administrative burden. Support should concentrate on the very early stages such as the pre-seed and the seed phase, when firms assess the feasibility of their business plans, develop their product concept and assess their market potential. With slight adaption respective support for start-ups could also be used to promote innovation projects of innovation newcomers.

Pooling Instruments to Cover all Phases of the Early Stage

A possible solution to simplify early stage financing is to pool different existing instruments to allow for a financing that covers all phases of the early stage business start up process. This would reduce administrative burden considerably. Such a support scheme should

* split the process in several stages to reduce the risk of the investment for the public investor,
* ensure that external expertise on markets, technologies, management and finance are involved from the very beginning,
* ensure that only projects are chosen that need private equity or venture capital.

Furthermore the commercialisation strategy should form an integral part of the proposal and the evaluation should also be based on this aspect even though this stage should not be funded.

Early stage start up support should

* address start-ups of firms
* award money for the proof of concept phase (innovation vouchers + additional funds for more demanding proofs of concept; up to €30,000)
* award money for the prototype development phase paid out for the achievement of predefined milestones of the project with an ongoing assessment of the continuation of the project after each milestone has been passed (up to a maximum of €500,000).

(§34) The present institutional and legal framework conditions for the establishment of venture capital funds are not satisfactory. With the phasing out of the *Mittelstandsfinanzierungsgesellschaft* as legal form for venture capital funds the legal conditions concerning private equity are ambiguous. It is therefore necessary that this situation is cleared as soon as possible.

(§35) The Federal Ministry of Finance has presented a bill to strengthen Austrian capital markets and innovation (*Kapitalmarktstärkungs- und Innovationsgesetz -- KMStIG 2008*). The bill promotes the establishment of investment companies for which special taxation rules should be applied that are particularly relevant for private equity/venture capital markets. The provisions of the bill are to ascertain the free flow of risk capital without fostering speculation. There are, however, a number of reservations concerning the types of acceptable investments (some forms of investment are not considered), the minimum and maximum durations of the investment stipulated in the bill that would complicate IPOs, information disclosure obligations, or requirements for managers that are not clear. Despite the fact that this bill represents a contribution to considerably strengthen the Austrian capital market, further amendments are necessary.

We recommend:

Improving the Legal Framework Conditions for Private Equity/Venture Capital

A baseline solution to improve the conditions of the Austrian venture capital market is to amend the bill for the *Kapitalmarktstärkungs- und Innovationsgesetz* 2008 and pass it into law in order to ensure that Austria has an internationally competitive private equity law.

The Ministry of Finance should take action to improve the legal framework conditions for the operation of venture capital funds: it should advance an independent and internationally competitive private equity law, create reporting standards for more transparency and reassess the investment rules for life insurances. The *Oesterreichische Kontrollbank* should assist in collecting relevant data.

Establishing Funds of Funds and Extension of Capital Guarantees by AWS

In order to increase options for diversification and to attain larger funds we recommend establishing a fund for public participations in private venture capital funds focusing on early stage finance. This would ensure higher liquidity in the early stage venture capital market. The participation would be at market conditions. The public should only act as minority investor with a participation of up to a maximum of 30%. Extending the AWS capital guarantees would facilitate protecting venture capital investments while fund volumes are too small.

Support to Small and Medium-Sized Firms

(§36) Broadening innovation means that more firms, specifically smaller firms, engage in innovation and research. Tax incentive schemes cover small firms quite well – provided that they invest in R&D. The crucial point is that innovation activities of small firms are mostly less technical in nature and hence they mostly do not meet the criteria for (Austrian) tax funding. As for direct support, administrative burden of application procedures seem daunting. This is especially true for small firms with little (or no) innovation experience; such firms face an unfavourable cost-benefit ratio of insecure funding prospects some time in future and initial fix cost of application. By contrast, the innovation voucher offers easy (and in many cases: first time) access to direct funding, including consulting services.

We recommend:

Continuing the innovation voucher scheme

The innovation voucher is an easy, non-bureaucratic measure to encourage innovation activity of small firms. We recommend continuing the innovation voucher scheme and encouraging its actual use. It is instrumental in raising awareness that innovation is both necessary and feasible in small firms The scheme should be evaluated after three years.

Reform of Indirect Support (Tax Incentives)

(§37) While the rationale for tax funding is quite simple, the current system of tax incentives for research is highly complex and not easy to communicate. Tax incentive schemes are administered by the Ministry of Finance and by the Ministry of Economics. The instrument set consists of tax allowances and tax credits. The subsidy component of allowance schemes differs between incorporated companies and non-incorporate firms. Calculation of allowances is mostly based on volumes of eligible expenditure, but there is also an additional subsidy for incremental expenditure. Two different bases of assessment co-exist, one relates to inventions valuable to the economy, the other one relates to R&D expenditure as defined by the OECD's Frascati manual. Firms can choose between different bases of assessment and may also opt for a combination of both. The provisions for contract R&D vary substantially depending on the scheme chosen. Seen from a system perspective, the major concern is to increase R&D *in general* and to promote open innovation. Integrating external knowledge in the process of innovation will speed up and improve its function.

