International Audit of Research, Development & Innovation in the Czech Republic

Final Report - 7

Human Resources in R&D

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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Abbreviations

ASCR	Academy of Sciences of the Czech Republic
BA	Bachelor's degree
CF	Cohesion Fund
CZK	Czech Crowns
DFG	German Research Foundation
EIT	European Institute of Technology
ERA	European Research Area
ERC	The European Research Councils
ERDF	European Regional Development Fund
ESF	European Social Fund
FDI	Foreign Direct Investments
FTE	Full time equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
HEI	Higher education institution -
HR	Human Resources
HRM	Human Resource Management
KNAW	Dutch Royal Academy of Sciences
MA	Master's degree
MEYS	Ministry of Education, Youth, and Sports
MIT	Ministry of Industry and Trade
NSF	U.S. National Science Foundation
NWO	Dutch Research Councils
OECD	Organisation for Economic Co-operation and Development
OP EC	Operational Programme Education for Competitiveness
OPIE	Operational Programmes for Industry and Enterprise
OPEI	Operational Programme for Enterprise and Innovation
OP R&D&I	Operational Programme Research and Development for Innovation
PhD	Doctor of Philosophy
PPS	Purchasing power parity
SVTP	Science and Technology Park Association
SME	Small and Medium-sized Enterprise
WCU	World class university

Executive Summary

The Report on Human Resource in the Czech R&D&I system focuses on the analysis of the Czech R&D&I system of academic careers, researcher mobility, doctoral training, challenges of HR for new R&D&I fields and new infrastructures in a regional setting and discusses the issues surrounding cooperation and concentration of human resources in the Czech R&D&I system. Based on European good practices extensively presented in this report a number of recommendations are proposed.

Career Structures

The study addresses various aspects of the career structure in the Czech Republic such as the recruitment and promotion, contractual relationships, remuneration and career schemes, and human resource management at universities and research institutions. A number of key findings emerged from the study. These were as follows.

For institutions the most important recruitment source are their own graduates, and this source is expected to increase in the near future. For research institutes the regional institutions are an important source as well, while recruitment on the national level is considered considerably less important. This indicates that the Czech academic labour market is quite internally oriented, partly due to prevailing recruitment policies and partly to the disinclination of Czech academics to move between institutions.

Among Czech academics there is a high level of dissatisfaction with their pay and working conditions. Although comparisons with other employment sectors and academic salaries internationally are difficult to make, available data show that for some disciplines salaries in the private sector are substantially higher (e.g. physics), whereas for scientists in other fields the difference is negligible. Compared to international figures, the yearly salary average of researchers in the CR is far under the EU average. However, when corrected in terms of purchasing power parities the Czech average approximates the EU average. International comparisons of academic salaries show a quite large average salary range. In the CR the range is quite wide allowing larger salary differences within and between academic ranks.

The career and promotion structure is very cumbersome and rigid. Indicative for this are the relatively high age of academics within the highest hierarchical ranks (more than 86% of professors are aged above 50) and the low representation of women (half the EU-27 average). Climbing to the top is a very demanding life-long endeavor.

Respondents were quite critical about the capability of their organization to develop human resources policies and to provide career opportunities for researchers. Major barriers were: limited career development plans, inadequate regulatory frameworks for young researchers' careers, and insufficient training possibilities. These themes are very actual in many countries and references have been made to initiatives on the European level for a renewal of career paths regarding recruitment and retention, promotion and reward systems.

<u>Recommendations (in order of priority)</u>

1. *Strengthen the role of Human Resource Management (HRM) on the central institutional level.* Counteract the loose federative structure with decision-making powers at the lowest level by active HR policies regarding recruitment and careers and correcting current age and gender imbalances and in-breeding at all levels. Adherence to principles of open competition for positions and transparency of appointments and promotion procedures should be given particular attention.
2. *Manage the academic career in a flexible manner.* Develop career plans that enable academics to develop their own strengths, create flexible career paths, joint

appointments, junior positions that break through the current long hierarchical career ladders. These plans should be oriented to make the academic career more attractive to young researchers.

3. *Apply more diverse criteria to assess and reward the performance of academics*. Performance assessment should not predominate, but should constitute part of a broader set of criteria, including the perspectives of individual staff and combined with staff development plans and training possibilities.
4. *Encourage research collaboration and interaction with external organisations*. Work outside the traditional academic framework, for example through staff exchange or adjunct appointment systems, should be recognized more in academic appointments and careers, and become part of performance appraisals and rewards. There should be no legislative barriers to prevent institutions from encouraging this.
5. *Create greater stability for human resource policy*. Multi-annual research budget allocations rather than annual allocation of the budget would create greater stability and certainty in the policy environment for HE institutions.

Researcher Mobility

The study addressed the barriers and facilitators of researcher's mobility in the Czech Republic by identifying the trends in outgoing and incoming researcher mobility. In the past decade the Czech government support for researcher mobility in R&D was not very high on the policy agenda. The White Paper on R&D&I 2008 was an important document, which has identified low horizontal mobility of researchers and professional staff and insufficient migration policy as weaknesses of researcher mobility for R&D in the country. It proposed a number of recommnendations although no concrete implementation tools. A further document that identifies research mobility as an important policy goal is the National R&D&I Policy 2009-2015. Its goal 6 "Ensuring human resources for R&D&I" defines three core activities to be implemented by 2015 which are related to international or inter-sectoral researcher mobility. Recently, the Czech government has signed the agreement for the ERC CZ grant and RETURN grants ('NAVRAT')–which is a positive step towards providing longer term funding for researchers. Further, interviews revealed the Regional Reintegration Fund is a good example of an initiative at the regional level to support international mobility. The government programmes do support inter-sectoral cooperation, although only to some extent, since they are rather focused on some fields and are only few in number. Further since 2005 the Czech government has adopted strategic documents aiming to facilitate the integration of immigrants in the Czech Republic. International research mobility is regulated bythe immigration law in the Czech Republic.

The number of incoming foreign researchers has increased in the Czech Republic; especially this is true for researchers from non-EU countries. However the attractiveness of a research career in the Czech Republic for foreign nationals is relatively low due to complicated administration of visas and often non-competitive level of earnings compared to the average in the EU-15 countries.

Human resource mobility between sectors has been limited, since as noted by respondents in interviews and focus groups, it is difficult to ensure an academic career if one leaves business and industry. The example of successful entrepreneurs who left academia shows that often for financial reasons, former academics who are successful entrepreneurs do not intend to come back to academia full time. At most they do occasional teaching.

There is a long-standing collaboration between institutes and universities; most of the researchers working at ASCR institutes are the graduates of those universities and they still teach at universities. At the same time, university academics like to use the equipment available at research institutes.

The key concern of most respondents was the lack of national strategy on how to attract talented academics to the country. In this respect, the absence of horizontal cooperation between ministries and different departments was emphasized, since the issue of mobility includes various spheres, such as education, social welfare, immigration and science.

For the incoming foreign researchers the strong barriers are the low level of academic salaries in the Czech Republic, complicated immigration procedures, bureaucracy and language barriers. Salary ceilings were mentioned as a strong barrier if institutions want to attract top scientists from abroad.

HR Survey data shows a number of barriers for the inter-sectoral mobility of academics and researchers. According to respondents at universities, 50% think that a strong barrier for inter-sectoral mobility is linked to inbreeding. Other identified barriers from the researcher's point of view include the differences in the duration of projects between industry and academia, which limits for example, linking industrial projects to PhD projects. The unpredictability of business and markets has been indicated as another important reason

The focus group discussions with R&D entrepreneurs revealed a number of perceived barriers from the point of view of industry for inter-sectoral mobility. The most common concern was the difference in the worlds of academia and industry in terms of work speed and targeted problem solving. The preparation of graduates was a concern for entrepreneurs, since in their view PhD candidates and postdoctoral researchers lack soft skills, problem solving capabilities and entrepreneurial spirit. A strong limitation of the system is the difficulty to get temporary leave in the system, which limits extended work, either in industry or a university abroad.

<u>Recommendations (in order of priority)</u>

1. *Create an explicit inter-ministerial strategy and action plan* on how to coordinate immigration (visas and permits), pension schemes and mobility promotion activities both at universities and ASCR research institutes.
2. *Stress the human resources dimension in university-industry collaboration schemes* besides infrastructure development and the creation of technology transfer offices.
3. *Increase the transparency of hiring in the R&D system* via requirements to advertise the new positions nationally and internationally in media and on the Euraxess jobs and other international portals.
4. *Use a comprehensive approach to attract foreign top researchers as well as expats back to the Czech Republic* by combining financial and 'soft' mechanisms – support to families, housing, institutionalised help with visas, residence permits (e.g. translation services at the institutions within the international offices).
5. *Create subsidies for Czech academic staff to go abroad for longer periods* (post-docs) with the requirement to return to the home country upon completion of the programme.

Doctoral Education

This section reviews the position of doctoral education. Since 1990 universities have been legally allowed to provide doctoral education and to award the PhD degree and they obtained later the full responsibility for doctoral education. The most common form is the "apprenticeship model" of the student-supervisor relationship. There are clearly defined regulations regarding the set of requirements throughout the PhD process. For students the whole process is well-structured, but very demanding involving research training, state examinations, 'pedagogical practice' and publishing a scientific article. The following critical issues were identified.

- A high proportion of students do not complete in time or drop out. One issue concerns the dependency of students on the availability of good tutors. This varies considerably across different institutions and disciplines.
- Doctoral students receive low financial support. Students are often forced to accept others jobs that negatively affect their study progress, and may explain the high drop-out rate.
- In some fields there is concern about attracting enough students who meet the quality standards. Often vacancies can be filled, but it would be good to have more eligible candidates to choose from. A relationship was made between the low doctoral grants which makes it difficult to compete with salaries earned elsewhere or internationally.
- Controversies between universities and institutes of the ASCR regarding the training of and responsibilities for doctoral students continue to exist. Although much cooperation exists as well, from the side of the ASCR there are feelings they are not in an equal position and the view was expressed to return to the situation prior to 1990 when the ASCR had an independent role in providing doctoral studies.
- There is little cooperation with industry and generally little financial support from the private sector. However, examples were found where doctoral research is taking place in the context of an industrial project, with a second supervisor from industry.
- Developments in other European countries show how doctoral education can be of greater relevance by including both core skills and wider employment related skills. More attention has been given to prepare doctoral students for careers in the knowledge intensive sectors outside academia.

Recommendations (in order of priority)

1. *Improve the remuneration of doctoral students.* A combination of different resources is seen as most effective, such as targeting specific priority areas, stimulating collaborative forms of doctoral education, the quality of the programme or the balance between supply and demand of PhD graduates on the labour market.
2. *Strengthen the internal and external quality assessments of doctoral education.* Despite the general high level of doctoral education, the quality varies in the system as a whole. Although some structures are in place, the quality assessment of doctoral programmes should be more integrated into institutional policies and HR strategies.
3. *Strengthen the relationship between universities and AS research institutes.* There is currently much cooperation although also controversies have been noticed. Rather than taking legislative steps to have PhD degrees awarded by the ASCR as well, it is recommended to strengthen the model of cooperation between universities and AS institutes utilizing their respective strengths. Other European countries provide examples to find creative solutions for practical problems.
4. *Develop critical mass in doctoral education.* This can be achieved by creating larger settings where students are confronted with a broader range of knowledge than in the prevailing master-apprenticeship model. Structured forms of graduate training that are emerging in Europe such as graduate schools and research schools are means to achieve such critical mass.
5. *Encourage the international orientation of doctoral education.* The current initiatives and co-supervisor arrangements with universities abroad should be expanded where possible. This is an important instrument for recruiting international students and increases the compatibility among doctoral programmes internationally. These initiatives should be supported by policy, for example by providing adequate funds or research grants.

6. Increase labour market consideration and monitoring of PHD graduates. The growing relevance of PhD graduates on the labour market implies that it is important to know what doctoral students are being prepared for and how well this is being done. This includes exploration of the skills and competences that PhD graduates require informing doctoral programmes as well as their rates of return.

The HR Challenges of potential new fields for R&D&I and current investments in R&D&I infrastructure

In the next two decades, the Czech economy is likely to modernise in two phases; R&D&I will contribute to each of these phases although in very different ways.

- The first following phase in the Czech industrial transition is in the upgrading of its manufacturing activities from assemblies and mass production towards more knowledge-intensive and value added manufacturing.
  - The most important new businesses will emerge in fields supplying into existing supply chains e.g. automotive, but on an increasingly global scale rather than exclusively within the Czech Republic. Creating these businesses requires a mix of technological and entrepreneurial skills, and primarily the absorption of D&I through technology transfer.
  - Some D&I is necessary to reorient declining heavy industries e.g. chemicals, steel, mining, and retain competitiveness and some employment.
- The second phase (in around a decade) will be the emergence of new high-technology economic sectors. The most immediate change necessary is an upskilling of the workforce reflecting the Czech Republic's diminishing status as a low-wage economy and the need for a much higher degree of workforce flexibility to deliver customisation.
  - In the next decade, firms in entirely new technology sectors will begin to emerge, moving beyond existing supply chains, creating novel sectors in the Czech Republic that from 2020s will become increasingly important to Czech economic performance. This is the main outlet for the application of 'R' (Research).

These changes will reinforce existing patterns in the distribution of private sector researcher employment:

- Numbers in Prague will be very low, reflecting a domination of Prague's economy by the knowledge-intensive business services sector (with a very low R&D&I input).
- Strong R&D employment growth in Central Bohemia reflecting locations of corporate headquarters seeking proximity ('clustering') with Prague agglomeration
- Strong growth in (R&)D&I employment in the growing non-Capital regions (southern Bohemia, Brno).
- Some growth in D&I employment (as part of overall employment declines in manufacturing) in the old industrial regions of northern Bohemia and Silesia-Moravia.

There will be a strong bias towards Prague in terms of the location of publicly funded researchers (in universities and research institutions). This is only a problem if there is a crisis and one sector sheds jobs more rapidly than the other can create them.

Both elements of the Operational Programmes (OP) could help in both phases of these activities, creating innovative businesses in existing clusters/ supply chains and creating new micro-clusters of globally active innovative endogenous business.

- The Regional Centres have a strong role to play in terms of technology transfer and knowledge exchange around existing sectors, in particular in process and management innovations.
- The Centers of Excellence (CoEs) have got the potential to create new, innovative businesses in existing and emerging sectors, which could in turn support novel technology sectors in the 2020s.