In order to increase the effectiveness of tax incentives they should be easy to understand and to communicate, for otherwise companies will not respond to the incentives set. The present structure of tax incentive schemes is highly complex and in fact it is much more complex than necessary.

We recommend:

Implementing a Single, General Tax Credit

We recommend relying on only one single instrument, namely a tax credit (tax premium).

Eligible claims should be based on Frascati R&D and include commissioned research - without the current cap of €100,000 per year. The more generous provisions on contract R&D would promote knowledge and technology transfer, research co-operation and co-operation with universities would improve.

There should be no further provisions for incremental expenditure; the new scheme should be volume-based.

(§38) While the relative generosity of R&D tax treatment in Austria used to rank top by international comparison, today it is only average or even slightly below. This downward shift is due to the reduction of corporate tax rates (in 2005), but also due to improved tax incentives elsewhere. Recommendations on the desirable generosity of tax funding of research ultimately hinge on the willingness to trade present loss in tax revenue off against future tax revenue; it is a bet on future economic success of current research investment and hence there can be no correct let alone optimal assignment. From an economic point of view the tax credit should be considerably higher than today in order to keep - and renew - the attractiveness for research in Austria in a more competitive environment and to draw near to the targeted R&D quotas set by the government. The political implementation of a new regime will be the easier the more companies will find the new scheme no less advantageous.

We recommend:

Raising the Tax Credit to 12%

If the tax premium is raised to 12% (smart solution) all firms in the corporate tax scheme will be better off to a substantial degree. It is less attractive for firms liable to income tax- but only if they formerly drew on the increment-based allowance scheme that applies to expenditures relating to economically useful inventions. The number of reform losers would be very small.

If the tax premium (tax credit) is increased to at least 10% (soft reform), incorporated companies would still be better off, but non-incorporated firms that formerly drew on any of the allowance schemes would generally lose.

(§39) Irrespective of the rate of the new tax credit the recommended reform in tax incentive schemes would entail losses to companies which used the old allowance scheme primarily with reference to economic usefulness, and less so with reference to research activities. Such policy change is quite in line with the recommended focus shift (i.e. from a catch-up to a frontrunner strategy).

(§40) In fine-tuning the new structure of tax funding there is an argument for more ex post controls as well as for a pre-approval facility. A tax credit of 10 or 12% is non-negligible, nor are the accumulated cost of fiscal funding. On this account ex post controls should prevent the misuse of the tax credit and thereby strengthen the credibility of this instrument. At the same time, the beneficiaries of the tax credit (who still bear 88-90% of the research cost) sure enough have a high preference for some planning reliability.

To counter the argument that the liquidity effect is provided only ex post (with the delivery of the tax declaration), research outlays could be claimed at the beginning of the year (during the year), comparable to the "reductions of expected profits clause"[28] if there are good

[28] Firms pay a certain sum for business taxes during a year, estimated on the basis of last period profit. If there are good reasons for expecting lower profits the firm may ask to reduce these ex ante payments. This could be extended to reduction of profits or extra cost due to research expenditures. This would also help the research department to argue the value of its activity within a firm (this is not the case to the same extent if the expenditure is used to get a tax rebate ex post).

reasons. However, it is most important that the new premium is easy, understandable and reliable. The quest for reliability applies last but not least to ex post auditing practices which

We recommend:

Granting preapproval facilities and enforcing ex-post control

We recommend granting a pre-approval facility to increase planning reliability of potential users of the new tax credit. We also recommend responding to concerns about misuse of tax incentives by improving ex-post control. This would strengthen the credibility of tax funding instruments and thereby increase its acceptance beyond the still-narrow sphere of immediate beneficiaries. Finally we recommend responding to firms' concerns of improper auditing, for greater legal certainty constitutes a core advantage of tax funding as opposed to discretionary funding via agencies.

These concerns should be addressed by establishing a pool of highly qualified auditors. Auditors should hold a university degree in engineering or natural science; they should be independent from the tax authority.

Control (auditing) should be enforced on the basis of a random selection process where any user of tax incentives faces close ex-post examination at least once in five years.

Reforms in the tertiary education system

(§41) The quality of the tertiary educational system is of overarching importance for the innovation system of a country. This specifically holds for high income countries that intend switching to a frontrunner strategy. There is clear evidence that the secondary and tertiary education is a weak point in the Austrian innovation system. On the other hand there is also substantial evidence that world class university research does not only promote industry research, but it is also a source for new businesses. Improved university research enhances and deepens the innovation base in firms. Good universities with specialised knowledge attract also foreign direct investment and foreign research labs.