The focus of the new infrastructure is primarily on R&D, and there is a clear, obvious lack of demand-side pull for the most novel innovations. There is a risk that the new infrastructures neglect technology transfer and knowledge exchange in favour of 'upstream R&D activity' that fails to drive innovation.

There is a need to create strong framework conditions for innovation in the regions in which the centres are created. These include technology transfer activities, venture capital support, advice for potential high-growth, high-technology firms and entrepreneurship stimulation schemes. There is limited current 'natural' demand for these services but without their stimulation, there is limited potential for the OP infrastructure investments to translate into new high-technology sectors of significance for the Czech economy.

The HR challenges relate to the historical continuity. There has historically been a substantial problem around stability of research teams and an important challenge to recognise is that of long-term sustainability and mainstreaming against the risk that the infrastructure fails to deliver longer-term structural change.

A key element of the sustainability challenge is the way the new infrastructure contributes to researcher mobility at the European scale. There is a real risk that these new centres help improve mobility without equipping the attracted researchers to move into the Czech economy particularly in the D&I end of the R&D&I spectrum.

Given the necessity of improving the innovation environment, there are also skills shortages around technology transfer, knowledge exchange, business growth, entrepreneurship and venturing. There is no clear regional innovation leadership in the Czech regions outside South Moravia, and there is an urgent need to ensure fit-for-purpose knowledge-exploitation infrastructure is created to match the new knowledge-generation infrastructure.

Main recommendations (in order of priority)

1. *Early and effective budget planning* is necessary to ensure that the Czech innovation system benefits from the full €2bn community resources made available through OP R&D&I.
2. *Human resources policies* for those centres funded under OP R&D&I should ensure that employees funded through this route receive due recognition and are managed to deliver a national leadership/ 'hub' function in their field, to strengthen these fields across the Czech Republic as a whole.
3. Swift progress need be made in identifying Centres of Excellence and in developing scientific programmes and institutions, which transcend the existing problems in R&D&I in Czech universities.
4. The Centres of Excellence must be implemented in such a way as to strengthen rather than disrupt disciplinary activities elsewhere in the Czech Republic.
5. There is a need to retain a central (national/ regional) oversight of technology transfer activities under OP R&D&I, to ensure that there is not 'project sprawl' and that activities are contributing to strengthening the Czech, and regional, innovation system.

Co-operation and concentration of human resources in R&D&I

The main objective of this component is to analyze the trends in the Czech Republic regarding co-operation between research institutions and industry in concentrating human resources in R&D&I and to identify which factors encourage or discourage such co-operation and concentration.

In general, a systematic approach towards human resources development in R&D is required. Highly qualified researchers and academics are essential for high quality R&D systems. In such systems qualified R&D workers on all levels are needed in academia, research institutions as well as in industry.

Developing and securing human resources for R&D&I is a long term and complex process including multiple activities and measures targeted at different groups including science communication; science learning centres; support for students in the technical and natural sciences; support for researcher mobility; support for young and talented researchers from abroad; and platforms and networks linking researchers and industry.

It is obvious that the issues of research-industry collaboration and human resources development/concentration have been paid increasing attention in the Czech Republic over the last decade. The importance of this issue has been underlined in many documents, although often in rather general terms.

There is awareness within the science and business communities as well as within the state administration that concentration of human resources in R&D&I is very important as is co-operation between science and industry to achieve this concentration. This high level of awareness is an important first step towards the formulation and implementation of a coherent and efficient policy.

In terms of the concentration of human resources in R&D&I, representatives of academia and business share the opinion that a strategic, long-term approach to this issue is missing in the Czech Republic. At the same time, there is a high level of consensus that such an approach/policy is highly desirable – especially in areas in which a certain level of excellence has already been achieved and where good teams have been formed. In their view the political situation in the Czech Republic over the last few years has been an important factor influencing the research & development field in general. According to many stakeholders, political instability since 2006 has had a major impact on the overall atmosphere in higher education and research.

There are valuable strategic and analytic documents in many areas of R&D, innovation, and higher education. Yet at the level of implementation, those measures and activities that have been put in place have been mainly ad-hoc and have often not been sufficiently integrated with each other given that an overarching direction is missing.

Looking at the personal mobility as one way of cooperation, one can note that traditionally in the Czech Republic it is not typical for researchers to move from industry to science and vice versa. Co-operation in training and education is much more intensive than personal mobility but is still very dependent on a specific field and a specific institution. Many institutions (higher education institutions) attempt to involve people from industry in various phases of teaching. Partners from industry participate in the process of creating or modifying study programmes or selected people from industry deliver lectures. However, the involvement of external staff in teaching is limited due to accreditation procedures and conditions.

Activities, measures or programmes that support mutual co-operation between science and industry (for example mutual R&D projects) have an indirect impact on R&D&I human resources concentration

The Operation Programme Education for Competitiveness (OP EC) pays special attention to human resources in R&D by creating it as a specific area of intervention.

Projects supported by the OP EC are in various phases. Many of them are already in operation, some of them are waiting to be granted support, and a few calls for proposals have still to be announced. As all of the projects financed through EU structural funds in the 2007-2013 programming period are still in progress, it is very difficult to predict the overall impact of the supported activities. At the same time, the content of the projects are not in the public domain so it is almost impossible to assess which activities are taking place, how they are being implemented, and with what results. Nevertheless, some projects seem to be promising as judged from the information that is available on their websites.

According to the interview and focus group remarks, the EU structural funds projects have been submitted on various levels – not only on the university and faculty level, but also on the department level. According to some observers it is then very complicated to co-ordinate these activities at the central university level and to find synergies. Secondly, many receivers of project grants complain about the very high level of administrative burden involved. A significant amount of time and resources is dedicated to administration. At the same time the focus of the managing authority is mainly on formal outputs (number of participants, detailed budget items) rather than on the actual impact of the projects. Finally, many institutions perceive the structural funds (especially the OP EC) mainly (if not only) as compensation for decreasing support from the state budget.

Recommendations (in order of priority)

1. The implementation of policies and strategic intentions needs to be tackled systematically. Many critical issues have addressed in analytic and strategic documents drafted by various bodies (ministries, advisory bodies, etc.) but implementation has lagged behind.
2. Co-operation between the various key actors needs to be strengthened – especially the Ministry of Education, Youth and Sports; Ministry of Industry and Trade; the Council for R&D&I; and other relevant players. All measures and programmes need integration into a comprehensive set of complementary tools targeted at various levels of the education and R&D&I systems.
3. Increased attention should be paid to measures and programmes supporting science-industry links in general. These projects can have a significant impact on human resource development.
4. Detailed monitoring and evaluation is essential in the area of the new R&D infrastructure funded by the OP R&D&I. The newly built capacities will require high quality human resources. At the same time, the Prague region (still a leading locality in terms of the quality and quantity of R&D) is entitled only to a small fraction of the EU structural funds in the 2007-2013 programming period. Developments in Prague in terms of human resources in R&D&I in comparison to the rest of the Czech Republic should be carefully analysed.
5. The contribution of the education system at all levels to developing human resources for R&D&I should be carefully analysed. The recommendations of the OECD Thematic Review of Tertiary Education in the Czech Republic need to be acted upon.

1. Introduction

Highly qualified R&D human resources are essential in today's knowledge economies. At the European level and in many member states, various programmes have been developed to motivate young people to be mobile, to enter higher education and to pursue academic and research careers. Despite some encouraging developments, the European Commission still argues, "significant weaknesses remain with science teaching in some Member states"[1]. There are still only a limited number of women in science, most universities in Europe do not attract top talent, the commercialisation of research needs to be improved and inter-sectoral mobility is low. Reaching the Lisbon agenda goals of becoming a powerful world knowledge economy is a challenge for Europe.

However, there are good practices in human resources policies in various R&D systems in Europe, which could be more widely applied and could help governments learn from each other's experience in how to foster the growth and development of a strong base of highly skilled R&D staff in their higher education and research systems. Developing and securing human resources for R&D&I is a long term and rather complex process including multiple activities and measures targeted at various groups.

The *International Audit* is part of a broader review and reform of R&D&I in the Czech Republic. In particular it follows Green and White Papers on this subject in 2008, a new R&D Act in 2009, and an extensive analysis of the state of R&D&I in the Czech Republic in comparison with EU/OECD countries published by the Research and Development Council in December 2008.

We have attempted to locate the Human Resources work-package within this broader context by indicating how the White Paper assessed the R&D&I human resources situation in its SWOT analysis and in its policy recommendations. (The issues in italics have a direct linkage to this work package.)

SWOT Analysis: Human Resources for R&D&I (from White Paper):

- *Strengths*
  - Number of researchers has been growing more rapidly than in the EU
  - Level of some research teams is comparable to the best in the world
  - Tradition in education in engineering fields
  - High employment rate in medium high-tech and high-tech industries
- *Weaknesses*
  - Low number and unsatisfactory professional structure of HEI graduates
  - *Low number of researchers*
  - *Low horizontal mobility of researchers and professional staff*
  - *Unsatisfactory age structure of the research and pedagogic staff*
  - Low awareness of industrial property rights
  - Insufficient knowledge and use of modern methods of management

1 EC, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Europe 2020 Flagship Initiative Innovation Union, Brussels: European Commission, 2010, pp9

  - Low participation in lifelong learning
  - Low language skills and internationality of students
  - Lacking "soft skills" education
  - *Insufficient migration policy*
- *Opportunities*
  - Use of resources from Structural Funds for 2007-2013
  - Better coordination and implementation of the NP R&D&I
  - Rise in the attractiveness of the Czech Republic for researchers and other experts from abroad
  - Strengthening of "entrepreneurial spirit" in research institutions and at HEIs
  - Increased awareness of industrial property rights
  - Adoption of tertiary education reform
- *Threats*
  - Critical shortage of researchers in relation to extending R&D capacities through EU Structural Funds
  - Brain drain and a barrier to brain gain due to low wages
  - Lack of qualified labour in enterprises related to the development of production
  - Rigid educational system and its breakaway from the needs of innovative enterprises

Policy recommendations: targets in the area of human resources for R&D&I (from White Paper):

- *Provide enough qualified human resources for research, development and innovation:*
- *Increase the number and quality of researchers*
- *Improve the capabilities of human resources for the needs of a knowledge-based economy*
- *System measures needed to achieve targets:*
  - *Create favourable conditions for arrival of researchers and experts from abroad*
  - Differentiate HEIs according to their quality, including strengthening the role of research faculties and institutes
  - *Create a system of functional professor positions*
  - Differentiate study programmes and create interdisciplinary study programmes in co-operation with the application sphere
  - Introduce enterprise and IPR-related fields of study at HEIs, train for entrepreneurship
  - Create a system of HEI financing that will motivate education tied up to the needs of a knowledge-based economy
- Motivational measures needed to achieve targets:
  - Motivate students of SSs and HEIs to research work and science and engineering fields of study
  - *Stimulate international two-way mobility of researchers* and HEI students

- *Encourage two-way horizontal mobility between HEIs, other ROs and the enterprise sphere*
- Improve the school facilities and teaching of subjects regarded as crucial for a knowledge-based economy
- Support the enhancement of managerial skills among employees of ROs, including HEIs
- Support the gaining of practical knowledge by HEI graduates
- Develop motivation for involvement in lifelong learning

1.1 Aims of the Work Package

In the area of Human resources for R&D&I the Tender Document asks for an audit report and policy recommendations on the following issues:

Human resources

i) An analysis of conditions for scientific criteria in different types of institutions, conditions for the mobility of researchers between institutions, sectors, and branches; and migration between countries, including employment of third-country researchers; results, barriers, and supportive measures.

ii) Assessment of remuneration of researchers and the impact of this on the quality of research and development results; comparison with the European level within the context of the given country.

iii) Support for the return of capable young scientists from international placements; wage policy in the sector of institutions dealing with R&D&I.

iv) Assessment of the education system of students of doctoral studies, an analysis of the quality of graduates, their position in the labour market, their frequency in individual branches.

v) Defining prospective branches with regard to priorities of further development of R&D&I, regional distribution of potential employers of researchers, a follow up to projects of new research capacities and technological parks the construction of which will be funded from operational programmes.

vi) The approach of institutions and providers or industry towards the concentration of human resources and mutual cooperation, i.e. what trends are in the Czech Republic, what are the causes of the given situation, and what factors affect (positively or adversely) the situation.

1.2 Research Questions

We have interpreted and regrouped these six sub-work packages in the light of our understanding of the context of the *International Audit* and the policy review work that has already been undertaken in the Czech Republic. We believe the following are the key research questions:

- What are the career structures, promotion criteria/processes and remuneration schemes for researchers in the university, public research centre and private R&D sectors? What are the possible impacts on R&D&I in the Czech Republic in comparison with other European countries? **(Career structures)**
- What are the trends in terms of researcher mobility between institutions and sectors (including international mobility)? Are there particular barriers and obstacles? What supporting measures and policies (in general, and to encourage the return of capable young scientists from international placements in particular) might be introduced? **(Researcher mobility)**

- How effective is the Czech system of doctoral education and training? What are the competencies of PhD graduates; where, at what level and in which sectors/branches do they find employment? **(Doctoral training)**
- What are possible new industrial fields for the application of R&D&I and what could this mean for the regional distribution of organisations employing researchers? How could this relate to the major new investments in research facilities and technological parks (through the operational programmes of the structural funds)? What are the human resource challenges of these possible developments? **(New opportunities)**
- What are the trends in the Czech Republic in terms of co-operation between research institutions and industry in concentrating human resources in R&D&I? Which factors encourage or discourage such co-operation and concentration? **(Co-operation and concentration)**
- What might the Czech Republic learn from European countries with a successful track-record in R&D&I in terms of the above five areas relating to human resources for R&D&I? **(European good practice)**

In this chapter on Human Resources in R&D&I we present current trends and evaluate Human Resources policies in R&D&I in the Czech Republic following the structure of the research questions outlined above. We also provide European good practice examples in each area.