We recommend:

Increasing in accordance with progressing reforms

We recommend increasing funds for tertiary education to the level required by the European Commission (2% of GDP). Spending on higher education institutions should increase more dynamically than other forms of public R&D expenditures. However, additional spending for higher educational institutions should be accompanied by further reforms of the organisation of higher education institutions and by an expansion of the number and quality of study places.[29]

[29] This recommendation states that the total funding for the university system is supposed to increase over the next years to 2% of GDP. However, this increase in spending needs not to be carried by the taxpayer alone. Beneficiaries of the tertiary educational system should also contribute to the increase in spending e.g. through tuition fees

Clear division of labour, but reduction of social selectivity

(§42) The priority for improving the educational system at the secondary and the tertiary level is very high and a protracted slow pace of reforms as observed in the past years will harm Austria's long term competitiveness and prosperity. The quality of university research and teaching has to be drastically improved and many universities still have to find their own profile. By advancing knowledge of science and technology, universities create the foundation for economic growth and material well-being and improvements in human health. As the principal locus of basic research, universities play a key role in sustaining competitiveness and economic growth; if knowledge will overtake capital and labour as the key production factor in the 21st century, knowledge-producing institutions such as universities will become the main drivers of economic growth.

(§43) Given the overall medium tech profile of Austrian manufacturing, universities of applied sciences should play the important role to broaden the technological basis of the Austrian industry. Universities of applied sciences provide a specialised higher education with a professional focus and they contribute to the transfer of knowledge and technology. Co-operation with enterprises and local communities are important, small scale innovations should be encouraged. Further studies should assess the need of study places offered at universities and universities of applied sciences. An extension of the system of universities of applied sciences may be necessary for two reasons: (i) for the switch towards a science-technology-innovation driven growth paradigm more graduates from both universities and universities of applied sciences are needed, and (ii) the expansion of the system of universities of applied sciences increases the competitive pressure on universities to provide higher-quality education.

(§44) Austria's educational system is characterized by an early selection of students between an educational track leading to tertiary education (secondary schools, universities) and an educational track leading to vocational training (Hauptschule, apprenticeship). The selection takes place at the age of ten. For pupils, choosing the vocational track, education ends at the age of 15, and a switch to the tertiary educational track is no longer possible. This early selection corresponds also to a social selection, as the children who enrol on the vocational track, in many cases derive from a socially disadvantaged background. Although there are ongoing reforms to reduce the early selection and increasing links between secondary schools and an apprenticeship career, the split will to some extent continue and it is necessary to reduce this selectivity of the educational system by enabling people to upgrade their education up to the tertiary level.

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together with income contingent loans. Given that the cost per graduate in Austria lies well above the OECD average, but the average budget per student is below the OECD average, there is substantial room to increase the efficiency of studies. Graduates in Austria are more cost-intensive because the average duration of studies is also longer.

We recommend:

University: Primary institutions for government-funded research

Universities have to remain the primary institutions in which government-funded research is carried out. Universities should continue to convey Bachelors, Masters, PhD and postgraduate training degrees. The PhD degree is to be conceived as a pure research degree suitable to pursue a scientific career based on extensive training in scientific research methods. The PhD thesis should in all instances replace the "Habilitation" thesis as the main proof of capability to undertake independent research and teaching.

University of Applied Sciences: Degrees focused on professional profiles

Universities of Applied Sciences are the top level in an education line from vocational training to applied secondary schools (Berufsbildende Schulen). All the degrees awarded by universities of applied sciences have to be specific and focused on a precisely defined professional profile. Universities and universities of applied sciences should not be closed for each other, but remain open in principle to students who want to switch between the two of them.

Organising and supporting an "applied career track"

There should be an educational track (applied carrier track) from apprenticeships to vocational secondary schools (awarding general qualification for university entrance) and further on to Universities of Applied Sciences. This educational track should be as flexible as possible. Employment and upgrading education could alternate several times during a (in the course of a) career.

Harmonising the funding principles

(§45) To achieve the functional division of responsibilities in providing knowledge as public good, a closer administrative and functional integration of the two types of higher educational institutions seems to be necessary. This should be achieved through a harmonisation of funding principles between universities and university of applied sciences. The Bologna process has led to an alignment of the types of degree programs offered by universities and universities of applied sciences. Now both institutions offer Bachelor and Masters Degree programs which have contributed to a consolidation of the landscape of higher educational degrees, but, in terms of the budget allocation the two types of institutions are treated in a very different way.