1.3 Methodology

The WP f, Human Resources in R&D&I study is based on a range of data sources and data collection methods. To ensure the validity of our findings, a national human resources in R&D&I consultative workshop was held in Prague in mid-April. The data included the review of major Czech documents (Green and White Papers, OP Programmes, Strategic documents, institutional websites), secondary literature (EU, OECD and national studies, as well as scientific publications on R&D&I). Statistical information was gathered with the help of the Technology Center and the Czech Statistical Office. For certain components, for example doctoral education, the data was scarce so we conducted an HR survey among university deans and Academy of Sciences of the Czech Republic (ASCR) research institute Directors (n=74).

We also contributed questions to, and analysed the data from, the International Czech R&D&I Audit survey of researchers. This online survey was conducted in January and February 2011. In addition, three focus groups were organised with researchers, academic entrepreneurs and industry representatives respectively. Finally, 55 interviews were held with various actors in the Czech R&D&I system that in one way or the other deal with HR policies or are the target group of such policies. We interviewed officials at the Ministry of Education, Youth and Sports; Ministry of Labour and Social Affairs; ASCR; National Training Foundation; Euraxess centres; university administrators and academics; PhD students; postdocs; research institute directors and researchers. The plethora of interviews substantiated the data gathered from the survey and other data sources and provided a solid ground for analysis and conclusions.

1.4 Structure of the Report

This chapter follows the structural logic of our research questions. Each component in this report identifies main policies and trends, analyses these, suggests European good practices and makes recommendations. The chapter starts with the presentation and the analysis of the Czech R&D&I system of academic careers. It identifies the main categories of academic careers, and evaluates the trends in academic careers. The second component on researcher mobility discusses the policy context and trends of international, inter-sectoral and intra-sectoral mobility. It focuses on the barriers to and facilitators of mobility in the Czech R&D&I system. The third component highlights the main structures of doctoral training in the country, and evaluates their strengths and weaknesses. The fourth component analyses the challenges of human resources for new R&D&I fields and new infrastructures in a regional setting. The fifth component presents and discusses the policies and trends in concentration of human resources. In particular, it highlights the factors which foster this concentration to boost the development of a knowledge economy in the Czech Republic. The last chapter presents the good practices found in European R&D&I systems in addition to those presented in each component. The conclusion ends the report with the list of main strengths and weaknesses of the HR in the R&D&I system in the Czech Republic and provides a list of recommendations.

2. Career Structures

2.1 Introduction

The aim of this component is to analyse the prevailing career structures of researchers at universities and R&D&I research organisations. Special focus will be on:

- Recruitment, appointment and promotion policies and procedures: national regulations, institutional policies.
- Conditions under which institutions are able to attract and retain well qualified researchers in competition with other employment areas. Human Resources (HR) strategies and practices.
- The impact of internal and external labour markets on the attractiveness of pursuing a research career.

This text is organised as follows. The first two sections outline the academic staffing structure and appointments in Czech higher education and research institutions. Next the working conditions will be discussed with attention to the remuneration and employment relationships and satisfaction levels of Czech academics on a number of issues. The age structure and the position of women in science will then be considered in more detail. This is followed by examining the ability to develop human resources and the practices and barriers to provide career opportunities for researchers.

Against the background of the Czech context and practices, the career structure for researchers will be placed in the European context, with reference to particular national policies to make the research career more attractive, in particular to young researchers. Finally, some policy recommendations will be provided with some directions in which human resource management in the Czech Republic might evolve in the future.

2.2 Academic staffing structure

Czech academics and researchers operate in both higher education institutions and in independent research institutes. This separation is the legacy of the Soviet dual model of the ASCR focusing on (basic) research, whereas HE institutions were expected to focus on teaching. Although legislation in the 1990s maintained this dual system till the present, the universities were assigned a role in research as well. Since then the engagement of universities in research increased significantly. Nowadays the research institutes of the ASCR and the universities collaborate especially in the provision of doctoral studies and in establishing joint research centres. Nevertheless in the area of research, competition often prevails over cooperation.[2]

Academic staff at universities devotes more or less the same amount of time to teaching and research, although teaching is the main source of income, accounting for about 60 per cent of the total salary, while 25 per cent comes from research activities[3].

The academic staffing structure distinguishes six categories: Professors (10% of all academic staff), Associate Professors or ‘docents’ (20%), Senior Assistants (50%), Assistants (8%), Lecturers (3%) and Researchers (9%). The law also permits experts

[2] Melchiar, M. & P. Pabian (2009) Czech Republic: A state of the report on the Czech academic profession. In: Locke, J. & U. Teichler (eds.) *The Changing Conditions for Academic Work and Careers in Select Countries*, INCHER Kassel: Werkstattberichte 66, pp. 39-56; See also Roskovec, V. (2006) The Role of Tertiary Education in Research and Innovation. In: Sebková, H. (ed.) Tertiary Education in the Czech Republic: Country Background Report for OECD Thematic Review of Tertiary education , Prague: CHES, pp.41-48.

[3] Mateju and Vitáskova, cited in Melichar, M. & P. Pabian (2009), p. 42..

who are not members of the academic staff to teach in higher education institutions. Internal regulations of the institution define the position of a visiting professor.

There is no legislation prescribing pedagogical qualifications for academics. Career development is a matter for internal institutional regulations. For becoming a docent the scientific qualifications of the applicant are examined, partly on the basis of the habilitation. Professors are appointed by the president of the Czech Republic on the recommendation of the higher education institution's council, submitted through the Minister of Education. Academic careers are hierarchical and consecutive, but the general procedures and requirements for career tracks may vary according to particular procedures. Generally the appointment of the associate professor (or docent) marks the transition from junior to senior staff.

The staffing structure of researchers employed at the institutes of the ASCR of Sciences (ASCR) is based on general directives, although institutes have quite some freedom to define the different positions. Generally four basic categories are distinguished. The first is the post doc position, usually those between 0 - 5 years after a PhD, the 'scientific assistant' or junior scientist, scientist, and finally the group leader or independent scientist. The group leader is the top position and heads independent research groups. Researchers from the ASCR are often engaged in university teaching, regularly on a part-time employment contract and have a task to supervise doctoral students. Individual career purposes play a role here, as only through university channels can the official academic titles leading to the professoriate be obtained. Group leaders at the AS institute are formally equivalent to professors, whether this person has the formal title of professor or not. As a director of an institute notes: 'It looks nice, but it is not important'.

Like in many other countries in the Czech Republic the number of students enrolled in higher education had risen substantially in the last decade, from 203,500 in 2001 to 370,000 in 2008. Statistics show that the number of professors and assistant professors employed by public universities and HEIs increased only modestly from 4,537 (in 2001) to 5,275 (2008) and the number of other academic staff increased from 9,104 (2001) to 11,704 (in 2008). In total staff at public HE institutions increased by about 25 percent while student numbers increased by more than 140 per cent, resulting in an almost doubling of the student-teacher ratio. These data suggest that the massification of students has been counterbalanced by an increase in the number of staff in lower academic functions.

Several aspects of the academic career structure have been identified in the Green and White Paper on Research, Development and Innovation in the Czech Republic[4] as weaknesses regarding human resources. Most notable are the low number of researchers in the system, the low horizontal mobility of academic staff leading to a clear pattern of inbreeding, and unsatisfactory age and gender imbalances. These will be discussed in subsequent sections.

Another aspect concerns the institutional and legal arrangements regarding human resources and the employment status of academics. In the Czech Republic legislation has reduced the role of the State transforming a highly centralized system into a system based on a high level of institutional autonomy in higher education. In particular when it comes to staffing issues institutions have, apart from national procedures regarding appointments and general employment conditions, extensive self-governing rights and decision-making powers which have been further decentralized to the faculty and departmental level. The employment relationship can be characterized as one where institutions employ individual academics in a market-driven decentralized system. Working in non-governmental public institutions, academics have the legal status of 'public employees' and their jobs are regulated by

[4] Karel Klusácek, Zdenek Kucera & Michael Pazour, White and Green Paper on Research, Development and Innovation in the Czech Republic. Prague: Technology Center ASCR, 2008.

contracts of employment under private law. Compared with civil service status in several West European countries, public employee status in the Czech Republic is more likely to result in flexible employment practices and to facilitate professional and organizational change. The emanating career system strongly tends towards the decentralization of academic terms and conditions, which intends to be able to adapt more easily to demands of staff flexibility. The employment relationship and job security will be discussed below.

2.3 Recruitment of academic staff

In the survey of directors of research organisations a question was asked about the importance of several sectors from which R&D staff are being recruited. A distinction has been made between current and expected future sectors (table 1).

Table 1 Importance of sectors to recruit R&D staff, current and future recruitment (%), N=74)

	Not (at all) important		Moderate		(Very) important	
	Current	Future	Current	Future	Current	Future
Our own PhD graduates	13%	6%	9%	8%	78%	85%
Regional research institutes / HE institutions	19%	19%	20%	19%	60%	63%
Research institutions or HE on the national level (from other regions in CR	20%	20%	44%	32%	36%	48%
International research institutes / HE institutions	55%	41%	20%	30%	24%	29%
Firms in similar sectors in CR	73%	66%	13%	22%	14%	12%
Firms in other sectors in CR	91%	94%	9%	5%	0%	1%
Firms located abroad	96%	89%	2%	6%	2%	5%

(Question asked on a 5-points scale, the two on both ends of the scale combined)

The table shows that own PhD's are by far the most important recruitment source and that this source is expected to increase in the near future. Universities rely more on them than the ASCR research institutes and in the future recruitment of own PhD graduates is even expected to increase. An important part of this recruitment process is the practice to encourage desirable people to apply, people that are most of the time already known within the organization.

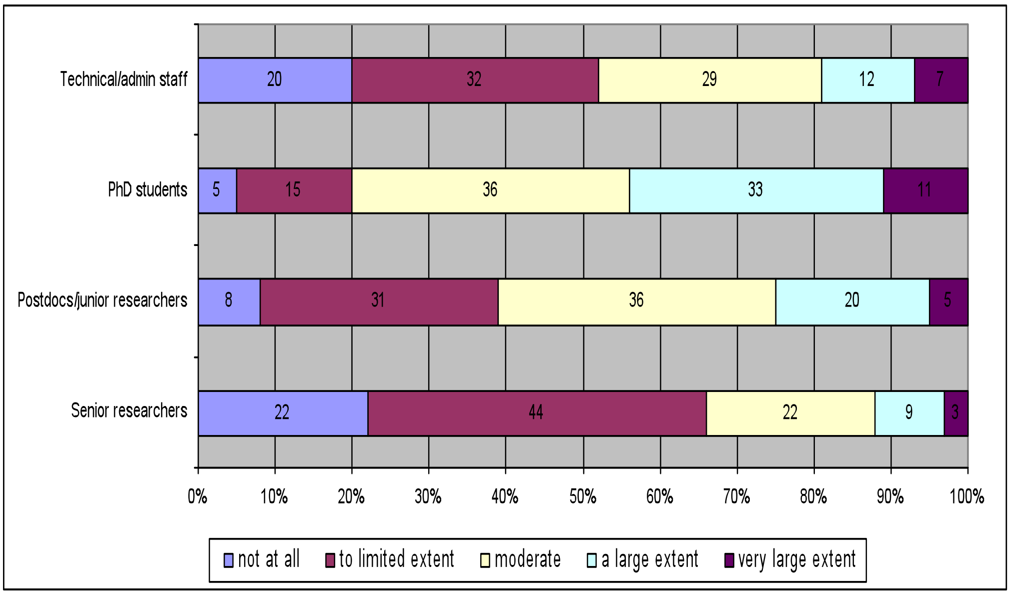
Regional research institutions and universities are in particular an important recruitment source for research institutes. Research institutes or HE institutions on the national level are considered less important, although re research institutes attach more value to this than universities. The other sources play hardly any role of significance in recruiting academic staff.

These findings indicate that the Czech academic labour market is quite internally oriented towards own students and staff and is geographically mainly regionally oriented. To understand the reasons for this outcome we asked about the extent to which national legislation would foster the institution to use these recruitment sources. This appears hardly to be the case and the question arises whether this internal orientation is the effect of prevailing HR policies of institutions or the low mobility of staff due to the mentality of many Czechs who tend to stay in the region after their graduation. In the interviews both explanations were mentioned.

A director of an ASCR institute states that the recruitment process is mainly an internal affair. Research groups have their own responsibility to choose their own people and research group leaders are quite independent in selecting their own researchers.

Figure 1 presents the extent to which institutions are able to attract sufficient qualified personnel for some different staff categories.

Figure 1 Ability to attract sufficient qualified personnel (%), N=769.



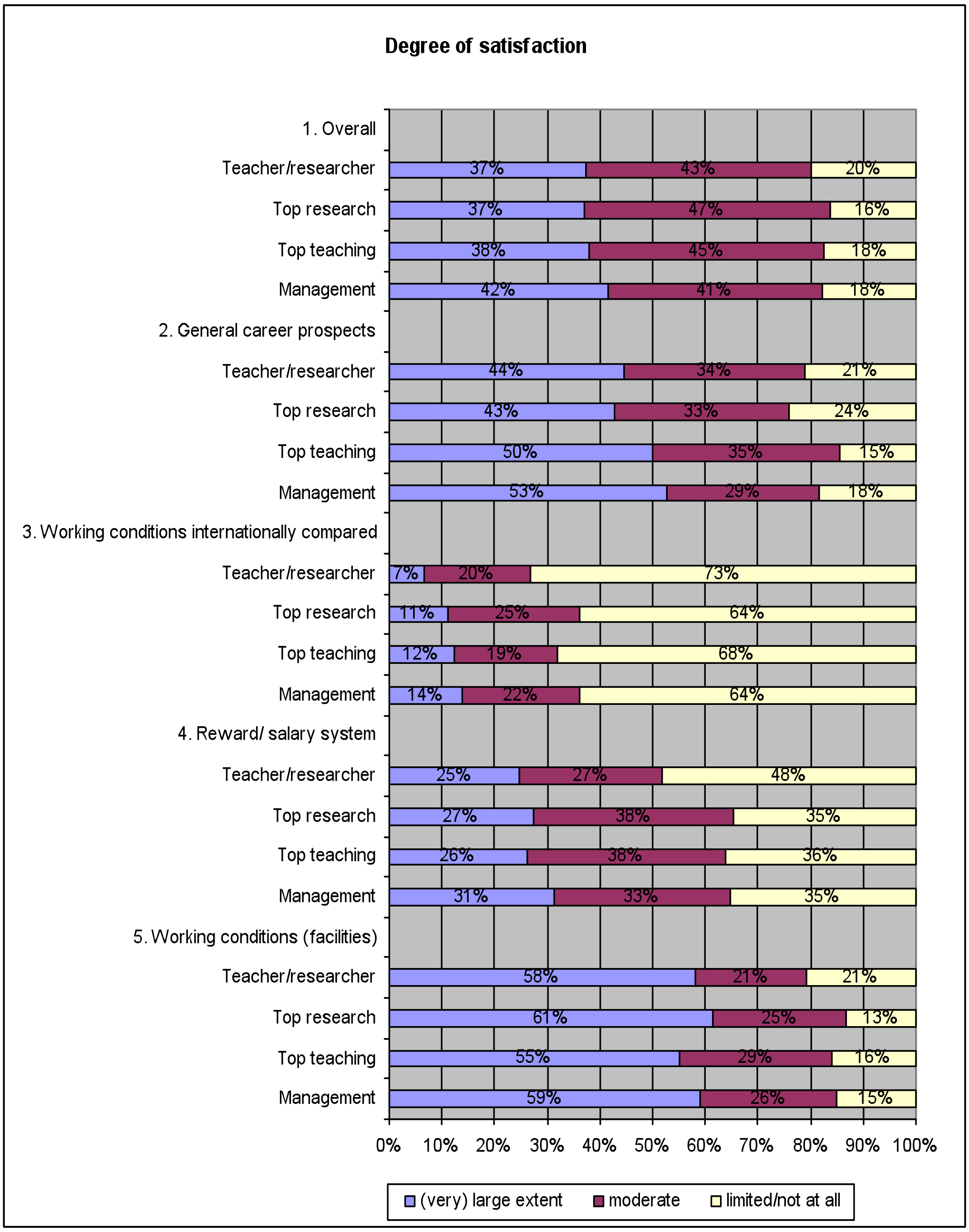
The figure summarises the views of all respondents in the survey as the different staff groups (teacher/researchers, managers) hardly differ in their views to attract sufficient qualified personnel. The management group, top professor and top researchers gave the same level of ratings, only the low teaching/research group show overall a lower rating, especially as far as attracting post docs/junior researchers is concerned.

Asked about hindrances and facilitators when hiring new R&D staff, the majority of respondents indicated that working conditions, available technical equipment, career opportunities offered and the reputation of the institutions were important facilitators. The most important hindrance to hiring new staff is the research funding available at the institution. Obviously, these factors may differ between institutions, but these are considered as important competitive conditions in attracting new R&D staff.

2.4 Working conditions

Working conditions involves a broad range of issues such as remuneration, terms and conditions of employment, security of work and career prospects as well as the available facilities and equipment. In the survey academics were asked to indicate to what extent they are satisfied with some of these working conditions (see figure 2).

Figure 2 Degree of satisfaction of different categories of staff with their working conditions



Question: *To what extent are you satisfied in each of the following categories, related to your primary organisation?*

Total N = 978: Management (408), Top teach (274), Top research (205), teacher/researcher (91), (5-points scale, the two extremes on both sides combined).

(Top teach = professors + associate professors at universities; Top research = senior researchers at ASCR; teacher/researcher = all lower and junior positions at universities and ASCR institutes).

The first impression from this figure is that most of the different groups have quite a similar score on most of the working conditions and that there is much agreement on most of the issues. It is notable that the category of teacher/researcher as the lower and junior position is not significantly more dissatisfied with overall working conditions and career prospects. Only in the international comparison and the salary/ reward system are they more dissatisfied, but not as high as might be expected given their position in the academic hierarchy.

These findings correspond with recent international data that show little variance amongst different groups of academics. In the so-called CAP project (the "Changing Academic Profession"), a survey among academics in 18 countries worldwide, younger academics overall were not more dissatisfied than senior staff.

In the UK 45% of academics described their overall satisfaction with their current job as high or very high. Young academics appear to be satisfied the most (51%) and the least dissatisfied (14%) whilst the group of older, established academics appear to be the least satisfied[5]. Responses to statements about the academic career support these findings and academics from the UK are more likely than those from other countries to agree with the assertion that: '*This is a poor time for any young person to begin an academic career in my field*', and '*If I had to do it over again, I would not become an academic*'. On the first question 47% of the young academics in the UK agreed or strongly agreed against 59% of the older academics. In the Netherlands, however, these percentages were the reverse: 33% of the younger academics (strongly) agreed against 25% of their older counterparts.

In the literature such findings have been attributed to the changing working environments for academics and their impact on the traditional intrinsic motivations of academics (such as a low degree of job descriptions and control, priority of doing challenging research). The increasing demands of accountability and financial constraints play a role as well.

Compared with these figures, younger Czech academics do not seem to have a more favourable view on their general career prospects than their counterparts in other countries. Further comparison would be necessary to get a better understanding. What in particular singles out are the views on salary/reward system (remuneration) and the employment relationship.

2.4.1 Remuneration

The previous figure shows that there is most dissatisfaction with the working conditions and the salary system compared to other employment sectors in the Czech Republic as well as to equivalent jobs abroad (respectively item 3 and 4 in the figure). Competitive remuneration with other employment sectors outside higher education requiring a similar level of education is a continuous source of dissatisfaction. It should be added that according to some interviewees in the field of life sciences, the differences between salaries earned in biotech companies and in academic institutions are very small. The first might be slightly higher but not so much that this would motivate researchers to work there.

Table 2 shows the salary differences between scientists and engineers working in the public and the private sector. These are substantively higher for scientists in physics. For scientists in biological and medical fields the difference is negligible. Remarkably are also the salary differentials between men and women, an inequality that persists within higher education.

5 Various draft papers (unpublished from the CAP –project e.g. Locke & Bennion, 2009)

Table 2 Average monthly salary of scientists and engineers by research fields (in CZK)

	Sciences and engineers total			In physics	In biological and medical fields
	Total	Men	Women		
Total	42.634	44.569	36.702	42.479	43.095
Private sector	45.207	47.035	38.402	45.569	43.645
Public sector	39.574	41.720	36.770	29.945	44.113

Source: Structural Salary Statistics 2009

The figures in this table are rather broad and do not separate for example in the public sector the salary level btweeen universities and public research institutes. On average the median salary of university employees is 10% higher than in the public research institutes.

The issue of competitive salaries within the Czech Republic shows a varied picture. The average gross monthly salaries of professors and associate professors are comparable with the highest average salaries in high-qualified positions in other sectors, such as higher employees in finance and banking and in the information and communication sectors. The top management of large companies has the highest salaries (CZK 62.229) followed by lawyers and top officials, physicists and architects (about CZK 42.000). Compared to these, the average salary of professors (CZK 60.0000) appears to be attractive and is among the best paid job categories.[6]

For the lower academic ranks, however, the average salary is significantly lower and only slightly higher than the average gross monthly salary across the country, making them less competitive compared to other employment sectors.

Regarding the international competitive remuneration of academics reference can be made to a study carried out for the European Commission[7]. This shows that within the European Research Area there are huge variations in the average salary for researchers. The value given to experience and the different levels of starting salaries also show up large differences across the EU. For example, a UK researcher can expect a significant increase in salary as the career progresses – as much as 335%, whereas a Danish researcher may see a 90% increase. In the overview of total yearly salary average of researchers the Czech Republic is far under the EU 25 average. However, in terms of PPS, converted through corrective coefficients, the Czech average approximates the EU 25 average (€ 36.950 and €40.128 respectively) and is above the associated countries average (€33.959). Not only East European countries are lower (except Slovenia), but also Finland, Italy, and Portugal. It can be added there are significant differences between male and female researchers, in some countries this difference amounts to 35%. An international overview of salaries of the main categories in some European countries is shown in table 3.

6 The Czech Statistical Office (CSO, 2009) *Structure of Earnings Survey*.

7 European Commission (2007) Remuneration of Researchers in the Public and Private Sectors. http://www.ec.europa.eu/eracareers/pdf/final_report.pdf.

Table 3 Average salaries per categories in selected countries (middle of scale), data 2008/09 in Euros

	Professor	Associate professor	Assistant professor	Post docs/lectors
Czech Republic*	2464 (60.098)*	1868 (45.551)	1272 (31.014)	986 – 1045 (24.038 - 25.493)
Latvia	1541	1233	987	790
Netherlands	5983	4939	4011	2916
Germany	5178	4205	3509	n.a.
France	4111	3190	n.a.	1699

*Czech figures in euros and in thousands of CZK (source: MEYS).

Source: CHEPS Monitor data.

The figures in this table are drawn from national salary tables and are factual, so not conversed in the PPS index, neither corrected for additional benefits or specific regulations that may vary widely across countries. This makes it very difficult to compare salaries across countries and major conclusions are hardly to draw.

A complicated factor is that these are average salaries. However, there is quite a large salary range reflected in the averages. For example in the Netherlands the salary scale of professors ranges from 7685 (top of scale) to 5000 (bottom of scale) and in Germany from 6416 to 3942. In Latvia the differences are much larger, from 2604 (top scale) to 1156 (bottom of scale). For the other ranks similar differences can be noted.

Although for the Czech Republic detailed figures were not found, it was reported that ranges of salaries in the different categories are quite wide. The real monthly salaries for professors and associate professors can vary at individual institutions by up to 50 percent of the average, while the variability of salaries for the lower ranks is slightly lower. This relates to the fact that salaries are determined at the institutional level and depend on internal regulations. In the Dutch and German system all professors are awarded according to the same salary scale determined nationally and applying to all institutions and to all scientific fields – thus a professor in history has in principle the same salary than a colleague in chemistry in no matter what university. By contrast the Czech system allows more differentiation between disciplines and within the same categories and average salaries also differ between institutions in different regions.

An important aspect of the Czech remuneration system is the distinction made between the tariff part determined according to the wage schedule for each academic rank and the flexible part that can be reserved for personal income and added to the basic salary. Institutions have freedom to use the tariff system as they wish and the smaller the tariff part, the more can be used for flexible rewards. Some institutions apply a tariff level as low as 50% implying that salary differences can differ substantially between staff in the same rank.

Similarly at ASCR institutes salary tables are not set centrally and the different extras (that can add up to 50% of the basic salary) are distributed to the most productive groups. Group leaders in turn operate quite independently in their financial affairs and have much freedom to determine the salaries of their group members on the basis of individual performances. This means that individual staff can be paid very differently between and within research groups.

Several arguments were expressed pro and contra this system. An argument to make remuneration more dependent on the most productive groups and individual performances is that this motivates people to be productive and to be as successful in the grant competitions as possible. The view has been expressed that this has a positive impact on the quality of research and development.

At the central university level it was argued that in case the tariff level is set low this does not offer staff much security and salary promises are hard to make. In particular a low tariff level makes it harder to attract younger researchers, as their salary is dependent on the will of their direct manager. For this reason, some favour a higher tariff system to guarantee more income security.

The counter-argument is that only 'secure money' mainly obtained from the Ministry and predominantly used for educational purposes can be used for the tariff part and that it is risky to determine higher tariffs if the income is not secure. When researchers appear not to be successful in terms of acquiring research grants, there is no money to pay the agreed higher tariff. Another reason to keep the tariff as low as possible is that the amount of secure money varies considerably between faculties - some are mostly living from education while others more rely on research income - implying that research money from a successful department will be redistributed on the central level.

One option would be to fix the tariff system not at the central university level with uniform standards as is commonly determined by the rectorate, but at the faculty level. This would make it possible to apply different approaches to different faculties. An academic leader of a more or less independent research institute from a larger faculty expressed much preference for such an option.

Such a far-reaching decentralisation towards the faculty and research group level as basic entities would have consequences for the development of human resources policies at the institutional level.

2.4.2 Employment relationship

The employment relationship can be characterized as one where institutions employ individual academics in a market-driven decentralized system. As working in non-governmental public institutions, academics have the legal status of 'public employees' and their jobs are regulated by contracts of employment under private law.

This means that tenured positions as commonly used in the American context or civil servant status with lifetime employment security do not exist in the Czech system. Since the amendment to the Higher Education Act of 1993 this was abolished employment contracts can be on a time-limited or indefinite (permanent) basis. Time-limited contracts vary from two to a maximum of five years and apply mainly to the lower ranks of academic staff. Current regulations allow two consecutive periods at most, after which a change of contract into an indefinite one is required.

Indefinite or permanent contracts apply in principle to the higher academic ranks. These contracts will continuously be extended on a five-year period taking into account the evaluation of individual performance (see section 3.6). In other words, strict permanency in the sense of tenure does not exist, as in accordance with current labour regulations the institution can terminatedan indefinite contract.

Compared to the graduate labour market in general in the Czech Republic it appears that a large proportion of graduates obtained a permanent employment contract in their first job – this percentage was higher for technology graduates (72.1%) compared to science graduates (64.4%). This proportion increased further in the second and third job[8]. These figures presuppose that there is more job security generally on the Czech labour market than in higher education and that HE institutions are evading the

8 National Observatory of Employment and Training – National Training Fund, The Competitiveness of the Czech Republic – Quality of Human Resources 2008-2009.

legislation of limiting the maximum duration of repeated temporary contracts. The argument most often voiced is that it has been explained to the authorities that because of the vital dependence on grants that are limited in their duration, salaries and working conditions cannot be guaranteed.

In statistics, however, a distinction is made between research staff on permanent contract and on temporary contract.

Table 4 Research staff by type of contract (in FTE)

	2005	2006	2007	2008	2009
Indefinite contract	42.074	5.989	47.689	49.260	49.342
Time-limited contract	1.296	1.740	1.502	1.548	1.618

Source: National Training Fund 2010.

Table 4 shows that apart from a substantial change in 2006 (probably due to differing calculations), the proportion between the number of indefinite contracts and time-limited contracts has remained rather constant. According to the Labour Code the differences between these two types of employment contracts are in terms of the specificatrion of working tasks. Those on time-limited contract are mostly working on the basis of a research grant for the duration of a particular research project.

Actually a very small percentage of all staff has a real indefinite contract that comes close to the notion of tenure as most with a permanent contract are subject to periodic personnel reviews. An employee can be dismissed under terms set down in the individual provisions of the Labour Code (or by agreement with the employer at any time) that are legally binding. Among the reasons for dismissal is the level of work performance. As the academic director of an ASCR institute puts it, “all scientists are on a maximum five-year contract, including myself. Regularly every five years we have an evaluation and on that basis it is decided whether the contract will be prolonged or not”. But he hastens to add that it is quite rare that a contract is not prolonged, only in cases of very bad evaluation.