Universities negotiate with the Ministry of Science a three-year global budget (Globalbudget) that covers all types of cost. It is allocated on the basis of a three-year forward looking performance agreement ("Leistungsvereinbarung" 80% of funds) and a "formula" or "allocation" budget ("Formelbudget") that is based on eleven back-ward looking indicators. Universities of applied sciences are funded on the basis of standardised costs per study place and student fees.[30] These differences in funding across higher educational institutions make the funding of this sector opaque. This makes the monitoring of performance difficult and as a result it is also difficult to implement a coherent strategy and set coherent incentives across all institutions of higher education and research.

We recommend:

Harmonising the budgeting process for tertiary institutions

We recommend to change the ways institutions of higher education are financed in order to provide coherent incentives to increase the number of graduates as well as improve the quality of their education and the research carried out at Austrian institutions of higher education. These goals should be achieved by harmonising the funding of tertiary education across all institutions of tertiary education *based on the current funding model of the universities of applied sciences*.

(§46) It is necessary to amplify the effect and performance-related part of public university funding – which has been implemented with the University Organisation Act (UOG 2002) – through separated calculation of research and teaching costs. In the first three years the University Organisation Act (UOG 2002) is not able to set coherent incentives and supervise the implementation of goals because negotiation of performance agreements is characterised by a situation of asymmetric information as universities are in a better position (than the ministry) to influence the allocation of funds by defining their future development plans and goals. As the "formula budget" mirrors the topics that are subject to negotiations for the performance agreement, expected losses in the formula budget can be compensated by a specific prioritisation of goals in the performance agreement and vice versa.

(§47) With exception of the indicator capturing grants awarded by the FWF no other indicator entering the calculations for the formula budget captures the quality and quantity of scientific output directly, and most indicators for teaching reflect purely quantitative goals.[31] It is also not clear what impact evaluations should have on the budget allocation. While the University Organisation Act (UOG 2002) demands from universities to develop quality control systems and to carry out both internal and external evaluations of their activities, nothing is said on the consequences these evaluations are having on the budget allocation. The University Organisation Act (UOG 2002) does not support or encourage technology transfer activities or industry-university linkages sufficiently.

[30] Some universities of applied sciences will waive student fees starting in fall 2009.

[31] For to quantify in excellence see *Hölzl* (2006).

We recommend:

Separate budgets for teaching, research and infrastructure

We recommend to define distinct budgets for teaching, research and infrastructure for both types of higher educational institutions (universities and universities of applied sciences). The weight and the endowment of each of these budget positions is to depend on the division of labour between the universities and universities of applied sciences and specific social functions envisaged by the government.

(§48) The budget per student varies considerably across universities and universities of applied sciences. It ranges from about €3,000 (Wirtschaftsuniversität Wien) to more than €35,000 (Veterinärmedizinische Universität). In general, the most expensive universities in terms of cost per student are the medical universities. Universities of applied sciences are funded on the basis of standardised costs per study place and student fees.[32] The standardised costs vary in dependence of the thematic focus of each degree program and range between €6,400 per study place for business-related studies and €7,600 for technical studies. The government funds 90% of these standard costs. Government funding for the universities of applied sciences therefore varies linearly with the number of study places offered. Universities of applied sciences in the field of business therefore get about twice the budget per student of the Vienna University of Economics and Business (Wirtschaftsuniversität Wien), whereas universities of applied sciences in the technical field get somewhat less than the technical universities. Considering that universities have to cover ongoing infrastructure expenditures, teaching and research from their global budget these rates compare rather favourably relative to those of universities. Universities of applied sciences cover their infrastructure and research costs from student fees (€363.36 per semester) and subsidies from the federal states that on average make for 30% of their total revenue. However, there are considerable variations across federal states ranging from a few to more than fifty percent. Given these differences, a high quality of teaching, especially at universities, cannot be guaranteed.

We recommend:

Standard cost based funding of teaching in higher educational institutions

Teaching budgets should be based on standard costs (given actual costs and warranted class size). The standardised cost funding rate should be adjusted in a back-ward looking fashion based on the average number of students per class in each degree course over a three-year period. The outcomes of teaching evaluations, the duration of studies in each degree course and drop-outs in each degree course should feed into this procedure.

(§49) Even though the allocation of research funds should be competitive, this does not imply that all research funds should be allocated through agencies. Universities should have their

[32] Some universities of applied sciences will waive student fees starting in fall 2009.

own budgets for research financed by the general university fund. This is important for universities to develop autonomously their research profile without a-priori depending on external sources. One way to allocate this research budget across universities could be based on merit established by following the general principles of the formula budget as established in the University Organisation Act (UOG 2002) but using different indicators capturing research quality rather than quantity.

We recommend:

Allocate a dedicated research budget to higher educational institutions

In order to support universities to define a precise research profile independently from external agencies they should receive a dedicated research budget through the general university fund. The total research budget for all universities could be allocated according to different indicators in a backward looking fashion and central attention should be given to indicators capturing both, the quality of scientific research and the quantity of research output as well as indicators for acquired external research grants (including also research grants for collaborative research with industry in pre-competitive fields). The R&D budget granted to each university should be allocated in a competitive process focusing on the merit of proposals from individuals rather than the quality of departments or institutes, as the latter tends to support of excellence. These dedicated research budgets should be used by universities to prepare younger research staff (post-docs) and to eventually apply for the more demanding FWF grants as well as to reward good researchers with a reduction of their teaching load.

Universities of applied sciences should receive small budgets for the preparation of project proposals and the maintenance of the given R&D support infrastructure. These funds should only be allocated after the FH*Plus* program has been used to start up the R&D activities at any university of applied sciences and if follow-up projects can be documented. Public funding should also be made available to cover losses of teaching income that accrue if R&D personnel of a university of applied sciences are involved in R&D projects. As most universities of applied sciences are by and large involved in development projects, these costs should largely be covered by co-operation partners from businesses that benefit from the cooperation. The remaining cost should be funded by the Federal government and the government of federal states and the latter should carry the larger part.

(§50) The costs of infrastructure vary greatly across universities. The global budget per student for technical universities is on average close to €11,000 a year, for the University of Mining (Montanuniversität) it is approximately €14,000 a year and for medical universities it is more than €26,000 a year. On the lower end we find general universities with a budget of about €5,300 a year or the Vienna University of Economics and Business with just above €2,900 a year. These differences largely reflect the varying costs for infrastructure that have to be paid from the global budget. Since 2002 the government has made available funds for a program supporting the renewal and upgrading of immovable property amounting to €141m. With this money 254 infrastructure projects have been realised. Much of this extraordinary funding has become necessary because equipment and buildings were either out of date or unsuitable for current duties. This indicates that in the past continuous investment and upgrading of large scale and expensive equipment and immobile property at universities has been neglected. For achieving excellence in research and teaching but also as a location factor for international business firms, a good research infrastructure and good research equipment are very important. It supports also inward mobility of top-level researchers. Ongoing investments in infrastructure should therefore at least equal the amount of write-offs of both, equipment and basic infrastructure.

We recommend:

Infrastructure budget at minimum covering write-offs

The infrastructure budget for universities and universities of applied sciences should cover at least the amount of write-offs of both, equipment and basic research infrastructure.

For very expensive and large scale investments that have to be covered by extraordinary budget from extraordinary budget allocations, as a general rule it should be assessed in all cases whether it would be more convenient to pool the resources of several university partners and government laboratories for the investment in question and whether to set up a joint use centre, where the partners have alternating access to the equipment.

The maintenance of the research infrastructure for universities of applied sciences should be financed by the Federal government jointly with the federal states. It should be covered to the larger part by the federal states. Given that both the Austrian Cooperative Research institutes and the universities of applied sciences primarily contribute to technology transfer to SMEs at the regional level, it should also be assessed whether it makes sense to merge some of these institutes with universities of applied sciences.

Non-university Research Organisation: heterogeneous missions

(§51) As in all developed countries we observe a highly heterogeneous sector of non-university research institutes also in Austria. The heterogeneity stems from the high variety of missions that research laboratories outside the higher educational sector have to accomplish. The mission of these organisations usually goes beyond the performance of basic research. Capabilities are typically concentrated in engineering and technology, followed by natural sciences, but more specialised capabilities are also evident in agricultural sciences, social sciences, medicine and humanities. In the past decades new government research priorities and pressure on public funding have contributed to re-shape the system. The debate in Austria has followed the global trend to demand from these organisations to generate commercial income and emulate business practices.

The Austrian public R&D sector seems to be quite large as compared to other high income countries and that the R&D subsidy ratio for the private enterprise sector is only moderate as compared to other EU countries since a significant bulk of R&D subsidies is devoted to the public R&D sector. This raises the question on the contribution of the public research conducted in these institutes to private innovations; a question that has not been investigated to date.

We recommend:

Research institutes should invigorate the innovation potential of firms

To pursue a front-runner strategy, it is necessary to broaden and invigorate the innovation base of Austrian firms and in particular SMEs. Research centres provide a natural route to reach this part of industry. The development of an overall strategic vision for the Austrian National Innovation System should provide guidelines and help larger research institutes to position themselves in the National Innovation System.

Further studies should assess whether there are potential synergies between smaller research institutes and the universities of applied sciences. It should also be assessed how larger research institutes can best complement the technology transfer activities of universities, and whether their current organisational structure is best suited to face this challenge. In areas where the call on expertise is intermittent, but important, it should be assessed whether the overhead costs of maintaining expertise and facilities in particular areas could be reduced by operating joint research institutions with European partner countries.