2.5 Aspects of the career structure

2.5.1 Age structure

The ageing of the academic population is a concern in many European countries where over 50% of academics at the highest rank of the career are over 50 years of age. The demographic composition plays a role here, but still the academic workforce as a whole has an older age structure than the workforce as a whole. The Czech Republic is no exception: the average age of professors and associate professors was 63 and 57 and the average age when appointed was 53 and 48 years respectively[9]. More recent figures indicate that there is not much change. At a large university currently 45 full professors out of a total of 55 are over 50 years of age and 37 of them are 60 years and over. Of a total of 125 associate professors 73 are 50 years of age and over.

The White Paper on Tertiary Education attributes the unsatisfactory age composition of the academic staff the Czech HEIs to the system of qualifications as being ‘extraordinary cumbersome’. For legislative and traditional reasons, the scientific and academic titles of professors are perceived as having lifelong and countrywide validity, even though specific conditions for habilitation and professorial appointment procedures depend on the home institution[10]. In addition, the Czech career structure has been characterised as a strenuous one whereby climbing to the top of the qualifications hierarchy is a very demanding life-long endeavour.

9 Based on sources from Melichar & Pabian, 2009, p. 43.

10 Ministry of Education, Youth and Sports (2009) White Paper on Tertiary education. Prague, p. 27.

This rigid career structure associated with the ageing of the academic staff might lead to blockages in the career progression of young academics and hinders the replacement of the current generation of senior academic staff with well-qualified and well-motivated younger ones. For some Czech authors this is one of the reasons for many young researchers to leave academe, thereby contributing to the perception of the ageing academy[11].

Initiatives to cope with the issue of the ageing staff can be sought in creating flexible working arrangements, personnel policies towards older staff and attractive working conditions and career prospects for younger researchers. These will be discussed in the next section on human resource management and in the European overview.

2.5.2 Women's careers in science

The position of women in research has internationally been acknowledged as an important aspect of the career structure. Generally a need is felt to have more women in research and especially in senior positions and to know more about the barriers to these positions and best practices in the countries of the European Research Area.

Eurostat data indicate that the percentage of female researchers in the Czech Republic is far below the overall EU average and significantly behind the new member states where the percentage of women among researchers is sometimes twice as high as in the Czech Republic.

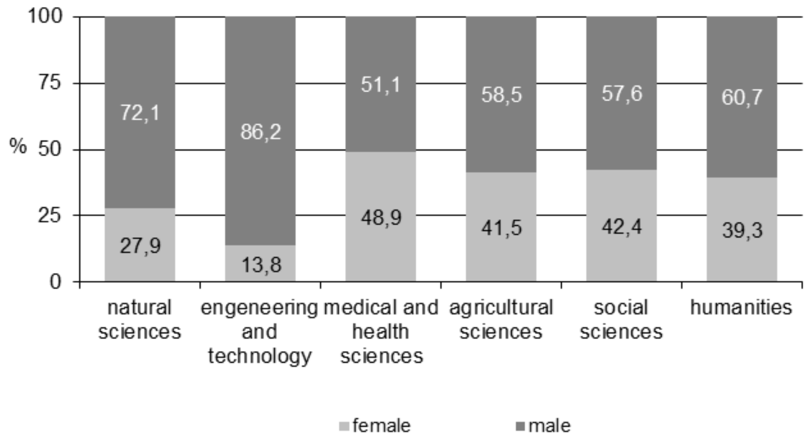
The percentage of female researchers in the Czech Republic is around 29% and around 25% in FTE[12]. These percentages have not changed over the last eight years although the number of researchers in the country has doubled since 2001. However, the percentage of women at all levels of study has been growing, as has the percentage of female university graduates in the Czech population. At the Bachelor (BA) and Master's (MA) study levels women have outnumbered men since 2005. In 2008 women made up 54.1 % of BA students and 59.9 % of MA students and women are at least as successful in graduating as men. This increase in the percentage of qualified women has not been reflected in the total percentage of women in science.

Women students and researchers concentrate in humanities, social, medical and agricultural sciences, where they make up around 40 % of students. In the technical and natural sciences where 73.1 % of all researchers in the country are located, the percentage of women is only 13.8 % and 27.9 % respectively. Moreover, the share of female researchers in technical sciences has dropped compared to 2001, and stagnated in the natural sciences. Figure 3 shows the share of female researchers by fields of study.

11 Tollingerová

12 All the statistics in this section are taken from Hana Tenglerová (2010) Postavení □en v □eské v□d□ a aktivity na jejich podporu Monitorovací zpráva za rok 2009. Praha.

Figure 3 Share of female researchers by fields of study in 2008 (in FTE)



Source: CSU 2009 in Hana Tenglerová (2010) p. 22.

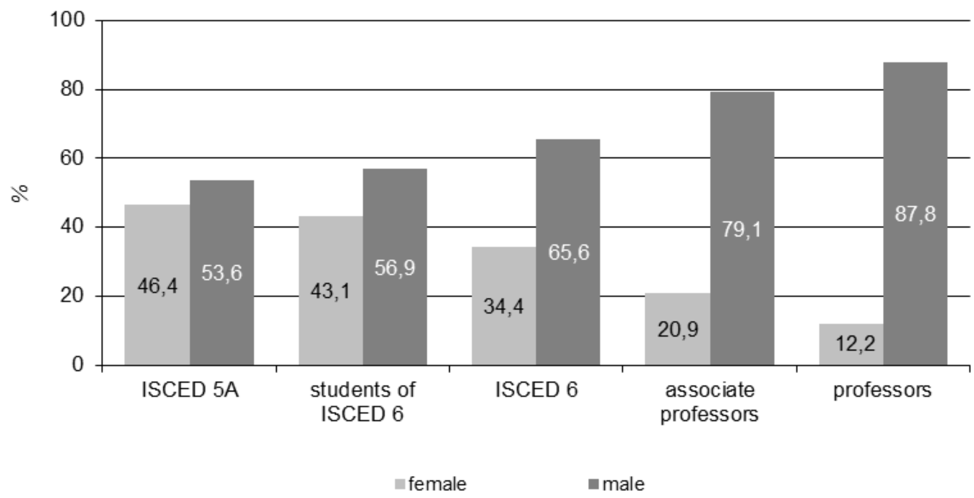
Major differences exist between the proportion of women in MA and doctoral studies, particularly in the medical, agricultural and social sciences. In technical and natural sciences, where the percentage of women is lower at the outset, the proportion of women that continues to doctoral study is the same as at the MA study level. The percentage of women, however, drops dramatically when entering the scientific profession.

Figure 4 shows the share of women in subsequent educational levels and their representation in academic positions. In 2008 women made up 12.2 % of full professors and 20.9 % of associate professors in the Czech Republic and that the increase of their numbers in these positions is minimal. This qualification structure differs across disciplines with the major differences being the following[13]:

- In the natural and technical sciences men predominate at all qualification levels but women more often than in the other disciplines continue toward habilitation and professoriate.
- In the natural sciences the percentage of women among full and associate professors has fallen since 2005. In agricultural sciences the percentage of women has increased at all qualifications levels.
- Women have the hardest time achieving full professorship in the humanities and social sciences.
- In technical sciences the gap in the percentage of women is the highest between doctors and associate professors; in the natural sciences between PhD students and doctors (postdoctoral level).

13Tenglerová, Hana (2010) Postavení ☐en v ☐eské v☐d☐ a aktivity na jejich podporu
Monitorovací zpráva za rok 2009. Praha.

Figure 4 Share of female researchers by qualification and position in 2008 (%)



Source: CSU 2009 in Hana Tenglerová (2010) p. 24.

From this data four critical transition points of career development exist in science and research where usually more women drop out of a career than men, namely from PhD to post doc, to associate professor, and to full professor.

On each of these transition points women have severe problems in continuing their scientific careers, the so-called leaky pipeline. The gender issue falls into several categories: those related to maternity (including career breaks due to family reasons) and those related to differing traditions and expectations. In particular the low representation of women in decision-making bodies in research institutions and institutions for science policy are considered important hindrances for gender equality[14]. A higher number of women on scientific boards and selection committees, as well as a growing awareness for gender equality especially for women having different career paths would have a positive impact.

On the basis of the foregoing analysis Czech researchers are proposing a state conception of support for gender equality in the area of science as well as building institutional arrangements for addressing gender equality in science[15].

2.6 Human resources management

This section discusses the extent to which R&D&I organizations are able to develop human resources and their views on the current practices and barriers to provide career opportunities for researchers. Table 5 summarizes four aspects of human resources linked to barriers for R&D&I performance.

14 In the interviews reference was made to the low representation of women in the Academic Senate and Scientific Board of different faculties. Brno university of Technology for example, provide in their annual report the number of women in university academic bodies. Generally no specific policies on this issue were mentioned.

15 Ibid. Tenglerová, Hana (2010); Linkova, Marcela & Tenglerová, Hana (2008) Gender Equality in Science, in Petr Pavlik et al Shadow report on equal treatment and equal opportunities for women and men, Programme of the EQUAL Communitive Initiative, Prague: Open Society Fund, pp. 104-120.

Table 5 Barriers for R&D&I performance in the Czech Republic

	Management N=379		Top teach N=244		Top research N=190		Teaching/ research N=78	
Scores 1-5*	1-2	4-5	1-2	4-5	1-2	4-5	1-2	4-5
Lack of qualified academic personnel	27%	38%	30%	39%	32%	28%	12%	38%
Inadequate HR Management	37%	33%	40%	34%	49%	26%	33%	31%
Insufficient training possibilities	27%	41%	29%	33%	38%	34%	18%	49%
Inadequate regulatory framework for young researchers/ post docs careers	66%	9%	69%	6%	75%	5%	37%	15%

1-2 = not at all/ to a limited extent; 4-5= to a large/very large extent (in %), *3 = moderate (not included in the table), adding up to 100% .

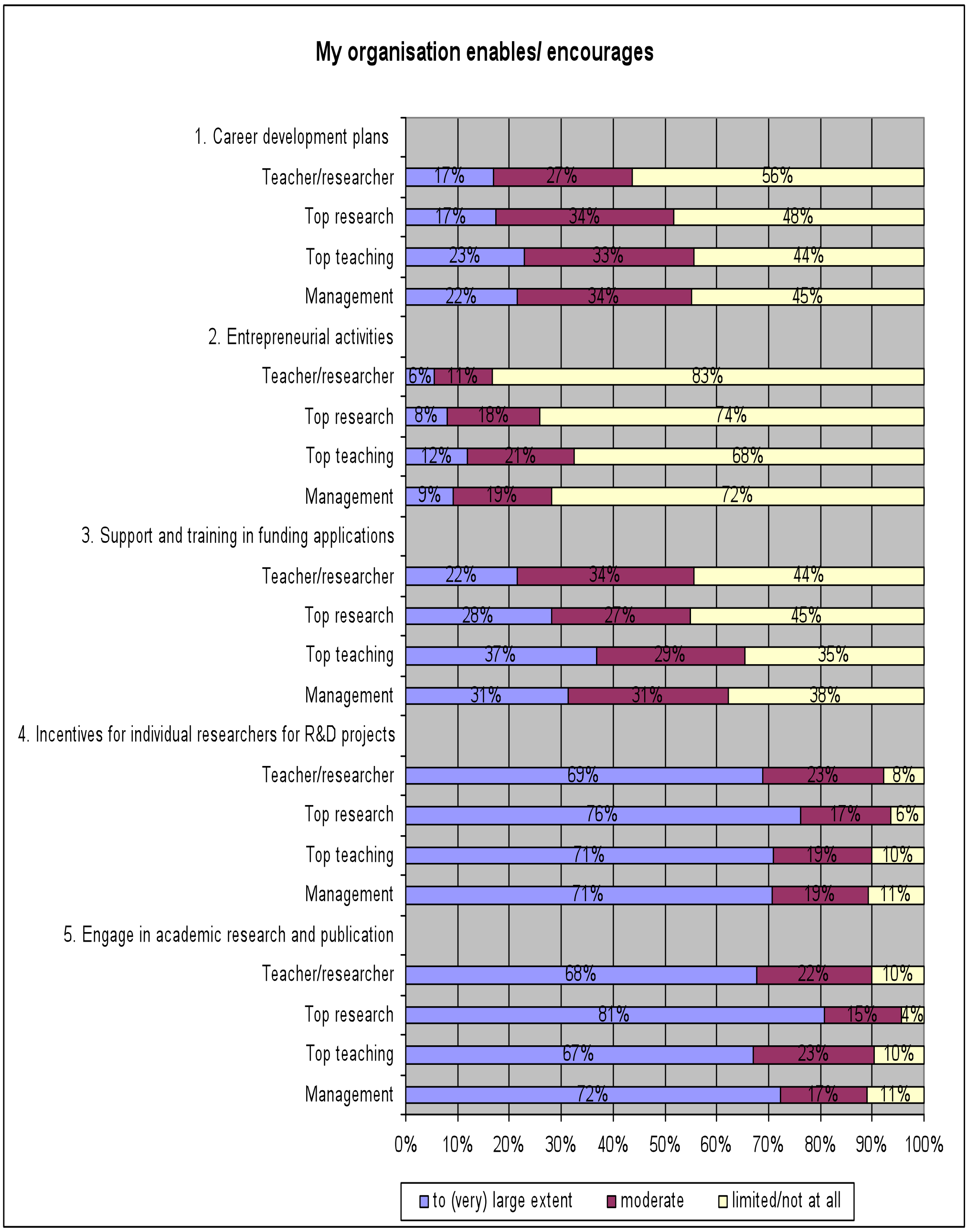
The findings show overall that the different groups agree within reasonable limits on most of these aspects and about a third to over 40 percent see the first three aspects as being a performance barrier. Lack of qualified academic personnel and insufficient training possibilities are the major barriers for most groups albeit for the top researchers to a relatively lower extent than for the other groups.

The research group (non-professorial positions) considers the insufficient training possibilities as a barrier as well as the inadequate regulatory framework for young researchers, although this is strongly counterbalanced by those who do not consider this at all or only to a limited extent as a barrier.