(§52) The large number of research institutes with an orientation towards industry and especially to SMEs show that the market (manifested by industrial contracts) has identified a need for their services. There is substantial empirical evidence that outsourcing of R&D by firms is increasing and that a significant share of this goes to industry-oriented research centres. There is also another role for research centres. They provide development and technical services to traditional firms which have little or no R&D capability of their own, many of these are SMEs. For this reason policies to enhance their capability to support innovation should be put on the agenda. In the execution of these activities research centres could also act as intermediaries between university research and industry through applied research and innovative development. There are, however, examples, where these activities are successfully carried out by universities (e.g. the Harvard Accelerator Fund). In this case an alternative role for research centres would be to focus exclusively on consulting activities to the support of partnerships and knowledge-sharing between academic institutes (example: Steinbeis foundation in Germany). At the present there is little systematic knowledge on how these different roles have developed in Austria, and more specifically on the nature of existing interactions between the business sector and mission-oriented research institutes.

(§53) A key difference between mission-oriented research institutes outside the higher educational sector and academic science is the extent to which scientific excellence is a goal in itself. While some research institutes try to maintain their professional standing through publications and conferences, this is not their primary purpose. Many of the tasks these institutes carry out such as taking long-term measurements are important science but mundane in research terms. The specialised role of these research institutions lies on the one hand in their potential to act as an instrument of diffusion of technology, and on the other hand in their importance to provide R&D for public goods and the provision of scientific advice to government. Both functions increasingly become also a goal for universities, but not their primary purpose.

We recommend:

Providing public goods not offered by universities

The specialised role of the mentioned above non-university research institutes outside the higher education is to provide public goods and knowledge-based services that universities do not provide. Non-university research institutes should therefore act as an instrument of diffusion of technology, provide R&D for public goods and scientific advice to governments and businesses and act as intermediaries to improve the linkage between university research and industry with the aim to broaden the knowledge base and the innovation potential of the economy.

(§54) Research centres are also a potential source of new technology-based firms. Here, the greater contribution is likely to come from centres which are performing more basic and strategic research. In Austria this concerns mostly the larger research centres and the co-operative research centres (K-/Comet competence centres, as well as the Ressel and the Christian Doppler research laboratories). Mission oriented research centres are in the most favourable condition to start up businesses if they, not their clients, own the intellectual property of their technologies. The management of IPRs should therefore be given particular attention. Temporary research structures such as the competence centres have a high potential to support the creation of technology-based firms due to their temporary character and their operation at the interface between high level academic research and business. However, IPR aspects are likely to be crucial for these laboratories as well. Further research should study the start-up potential in the Austrian cooperative sector, and assess the main drivers and obstacles for spin-offs.

We recommend:

Support start-ups from non-university research institutes

Due to their strategic position at the interface between applied research and innovation non-university research institutes are a potential source of technology-based business start-ups. Studies should assess the potential for firm creation at public research institutes and evaluate how this could be systematically exploited to support structural change in the business sector. Non-university research institutes should develop capabilities to support the creation of start-ups.

(§55) A result of this evaluation shows a positive relationship between the share of budget research laboratories outside the higher educational sector get financed through block grants and their capability to successfully acquire grants and contracts from other sources.

Institutional funding should, however, depend essentially on the extent that a research institute produces public goods or addresses specific systemic or market failures that lead to underinvestment in research and development, such as information asymmetries or technological interdependencies.

We recommend:

Block grants are to be awarded for public goods and external effects

To get block grant funding non-university research institutions should provide a mission statement which should include a definition of the public goods and external effects they generate, as well as characterise the nature of research they are engaged in. They should also declare quantitative and qualitative objectives for the next period and specify the infrastructure that is of direct utility to private or public enterprises and the academic community. Evaluations after 5 years should assess if the targets have been fulfilled. In case of a negative assessment the block grant should phase out according to a defined scheme. Geographic proximity to the clientele/and or universities or education facilities is recommended.

Guiding Characteristics for Change

Change as a process

(§56) Switching to a frontrunner strategy cannot be done by financial resources only. It requires a permanent positive attitude to change and learning. Change has many dimensions: change in the management techniques, in the behaviour of firms and individuals, in the competencies and government structures, etc. We specifically address some characteristics favourable for this strategy change: mobility, openness, innovation as a principle in education. Cooperation, experiments should be important drivers of adaption to the challenges.

Mobility as an asset

(§57) Mobility and knowledge are to a certain extent embedded in persons. The mobility of researchers, but also of human capital in general engaged in the innovation and knowledge system fosters the dissemination of knowledge and the cross fertilizing of innovation. Still mobility is often low due to rigidities, income schemes, non-transferability of benefits, and discrimination in favour of insiders, inertia and low entropy in general.

We recommend:

Mobility as Priority Principle of Public Policy

Mobility of persons and the spread of information should be a priority for public policy in general and for the framework conditions in the innovation and educational system in specific. This holds for the mobility between firms and universities, between agents of the innovation system and firms as well as universities, between domestic staff and international community. Universities and extra-mural institutions should be more attractive for international students and researchers, and they should have the possibility for sabbaticals, temporary breaks etc.

Openness for newcomers

(§58) There is evidence that endemic insider advantages exist in the Austrian innovation system. Firms which used to get direct support will continue to do so. Firms which cooperate with universities continue and intensify contacts. The same holds for non university research institutes, cooperative clusters and networks. All institutions and actors have intensive contacts and know each other ("network relations"). Openness to newcomers and activities attempting to include new firms, researchers should be a persistent feature of the Austrian innovation system.

We recommend:

Built-in Obligations to Open up for Newcomers

Each institution should be open to newcomers and have the obligation to actively try to get new members on board. This could be achieved by publishing entry conditions, offering information days, internet information or by defining active recruiting of new members as performance goals. There should be annual workshops (open to newcomers and the public at large) to discuss strategy and persistent problems. Pilot calls should stimulate new, unexpected developments.

Innovation as a principle and goal in education

(§59) Innovation in firms depends crucially on the innovative capacity and innovative attitude provided in the educational system. Attitudes towards innovation and science are shaped in the Kindergarten, they are further developed in schools and deepened in universities and life-long learning. Teaching methods and schedules, and the organisation and structure of the school system are outside of this evaluation. However, innovation-friendly attitudes are a crucial complement of an innovation strategy.

We recommend:

Encouraging Engagement in Science and Technology

The interest in science and in enrolment in technical schools and studies should be increased. This holds for both genders and requires additional intervention. The future labour market demand for graduates of specific fields should be well known to each student. Additionally we recommend to indicate labour demand by a differentiation of study fees, credit schemes, scholarship programs according to expected labour demand (not costs per student alone). Currently a small share of students in Austria enrols in technical studies, a relatively large part in studies where demand is not buoyant and full-time employment chances are low. This is even more disadvantageous as the number of graduates is lower in Austria than in most other rich countries. A considerable share of tertiary educated people then takes jobs for which they are overqualified. If this is done on purpose and under full information, we can consider this as a decision for a special lifestyle and a welcomed feature of a post materialistic society. If due to the lack of information studies are chosen where labour market demand is low, it is a waste of resources and a public failure. In the long run the educational system should make these differentiations less important since the relevance of studies should be reflected already in the teaching syllabus.

Boosting cooperation

(§60) Innovation cooperation used to be underdeveloped in Austria in the past. This held for cooperation between firms, cooperation between firms and universities, between basic and applied science, for international cooperation, sometimes even for cooperation between clusters in different regions and across universities or between basic and applied research. However, the number of university-industry R&D partnerships (UIPs) has increased considerably in Austria in recent years. This can be partly attributed to the introduction of programmes initiating or reinforcing university-industry R&D partnerships by the funding agencies. The positive trend in innovation co-operations may also be related to the increasing role of science-based industries in the Austrian economy.

We recommend:

Enforcing Cooperation in Innovation

Programmes enabling cooperation between firms, but even more between firms and universities, should be further encouraged. Cooperation between domestic and international partners should be taken into consideration when allocating public funds to programmes and/or institutions. Universities, universities of applied science and non-university institutions should be encouraged to open their infrastructure to other institutions and firms. Universities successfully acquiring third party funds should get more money, or a bonus premium in general (e.g. a bonus of 10% can top of Third Party Funds acquired by university departments) in the performance budgets.

Promoting Non-Technical Innovations (in Services and SMEs)

(§61) Promoting innovation in the service sector is an increasingly important task. Austria has a specific deficit in sophisticated services and research in the service sector is rather low as compared to frontrunner countries. On the other hand the share of the service sector is increasing, and services contribute to the enhancement of the competitiveness in the manufacturing sector.

We recommend:

More Focus on Service Sector by Widening the Definition of Innovation

Direct research programmes should take a specific focus on enhancing innovation in the service sector. Projects in manufacturing could include the service components associated with industrial projects. Another approach would be to enlarge the definition of innovation. Current–ly support measures concentrates on research and technical innovation. In the service sectors - and this also applies for SMEs - important innovations are non-technical innovations e.g. changes in organisation. It should be considered to develop specific support measures for research and development activities in service firms. For tax incentives it should be verified whether an adaptation of the Frascati-definitions could improve the support for service firms. Direct support measured could focus on cooperative research projects that have the aim to develop new trademarks, designs or patents.