These same items were presented to rectors, directors, and deans of faculties. They saw substantially lower barriers on all of these items except for the last one. Among the university administrators 36% considered the inadequate regulatory framework for young researchers careers as an important barrier for R&D&I performance, against 22% of those from ASCR and 6% of other research institutes.

The following figure presents views on the degree to which the organization enables or encourages selected aspects of human resource management according to views from the different groups of academic staff.

Figure 5 Role of the own organisation regarding human resources (N=973)



Total N= 973: Management (407), top teach (273), Top research (203), teacher/researcher (90).

The figure shows that there is quite some agreement among the four respondent groups. On most items the percentages do not differ, although the lower category of teachers/researchers are less positive about the organisations' ability for career development plans and the encouragement of entrepreneurial activities than the other groups. The data indicate that the emphasis is on creating incentives for individual researchers to develop R&D projects and the engagement in academic research and publication. Top researchers who are mainly from the ASCR institutes share this view more than those from universities.

The same items were presented to directors of public research organizations and deans of university faculties. Table below shows the percentages of those who agree with the statement to a large and very large extent.

Table 6 Characteristics of the organization on a 5-points scale; responses 1 and 2 (to a large or very large extent) (%), N= 74

My organization:	Overall	Universities	ASCR	Other
offers career development plans for researchers (career paths, facilities etc.	39%	39%	39%	39%
encourages researchers to adopt entrepreneurial activities outside our institution	8%	18%	0%	0%
provides support and training in preparing funding applications	44%	48%	34%	50%
Has incentives for individual researchers to apply for R&D projects	91%	87%	96%	89%
encourages researchers to engage in academic research and related publication activities	87%	84%	100%	78%

It appears that the scores of this group on all items are higher, suggesting a more positive view on the organizational abilities to pursue HR policies than the academics. Nevertheless the encouragement to engage in entrepreneurial activities outside the institution still scores low and at ASCR institutes this is virtually non-existing.

Some tentative conclusions can be drawn from figure 5 and table 6.

First, although the organization has incentives for individual researchers to apply for R&D projects, there is much less support in preparing funding applications. Presumably this is something researchers have to figure out for themselves. A professor from a chemical faculty told about the very demanding process of submitting a proposal including detailed descriptions of technical equipment. This all took almost three years of intensive work that all had to be done by the staff themselves without any support or additional facilities. At the end the proposal did not succeed, but the reasons given were experienced by the group as very unsatisfying.

Second, only a minority of the respondents in all categories indicates that the organization provides career development plans (career paths, facilities) for the different staffing categories. The proportion of those who indicate that these career plans are limited or not existing at all comes close to 50% and for the younger teachers/researchers amounts to 56%.

These percentages may be neutralised by the fact that the encouragement to engage in academic research and publication is quite high, for top researchers 81% and for ASCR directors 100%. In order to understand this, a closer look is needed at the evaluation procedures that are used as basis for career development.

In the evaluation procedures the number of publications plays a central role. Every year each research group produces a list of the papers published in the previous year and these are evaluated in terms of the impact factor of the journal as a proxy for the quality of the research. This was illustrated as follows:

'If you have a paper in a journal with impact factor 10 and if all the authors of that article are from the group, you get 10 points for that. If only half of the authors are from the group you get only 5 points. There is some indemnification for the first author and the corresponding author. And so for each publication you can get publication points which can be from 0 up to the impact factor'.

Generally publication records are used as a major source for personnel evaluation whereby a shift in emphasis towards internationally recognized journals is taking place. This performance indicator follows the incentives set by the evaluation methodology based on quantitative indicators. If the money is supposed to be distributed to individuals according to their success, especially publication records and the specific journals according to their impact factor, this will automatically affect the human resources policies. Those who have a high publication record would like this system, while others are more reserved. The incentive effect is towards monodisciplinary journals that divert researchers away from interdisciplinary socioeconomic challenges.

Concern has been expressed about the tendency to shift the emphasis from impact journals towards applied research and the number of patents acquired as well as publications that have hardly any impact. Counting patents is a very easy thing to do and the rules to submit them are very soft. Also the fact that writing a book is very badly evaluated, even when it becomes an international textbook. It is felt that this does not do full justice to academic work.

The fundamental weakness in the Czech system, according to a respondent, is that in West Europe a professor has a budget from the university and therefore never has to be afraid whether next year (s)he still has a salary. As one put it: 'The reward for publication rewards brings enough money to support our professors (...) the other staff are fine if they know that their own chair is fine (...) it is very hard to think that your own chair is not secure and you cannot promise such to juniors if you don't have anything for yourself'.

However, the connection between the number of publications and the funding is not always an automatic process. Here a dichotomy seems to exist between universities and ASCR institutes. The latter institutes tend to operate in an independent way and integrate the publication factor as part of a more general review process. Most institutes have a system of five-year evaluations by international peer committees who asses the quality of the research of the whole research group.

As a director of an ASCR institute states the publications are very important, but other aspects are taken into account, such as the success in the last five years, the future prospects of the research group, and whether it is an established or a new promising group. Thus publication records can be a tool to produce data used as a basis for judgment by peer review, but not as a goal on its own. The external peer review mainly exists in the ASCR and occasionally at some faculties on their own initiative. For example, an interdisciplinary research institute belonging to a faculty of science of a university decided to subject their research performance to an international review committee consisting of leading scholars in the field. On the basis of a self-evaluation report written by the faculty, the committee spoke not only with the institute's leaders, but also with junior scientists and PhD and Master students. The general atmosphere was great and the committee produced a comprehensive report indicating the strong and weak research units, the most promising areas and who are on the breaking edge of science. On the basis of the recommendations of the review committee major (strategic) decisions of the institution as a whole could be made instead of an automatic application of criteria set by the Ministry.

However, nothing happened afterwards, practically no use was made of the outcomes of these evaluations on the faculty and central university level and the results were not translated into policies. At the central university level this initiative was looked at as a private activity of the faculty.

For younger staff such an external review processes can be very important. They have a chance to see leading scholars of world standard who are interested in what they are doing. 'On the one hand they have insecurity, but at the same time they see the success of big research projects, see how we are progressing and see how the building is growing, so they do not hesitate to stay with us'.

This example shows how evaluation procedures can have a stimulating effect on the general work sphere and the motivation of young researchers. Another example will be presented in the overview of European good practice to illustrate the working of the "*Education for Competiveness*" programme in the Czech Republic and its effects on human resources. Here we provide a short overview of current developments in Europe.

2.7 Career structures in European contexts

2.7.1 A four-stage research career

Throughout Europe the research career structure is a much-debated issue. Under the influence of various internal and external factors such as demography, changing demands, economic and educational development and growing international competition for researchers, human resources have become a priority area and higher education institutions are in a continuous process of overhauling the career paths of academics with respect to:

Recruitment and retention of academic staff, promotion and reward systems, flexible employment conditions;

Exploration of new forms of doctoral training, with less emphasis on pure research training;

Multiple working tasks in teaching, research and beyond and corresponding workload regulations.

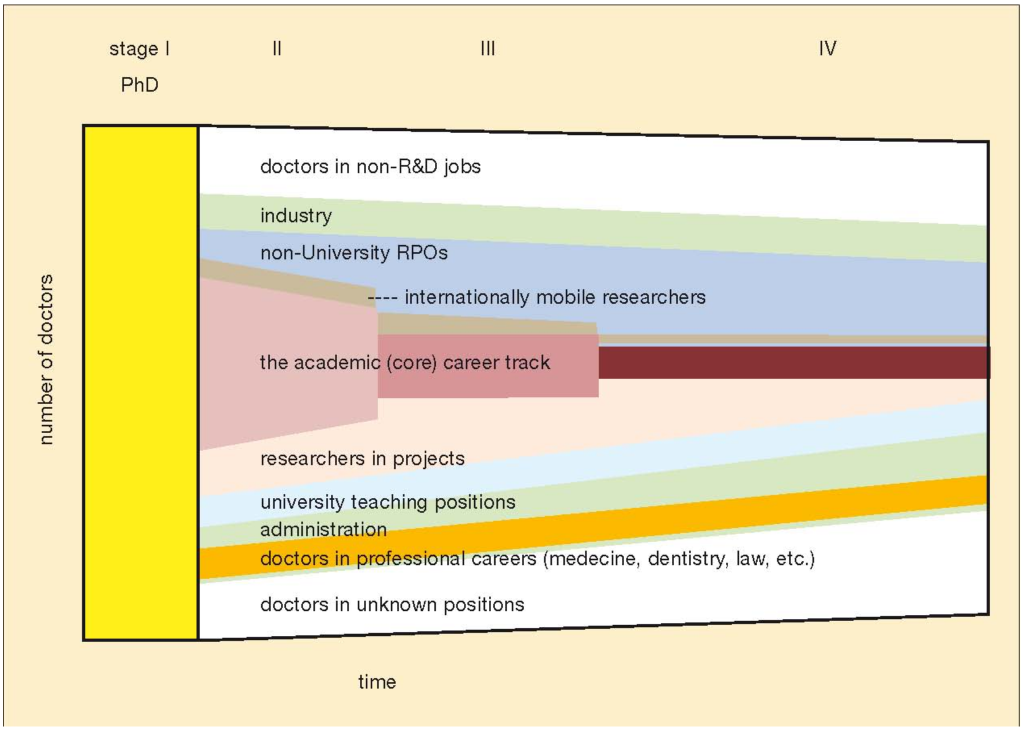
The academic career consists normally of a succession of related positions through which researchers move in an ordered, predictable sequence. In addition, employment has been based on the security of tenure and lifelong employment and was framed through the operation of an internal labour market. Although career progression is not automatic, the traditional view of the academic career is rather narrow.

Nevertheless there is throughout Europe quite some heterogeneity in the different career steps that can be made as well as confusion about different terminology. For this reason the European Science Foundation Member Organisation Forum on Research Careers developed a taxonomy for research careers with the view of comparing the different steps in the academic career and to improve the attractiveness and competitiveness of European research careers. On the basis of a survey across Europe the Working Group has divided the European research career into four stages as presented in figure 6.

Stage 1, comprising the doctoral training period, and stage II (the post-doctoral period) have relatively uniform definitions. Stage III is the most heterogeneous one, mostly referred to as ‘independent researcher stage’ or ‘group leader stage’ but extends further to encompass senior scientists and assistant professorships. Stage IV comprises the established researchers, mainly full professors, but includes other senior positions in academia and research-performing organisations. Regarding the Czech Republic the position of group leader of the ASCR institutes would belong in this category.

Further refinements are possible and some countries have divided Stage III further into two separate stages, but the Working Group adheres to the four-stage structure.

Figure 6 Schematic illustration of the diversity of research careers in the European Research Area (ERA), using Finland as a concrete example[16]



This four-stage career structure provides a general framework, but each of the different stages may differ greatly between national systems and various disciplines. In some countries the different career steps are quite fuzzy in the sense that transition from one stage to the other is not sharply delineated, while in other countries every next step goes along with increasingly rigorous selection procedures and highly competitive positions on the basis of peer evaluation and interviews.

This four-stage career structure is not intended to achieve uniformity across Europe, but to allow orientation and comparability. Two purposes seem to stand out.

First, in several countries national funding agencies use financial schemes to support the different steps of the research career. For example, the Dutch research council (NWO) applies the so-called 'Veni-Vidi-Vici-scheme' to support young and promising researchers to follow a career track starting from the position of post-docs and ending as a top research professor. Similar initiatives exist in the Nordic countries, Germany (German Research Foundation DFG) and Switzerland. These schemes provide an opportunity for young staff to develop their own career lines and to control their own research budgets through targeted funding programmes.

A second purpose is to increase the transparency in the process of making different career steps, which in turn may facilitate the mobility of researchers. In-breeding of academic staff staying in the same institution where they received their undergraduate and postgraduate education is a widespread phenomenon in academia in many

16 European Science Foundation (2009) Research Careers in Europe – Landscapes and Horizons. ESF: Strasbourg (www.esf.org).

countries and is quite high in the Czech system. Transparency in career steps would create conditions for more inter-institutional and international mobility[17].

Along the same lines, principles of open competition for positions, selection on the basis of merit and transparency of staff appointments, promotion and performance appraisal processes can be given their place in the four stage career structure. In this context the "European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers" is relevant as it aims at establishing better working and career conditions for researchers and to apply these at institutional level. To further strengthen the position of researchers in the European Research Area the European Partnership for Researchers provides a comprehensive agenda in four key areas:

- Open recruitment and portability of individual grants awarded by national funding agencies and Community research programmes
- Meeting the social security and supplementary pension needs of mobile researchers,
- Attractive employment and working conditions
- Enhancing the training, skills and experience of European researchers[18].

This agenda includes full recognition of researchers' qualifications from other institutions and countries, better career development opportunities for early career researchers including regular evaluation and more autonomy, and better training throughout their careers to improve their employability within higher education and outside.

In the UK the "Concordat to Support the Career development of Researchers" (published in 2008) has a similar purpose (see the section on European Good Practice). The Concordat contains seven key principles which set out the expectations and responsibilities of researchers, their research managers, employers and funders to increase the attractiveness and sustainability of research careers.

The European Charter and Code and the Concordat are important because they challenge institutions to embed these principles into their practices and to seek clear career pathways and career advancement modes especially for contract researchers. More insight is needed on the effectiveness of such schemes, their implementation on the national, institutional or departmental level, as well as impeding factors for success. Participating institutions can benefit from mutual learning and the sharing of human resource strategies.

2.7.2 Creation of diverse multiple career paths

There is widespread recognition that the prevailing career system based on academic reputation does not match the full range of functions and professors are often caught between competing obligations. The Boyer Commission called for expanding the definition of scholarly work beyond the narrow confines of specialized research and publications. Scholarship also encompasses the application of knowledge, the engagement of scholars with the broader world, and the way scholars teach as interdependent components (the scholarship of discovery, application, teaching, and integration)[19]. The scope of these activities includes the many ways in which academics draw upon their expertise in performing these tasks. These broader

17 Knowledge about the career paths of researchers in non-academic R&D professions is still very limited. A clear picture of career destinations would identify good examples for intersectional mobility.

18 European Commission (2008) Better Careers and More Mobility: A European Partnership for Researchers (http://eur-lex.europa.eu/).