4.3 Conclusion: Elements of a new Agenda

Innovation Policies in the narrow sense refer to policies and institutions directly related to science, technology and innovation. Such policies should be transformed into a comprehensive innovation policy with close links to the educational system and to other policy domains such as labour market policy, competition policy etc. A comprehensive Innovation Policy has close links to the educational system and put a higher emphasis on the framework conditions for innovation.

New challenges

The Austrian System of Science, Technology and Innovation in the narrow sense has by and large worked quite well in the past. It is however better suited for a country which features a rather closed economy and which is catching up in terms of income and technology. Austria has long since become a leading country in per capita income and is well integrated into the globalising world economy.

At present Austria faces major external and internal challenges. Externally we are confronted with intensive competition both from neighbouring and Asian countries. Radical change is necessary, this comes not least as result of past success; a high-income country can compete only in sophisticated markets and products. Other countries are now moving into Austria's position as medium-tech specialists, deriving their competitive edge by adapting technology at somewhat lower labour costs. In addition, we see that higher innovation inputs have not been met by higher market shares and exports specifically in the highest quality segment in fast growing knowledge intensive industries. The number of firms innovating continuously remains small and business research expenditures are highly concentrated on a small number of firms. As compared to the EU average, in Austria twice as much business research is financed by foreign R&D players, and multinational firms have already started to shop around more widely for research facilities at the low end of the spectrum in the globalising world.

Arguably, the largest challenge to the system comes from an internal weakness: the Austrian innovation system is loosely interlinked with and insufficiently supported by the educational system.

Efficiency lacking versus leading countries

The efficiency of the Science, Technology and Innovation systems can be assessed either by looking at innovation output, or by looking at the dynamics of industry – which are, of course, not independent from each another. Industry growth has been high in Austria and aggregate growth of the economy is above the average of EU-15 countries, and specifically, it is much higher than in Germany, Italy and Switzerland. Although the industry structure has changed in the last decade, it is still biased in favour of less knowledge-intensive and medium-tech industries. Moreover, deficits in high tech production and exports are persistent if not growing. Industries with high dependence on educational inputs are losing market shares relative to other countries and are falling behind in productivity growth. Furthermore, there is a deficiency in the number of innovative start ups which hampers the adoption and development of new technologies (*Werner Hölzl*). For the majority of innovation performance indicators, Austria's position is well above EU-average – but it falls far behind the leading countries. Specific deficits exist in public-private co-publications, ICT investment, and receipts from licences and patents. Moreover, patents are concentrated on traditional industries (construction, mechanical engineering), but are rare in ICT, bio- or nanotechnology. Similarly, the efficiency of innovation processes as measured by the productivity of R&D stocks and R&D personnel is relatively high when compared to EU average, but there is still room for improvement as we are still below the benchmark set by the top countries. Major bottlenecks to close the performance gap – i.e. to enter the top league of innovation countries – arise from the poor number of researchers and spinoffs. Framework conditions which need specific improvements are regulation of services, costs of start up, availability of seed capital, etc.

Shifting to a frontrunner strategy needed

The new position as a top income country and the new environment calls for a radical change in the innovations system from an imitation strategy to a frontrunner strategy. Radical change should be based on a vision of the new innovation policy, a vision created and owned by government, communicated to parliament and the public, and monitored by a new Council for Research, Science and Innovation.

Elements of strategy change

A strategy change includes the following elements:

From an innovation policy in the narrow sense to a comprehensive innovation policy,

from an imitation strategy to a frontrunner strategy,

from fragmented public interventions to coordinated interventions derived from a vision, from a multitude of narrowly defined funding programmes to a flexible, dynamic policy defining tasks and priorities,

from a blurred division of responsibilities to well defined competencies,

from managing public interference through bureaucratic procedures to modern public management techniques without micro intervention.

The need for change should not be underestimated

Based on the results of existing studies, on new analytical results in this document and on nine background Reports of the System Evaluation, we have proposed 50 recommendations, some for major improvements some for smaller ones, some for smart, some for soft reforms. Overall the rapid change in the economic landscape, including the current economic crisis, call for drastic changes in the Austrian System of Science, Technology and Innovation.

The focus of policy must lie on the dynamic elements of the economy that support change. The most important drivers of change are:

- education and scientific research,
- the creation of innovative firms,
- (disembodied) technology in- and outflows as well as research cooperations,
- foreign direct investment by research intensive firms, and
- large firms conducting advanced research.

Of these factors education and scientific research are considered to be the most important factors. National investment in primary, secondary, and tertiary education provide the foundation of economic development in an innovation led growth regime as it provides a foundation for a portion of the indigenous population to secure advanced education and high-tech work experience.

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