19 Boyer, E (1990) Scholarship Reconsidered: Priorities of the Professoriate, Princeton:
Carnegie Foundation for the Advancement of Teaching.

definitions of scholarship lead to diversifying career patterns and should be used in hiring decisions, merit reviews, and employment contract considerations.

These components have often been collapsed into homogenous categories that in fact cover a heterogeneous range of activities. The fault line is no longer simply between research and teaching as more hybrid forms are emerging.

Research cannot be conceptualized narrowly as the discovery and publication of fundamental knowledge but encompasses both fundamental, disciplinary research and various forms of trans-disciplinary research in the context of its application, strategic research and development, consultancy work and spin-off activities. The external orientation of research staff and their cooperation in larger research networks, the growing relevance of research and the intensive interaction between industry and higher education are increasingly entering the research reward system[20].

In other words a standard model of academics that allocates a fixed percentage of time for teaching and research does not acknowledge the diversity of tasks expected, nor different aspirations and competences. The following references point to staffing models that allow more flexibility and diversity in the relative proportion of the various task components for each individual academic.

- The German Science Council has proposed a differentiation of teaching and research professors depending on the actual appraisal of individual performances and on future individual plans[21].
- Similarly in France with a highly national uniformity of personnel regulations, there is a development to allow universities to negotiate different contracts with their academics regarding their teaching and research tasks[22]. It is stressed that each individual academic does not match all these tasks in the same way and that variations in the balance of these activities may occur within the same position during his/her professional life course.
- In the Netherlands the universities have adopted a new system of job ranking (the so-called UFO-model). The aim of this system is to make explicit the various roles, tasks and responsibilities that have to be carried out to achieve specific results. Academics can apply for specific roles on the basis of an assessment of their qualifications. This system of functional differentiation allows both vertical and horizontal mobility whereby research performance is not the all-determining factor in a career path. The system is designed to function as a basis for an advanced Human Resources instrument for the purpose of defining personal development plans and distinctive career paths, and the competences required for further academic career development.

A platform of young Dutch leading scientists (in the age of 25-45 years) belonging to the Dutch Royal Academy of Sciences (KNAW) advocates a broadening of academic careers by:

- Creating more multiplicity in academic careers. In addition to the model of top researcher, career trajectories should be created for excellent performances in other fields in the university system, such as education, science communication, administration.

20 Weert, E. de (2009) The organised Contradictions of Teaching and Research: Reshaping the Academic profession. In: J. Enders & E. De Weert (eds.) The Changing Face of Academic Life, Analytical and Comparative Perspectives. Palgrave Macmillan, pp. 146.

21 Teichler, U. (2007) Germany and Beyond: New dynamics for the Academic Profession, in W. Locke & U. Teichler (eds.) The Changing conditions for Academic Work and Careers in Select Countries, INCHER-Kassel, pp. 15-39.

22 Belloc, B. (2003) Propositions pour une Modification du Decret 84-431, Portant Statut des Enseignements Chercheurs. Paris: Ministry de l' Education et de la Recherche.

- Encouraging staff exchange: the possibilities for (temporary) exchange between universities and research institutes, and private R&D&I institutions, as well as the opportunity for lateral ingoing and outgoing staff. This is expected to break through the rigid career paths, to offer opportunities to acquire inspiration from elsewhere and to offer high potentials to return from the society back to science[23].

Institutions are challenged to develop a wider and horizontal array of career patterns each focusing on particular work components or combinations of them. A mix of these components may be an attractive option for staff to have more flexibility in moving across different working roles.

2.7.3 Evaluation of research

In the light of a diversified career structure the question arises how research is to be evaluated and reflected in the appraisal schemes of individual academics. In the Czech case the performance in terms of publication records in defined journals has been connected with the level of remuneration, which may have quite asymmetric financial rewards among academics. In other national contexts it has been argued that the appraisal of individual employees is almost inevitably dysfunctional. Such appraisals do not lead to improvements in organisational performance, but rather divert attention from more important tasks. By emphasising personnel targets, the performance of the organisation as a whole tends to be overlooked. Another threat is the effect of leading to a jealous or forced working sphere. This may reinforce strategic behaviour that is oriented to attain the stated criteria. “Large differences in rewards can as readily result in excessive time and energy spent on integrating oneself with one’s supervisor or trying to affect the criteria for reward allocation”[24].

A one-sided focus on publication records does not do justice to the diversity of work roles. Take for example engineers who are engaged in teaching, research and patented applied research or physicians who are engaged in clinical research, teaching, and treating patients in a university hospital. Presumably a university wants to have these academics doing all these activities But some may do better in one or another area and a university might want to adopt an assessment scheme in which they are evaluated based on the task that they have chosen to make their primary concentration, subject to maintaining acceptable performance in the other tasks. The emphasis on publication records leads to an irreversible shift of allegiance away from the goals of the institution towards those of their academic specialty.

Part of the career structure involves international research collaboration. The MORE survey samples show that researchers are increasingly collaborating with those from other countries with a higher concentration of geographically mobile researchers among the ‘academic’ researchers who collaborated with researchers in other countries (62% against 56%). Other data sources, notably the U.S. National Science Foundation (NSF) confirm this international collaboration: the number of international articles with authors from at least two countries more than doubled in share between 1988 and 2003 from 8% to 20%. Intercontinental co-authorship increased as a percentage of total article output for the US (from 17% to 27%), for the EU (from 18% to 26%), and for Asia (from 16% to 19%). These figures point to the role of research collaboration on research careers and human and social capital factors, both those in the early stages of their careers and those in vested positions[25].

23 De Jonge Akademie (2010) Rendement van Talent. Aanbevelingen voor motiverend en stimulerend loopbaanbeleid. Amsterdam: KNAW. (Recommendations for motivating and stimulating career policy).

24 Pfeffer, J. (1994) Competitive advantage through people. Boston (Mass): Harvard University Press, pp. 50-51.

25 Melkers, J. & A. Kiopa (2010) The Social Capital of global ties in science: The added value of international collaboration. Review of Policy Research 27 (4), p. 389-414.

How research evaluation can take a diversity of criteria into account can be illustrated by reference to the system of quality assessment as has existed in the Netherlands since the 1990s. Until 2003 the collective body in the universities was responsible for organizing nationwide evaluations on the level of each discipline. Since 2003 quality assessment of research institutes and research groups of universities are taking place every six years. Universities organize the assessments themselves and appoint an independent international peer-review committee. In addition to the external evaluation, an internal (self) evaluation of the institutes occurs on a three-year cycle. The research assessment is based on the Standard Evaluation Protocol (SEP) established by the associated universities, the Royal Academy of Sciences and the Netherlands Organization for Scientific Research (funding council).

The SEP provides common guidelines for the evaluation and improvement of research and research policy, based on expert assessments[26]. It has two objectives:

1. To improve research quality, based on external peer review, including the scientific and societal relevance of research, research policy and research management.
2. To ensure accountability to the board of the research organization and towards the funding agencies, government and society at large.

The assessment is based on four criteria:

- Quality (including international academic reputation and PhD training)
- Productivity (the relationship between input and output)
- Societal relevance of research (including valorization)
- Vitality and feasibility (the ability to respond adequately to changes in the environment).

It is believed by the Dutch scientific community that by taking a varied set of criteria into account a more balanced view on the quality of research can be obtained.

2.7.4 Recruitment, tenure and gender

For Europe to remain competitive in recruiting high-quality academics and researchers an urgent need has been felt in many countries to ensure the attractiveness of research careers, especially at times when the private sector offers much higher salaries or better career perspectives. This particularly concerns the challenges for the recruitment of younger researchers for an academic career, their conditions and career perspectives, as well as the promotion of women in science. Long-term prospects are not guaranteed and those who hold on longest attain a professorship at an older age.

Several policies have been adopted to attract and keep young promising researchers by giving them more job security and shortening career trajectories. For example:

- Most Dutch universities have implemented the tenure-track system similar to the Anglo-American system. This provides new entrants a career path based on concrete career steps rather than on standard procedures. Performance will be assessed according to agreed criteria at appointment that - if met - guarantees a tenured position later on.
- In Germany the key to make academic positions more attractive is to break through the prevailing strong hierarchical ladder by making junior staff less dependent on their professors. A tenure-track like career would lead to full professorships through the junior professorships, a position for a time-limited period.

26 The SEP 2009-2015 is available (in English) at www.knaw.nl

- National governments in various countries have support programmes to enhance the position of young researchers and to ensure that the new generation of scientists will be retained for the academic world. Financial schemes have been made available to give young researchers a 'personal budget which enables them to develop challenging research programmes (examples are the so-called 'innovation impulse' in the Netherlands and the 'junior research groups' in Germany).

Academic tenure is a much-debated issue and is a deeply rooted phenomenon in the academic profession. In West Europe this is mostly associated with the civil servant status which guarantees life-time employment. However, in a number of countries there are fewer opportunities for tenured positions. Over the last two decades the proportion of academics employed on non-tenured positions has increased and for those in the first two stages of the career model (see above) tenure or permanency hardly occurs. The following example from the United Kingdom illustrates the significance of the tenure system on human resources.

In the UK system tenure was abolished in 1989 when universities were forbidden to issue new contracts, either for appointment or for promotion that embodied tenure. At that time, fixed term contracts were only used for staff employed on finite funding. Since then all academic staff have been employees of the institution in which they work. Their appointment is not subject to state approval or regulation. The institution as employer is solely responsible for conforming to prevailing national and European employment law. However, since tenure was removed very few staff have been made redundant. Feelings of insecurity may be a factor in the degree of satisfaction of British academics, but this is attributable much more directly to underfunding and the general insecurity this brings than to their formal contractual status[27].

At EU level the standing of women is a regular part of the science policy agenda. From a human resources perspective it is important to have more women in research and especially in academia in senior positions and to realise the full potential of this human capital. It is also important to know more about bottlenecks in the countries of the European Research Area and to become responsive to the needs of the female researchers, different life and career concepts of women as well as equal playing fields. In connection with economic priorities, in which R&D&I play a key role, increased attention has been paid in particular to the inadequate representation of women in the natural and technical sciences as well as in decision-making positions. It is believed that with a higher number of women on scientific boards and selection committees, as well as with growing awareness for gender equality especially for women having different career paths, 'there will certainly be a positive impact'[28].

Some national governments have policies to enhance the academic careers of women, such as special research programmes for female researchers to develop their own research lines. A few examples of good practice will be provided in the section on European practices.

27 Fulton, O. & C. Holland. Profession or Proletariat: Academic Staff in the united Kingdom after Two Decades of change. In: j. Enders (2001) Academic Staff in Europe, Changing Contexts and Conditions. Westport: Greenwood Press, (2001), pp. 301-323.

28 European Science Foundation (2009) Research Careers in Europe. Landscape and Horizons. ESF: Strasbourg, pp. 36.

2.8 Policy recommendations

This report has identified some unsatisfactory characteristics of the current career structure in the Czech Republic, such as the skewed age composition and high age of academics in the highest ranks, low representation of women, low mobility and in-breeding of staff, and the relatively low remuneration of young academics compared to the average national salary levels. These aspects make it less attractive for young people to start an academic career. The causes of these issues have traditional as well as personal and structural dimensions. The very demanding and complicated nature of an academic career is an example of the latter.

The following recommendations in a priority order are aimed at counteract these shortcomings.

1. **Strengthen the role of HRM on the central institutional level.** Counteract the loose federative structure with decision-making powers at the lowest level by active HR policies regarding recruitment and careers and correcting current age and gender imbalances and in-breeding at all levels. Adherence to principles of open competition for positions and transparency of appointments and promotion procedures should be given particular attention.

   Our survey data show that about a third of all staff categories considered inadequate HR management as an important barrier for career opportunities. Czech HE institutions enjoy a large degree of autonomy and within general employment frameworks have extensive self-governing and decision-making powers. These powers have been further decentralised to the faculty and down to the departmental and research group level. Universities are loose federations and basically most decisions including human resources management and career advancement are predominantly taken at the lowest level.

   To counteract this fragmented structure institutions should develop more active HR policies with an important role attributed to HR policies on the central institutional level. Ways must be found to align career advancement with the particular strategic goals of the institution. The development of staff management systems that recognize and coordinate the contribution to university objectives of the work undertaken by all research units and by all groups of staff, will be instrumental in achieving these goals. The ASCR research institutes are because of their scope and independence more in a position to develop integral HR policies by cutting through the different research groups and interests, but universities should also make use of all the possibilities the system allows them. The principles of open competition for positions, transparency of staff appointment, and promotion and performance appraisal processes should be given particular attention. Adherence to these principles as laid down in the European Charter for researchers and the Code of Conduct for the recruitment of researchers would be relevant to establish better working and career conditions for researchers. These should be strongly applied at institutional level.

2. **Manage the academic career in a flexible manner.** Develop career plans that enable academics to develop their own strengths, create flexible career paths, joint appointments, junior positions that break through the current long hierarchical career ladders. These plans should be oriented to make the academic career more attractive to young researchers.

   On the international level there is increasing recognition that the prevailing career system based on academic reputation does not match the full range of functions of the academic workforce and should be expanded beyond the narrow confines of specialized research and publications. In the survey about half of the respondents in all staff categories indicate that academics of all ranks consider the current career development plans as too limited or not existing. This makes the case for developing career plans which would allow staff more freedom in the relative proportion of the different task components and to develop their own strengths, which may change over time. Staff can develop professionally by pursuing goals that are in accordance with the larger organizational and external environment. However, in the context of increasing academic entrepreneurship, it is important to ensure that entrepreneurial activities do not divert their attention and time from the core mission of the institution[29].

This flexibility includes the development of dual appointments and the introduction of professorships other than the standard functional professorships (or 'chair holders' in the West European context), for example professors who are highly qualified experts from practice and are affiliated with a particular organization or industrial partner.

The creation of flexible patterns can be used to break through the Czech system which attaches great importance to long career ladders with a number of hurdles to make the next career step. In some countries financial schemes have been set up with the aim to accelerate the maturity of young promising researchers. Such schemes support the separate steps of the research career in the four-stage career structure. This is a way to make the academic career more attractive to younger researchers as it provides career prospects and reduces the potential for patronage and over-dependency on a senior researcher.

3. **Apply more diverse criteria to assess and reward the performance of academics.** Performance assessment should not predominate, but should constitute part of a broader set of criteria, including the perspectives of individual staff and combined with staff development plans and training possibilities.

   In the Czech system the competition for resources is an important characteristic. This has implications for career structures and remuneration which is less tightly linked to academic rank and moderated by market forces and personal performance. Flexible rewards are the norm and salary differences can differ substantially between staff in the same rank. This also offers the ability to attract high-caliber (international) faculty.

   The assessment of performance reflects the principles of the evaluation methodology as an automatic driver for funding. This encourages researchers to focus on the quantity of publications and pushes them to fight (on points) against each other or multiplying the reporting of publications. A much heard criticism is that this one-sided focus is not a fruitful basis for collaborative and interdisciplinary research or for exploring new challenging areas.

   In general, quantitative aspects should count less when it comes to analyzing a researcher' track record. It was suggested that researchers should submit a very limited number of relevant publications or grants. Other views were expressed. For example at some research institutes a direct relationship between publications and remuneration is not made but constitutes part of a broader set of criteria. Practices were found of staff appraisal schemes in which not only the performance was assessed in terms of publications, but also the perspectives of individual staff were taken into account, their teamwork, their expectations and their development plans for the coming years.

29 See also OECD (2008), The Academic Career: Adapting to Change. In: Tertiary Education for the Knowledge Society – Vol. 2, pp.131-188.

Research evaluation by peer-review committees takes a diversity of criteria into account. These can be used for improvement purposes with a link to staff development programmes and training possibilities.

4. **Encourage research collaboration and interaction with external organisations.** Work outside the traditional academic framework, for example through staff exchange or adjunct appointment systems, should be recognized more in academic appointments and careers, and become part of performance appraisals and rewards. There should be no legislative barriers to prevent institutions from encouraging this.

   Several examples of fruitful collaboration between researchers from universities and ASCR were found, but also attitudes of competition and enviousness. Researchers who have a position in both organizations are mainly seen as doing this for their own career. In West Europe there is increasing collaboration between universities and research institutes and more 'institutionalised' forms are emerging. For example, in France the research centers with the label 'mixed research units' have been established as a recognized part of university life as well as a feature of the research institutes (CNRS). Such agreements enhance relationships and work in common among researchers of both types of organizations.

   Collaborative work with relevant external organizations including industry should be widened, for example in the field of staff exchange or adjunct appointment systems. Such collaboration has the potential to foster the professional currency of many academic staff. This topic will be discussed further in the component on co-operation between research institutions and industry, but it can be stressed here that work done outside the traditional academic framework should be recognized more in academic appointments and careers, and find a place in performance appraisals and rewards.

5. **Create greater stability for human resource policy**. Multi-annual research budget allocations rather than annual allocation of the budget would create greater stability and certainty in the policy environment for HE institutions.

   As said before the Czech research system is strongly based on competitive resources and budgets from the ministry. This has implications for recruitment and selection and staff development. Most of these budgets are on a yearly basis and together with the fact that these are competitive resources makes it very difficult to plan human resources.

   Multi-annual funding periods rather than the annual allocation of the budget would create greater stability and certainty in the policy environment for HE institutions. This would help to improve morale and confidence within the scholarly community.

3. Researcher mobility

3.1 Introduction

As part of the Human Resources in R&D&I work package of the International R&D&I Audit of the Czech Republic, the component on research mobility has three objectives:

1. To report trends of different aspects of researcher mobility in the country
2. To identify barriers and facilitators of researcher's mobility
3. To discern supporting measures to be introduced

Researcher mobility is a highly debated and important topic in the process of creation of the European Higher Education Area. Given that human resources in science, technology and innovation are critical to economic growth and that the global demand for talent has become increasingly competitive, European member states as well as European programmes have put forward policies facilitating international and inter-sectoral mobility of highly skilled professionals. The major rationale for international researcher mobility measures is on the one hand demand driven by demographic changes and at the same time supply is affected by the attractiveness of research careers. Further, researcher mobility is not just a supply issue –it facilitates knowledge diffusion and catch-up development. The position of Europe's open strategy on human resources in R&D has indicated that international mobility is beneficial for acquiring new knowledge and skills. The European Commission stresses brain circulation with an active mobility policy in the frame of enhancing Europe's attractiveness. The main issue is to profit from the traditionally mobile researchers and provide them with return opportunities[30].

Researcher mobility is understood as the geographical and inter-sectoral mobility of researchers aiming to broaden their professional skill base and to use the best career opportunities[31]. Studies have revealed the major characteristics of mobility. Mobility can be divided into international mobility (incoming and outgoing), inter-sectoral mobility and intra-sectoral mobility. The main characteristics of researcher mobility identified in the literature are the duration of the visit (permanent versus temporary, short-term vs long-term), geographical reach (local, regional or international), sectoral reach (mobility within one sector or inter-sectoral mobility), motivations for mobility, barriers and facilitators of mobility, the content of mobility (the transfer of knowledge or competencies) and the impact of mobility (on an individual researcher, organization or the national HE system)[32]. According to Ackers the factors facilitating researcher international mobility are scientific networks, individual motivation and willingness to take risks. Further professional autonomy, transparency of employment procedures and existence of career systems as well as financial benefits are important as motivating factors[33]. The study of Austrian mobile researchers in addition identify

30 Vis, C. European labour market for researchers. Europe's open strategy on human resources in R&D. Workshop on the International Mobility of Researchers, Paris: OECD 2007.

31 Ackers, L. Moving people and knowledge: scientific mobility in the European Union. International Migration 43 (5) 99-131, 2005; Millard, D. The impact of clustering on scientific mobility. A case study of the UK, Innovation 18 (3): 343-359, 2005.

32 Mahroum, S. Highly skilled globetrotters: mapping the international migration of human capital, R&D Management 30 (1):23-31, 2000. Morano-Foadi, S. Scientific mobility, career progression, and excellence in the European research Area, International Migration 43 (5): 133-162, 2005. Guth, J. and Gill, B. Motivations in East and West doctoral mobility: revisiting the question of brain drain" Journal of Ethnic and Migration Studies 34 (5) 825:841, 2008; Gill, B. Homeward Bound? The experience of return mobility for Italian scientists, Innovation 18 (3): 319-341, 2005.

33 Ackers, L. Internationalization, mobility and metrics: A new form of indirect discrimination? Minerva 46: 411-435, 2008

the following motivating factors for mobility: recommendations of colleagues working abroad, striving to improve one's own career (international mobility is understood as an important factor fostering the career), a wish to get a higher position and make a career abroad due to scarcity of academic positions in the home country's academic labour market, ambition to use better financial opportunities, seeking new experiences, prestige maximization though work with the top scholars in the top universities, top quality laboratories and infrastructures, different atmosphere and work conditions in the host country, attractiveness of the country or city and a wish to improve foreign language skills[34]. The impeding factors to mobility according to their study are: family reasons, unwillingness to go into the unknown, fear to loose the social benefits of their country, immigration laws, no possibility to employ one's partner in the host country, language barriers. Family reasons are one of the major factors promoting return to the home country. Researcher mobility in Europe varies per country and per discipline[35].

These studies have suggested that due to the huge variety of types of mobile researchers and given the difficulties in tracing them due to free movers, it is very difficult to quantify the trends regarding researcher mobility. Therefore, the available data on mobility is varied and sporadic. The European mobility programme evaluation however has shed some light on the mobility patterns in Europe. For example, the evaluation of the EU's scientific mobility programme, the Marie Curie fellowship programme has revealed that Italy, Spain, France, Germany and Greece are the five most important sending countries, contributing more than 75% of applicants under this scheme. At the same time, the UK is the most popular destination attracting 36% of applications, followed by France (20%), and Germany (10%)[36]. It is noted that the brain drain problem is serious both in Western European and Central-Eastern European countries. Studies have shown that the possible negatives for the sending countries are the lost productive capacity due to at least temporary absence of workers and students with higher skills, while the positives would include among others knowledge flows and collaboration, return of natives with foreign education and human capital, and remittances and other support from diaspora networks[37].

As noted in the literature, national governments can use a range of policies which may influence international and inter-sectoral mobility. Policy initiatives should involve coordinated and explicit strategies across ministerial portfolios. Concrete mechanisms may include economic incentives, immigration programmes, support mechanisms (e.g. housing, language training)[38]. For international mobility, the following policies may be effective: restriction, reparation, retention, recruitment, return and resourcing expatriates[39]. Many countries, for example, use retention policies like subsidies for researchers to participate in international projects, tuition wavers for graduates who work for a certain time in their home country or providing grants for incoming senior foreign researchers to build a laboratory and employ local junior researchers.

34 Kurka, B., Trippl, M. and Maier, G. Understanding Scientific Mobility-Characteristics, Motivation, and Location Decisions: A Study of Internationally Mobile Austrian Scientists and research Professionals, 2008. Available at http?www.esri.ie/research/research_areas/international_economics/dynreg/papers/WP30.pdf

35 Canibano, C. Otamendi, J. Andujar, I. Measuring and assessing researcher mobility from CV analysis: the case of the Ramon y Cajal programme in Spain, Research Evaluation 17 91), 17-31, 2008.

36 Kostelecka, Y., Bernard, J. Patockova, B. Kostelecky, T. How to Turn Brain Drain into Brain Gain. Policies to support return of researchers and scientists to their home countries. Prague: Institute of Sociology, 2008.

37 Dearing, A. International Mobility of Researchers. Workshop on the International Mobility of Researchers, Paris: OECD 2007.

38 Basri, E. The international mobility of researchers: recent trends and policy initiatives. Workshop on the International Mobility of Researchers, Paris: OECD 2007

39 Lowell, B.L., Findlay, A. Steward, E. Brain Strain. London: Institute for Public Policy Research, 2004.

Recruitment policies may include removal of technical and structural barriers. For example, these policies could include lower income tax, scientific visas, removal of work permit requirements or subsidized language courses. Return policy examples include information and financial instruments, such as sandwich programmes, fellowships requiring return, Internet portals and information points in the home country. For inter-sectoral mobility, tax incentives, funding schemes promoting public-private partnerships, national doctoral schools involving business and industrial partners could be examples of the policies aiming to enhance inter-sectoral researcher mobility[40]. As noted by an OECD expert, policies however cannot simply focus on monetary incentives, since human resources in R&D are attracted by wider support for science and innovation[41].

In the past decade Czech government support for researcher mobility in R&D was not very high on the policy agenda. The White Paper on R&D&I 2008 has identified low horizontal mobility of researchers and professional staff and insufficient migration policy as weaknesses of researcher mobility for R&D in the country. At the same time it pointed out the opportunity of the rise in the attractiveness of the Czech Republic for researchers and other experts from abroad. A major threat related to researcher mobility as indicated in the White Paper was brain drain and a barrier to brain gain due to low wages and lack of qualified labour in enterprises related to the development of production. The recommendations of the White Paper among others included systematic measures to create favourable conditions for arrival of researchers and experts from abroad as well as motivational measures to stimulate international two-way mobility of researchers and encouragement of two-way horizontal mobility between higher education institutions, other research organizations and enterprises. However, these measures were rather broad and did not include concrete tools to be implemented. A further document which indentifies research mobility as an important policy goalis the National R&D&I Policy 2009-2015 (Národní politika VaVaI v ČR na léta 2009-2015). Its goal 6 "Ensuring human resources for R&D&I" defines three core activities to be implemented by 2015 which are related to researcher international or inter-sectoral researcher mobility:

1. To create a system of post-doc positions filled through open public competition.
2. To launch programmes supporting participation of researchers (in particular doctoral students and young research workers) in internships at prestigious European as well as worldwide research institutions.
3. To promote placement of university graduates in applied research and innovation or hi-tech and knowledge-intensive sectors.

3.2 International mobility

International mobility is important for national economies today due to a number of reasons. First of all, facing international competition, knowledge economies need skilled workers. The demographic trends in many countries, such as low fertility and an aging population lead to increased demand for and decreased supply of workers. Further, specific sectors are chronically understaffed in some European countries, such as IT, natural sciences or medicine[42].

40 Borrell-Damian, L.Collaborative Doctoral Education. University-Industry Partnerships for Enhancing Knowledge Exchange. Brussels: EUA, 2000.

41 Basri, E. The international mobility of researchers: recent trends and policy initiatives. Workshop on the International Mobility of Researchers, Paris: OECD 2007.

42 Kostelecky, T. and Bernard, J. International Policy Approaches to dealing with Brain Drain. The Institute of Sociology of the Academy of Sciences of the Czech Republic. Prague: MISEP meeting of experts, 2008.

3.2.1 Policy context for international researcher mobility

Since 2005 the Czech government has adopted strategic documents aiming to facilitate the integration of immigrants in the Czech Republic.

International research mobility is regulated by the immigration laws in the Czech Republic. At present the system offers for longer than 30 days in a calendar year the following three options: a) a work permit/(temporary) residence permit. The maximum duration of the work permit is two years with a possible extension. The permit is provided by the Labour Office as stipulated in 92 par. 1 of the Act No. 435/2—4 Coll, on employment, b) by receiving a green card (only for citizens of 12 selected countries), which is issued by the Ministry of Interior (for high-qualified workers maximum three years with a possible extension of three years 3) an EU blue card, which is issued by the Ministry of Interior. The latter measure has been introduced from January 1, 2011 following the Directive 2009/50/ES implementation. This card is issued for the vacancies from a national database.

The Ministry of Labour and Social Affairs since 2003 has run a project to attract qualified experts from third countries and to test the possibilities of active migration policy: "Selection of Qualified Foreign Workers". Generally, it takes five years of uninterrupted stay in the Czech Republic (it used to be 10 years before 2007) in order to gain permanent residence. The advantages of this programme were to shorten the time to receive permanent residence for highly qualified workers. The participants of the programme (measure against brain drain) would get the permanent residence after 1.5 years. Together with project participants, their family members are also allowed to settle in the Czech Republic and to obtain permanent residence. The pilot phase of this project was 2003-2008 with 12 selected countries which was followed up with a standard project 2009-2010 with 51 eligible countries. Each participant after 1.5 years gets a recommendation from the Ministry of Labour and Social Affairs to the Ministry of Interior based on an evaluation of the achieved level of integration (assessment of employment, civil life, education and leisure activities). The project was terminated by governmental decree no. 880, in December 2010 for the period 2011-2013. The project did not receive as many participants as it was initially expected and with the budget cuts due to recession, restructuring of Ministry departments and changing political preferences the progamme was closed. In total during 2003-2010 the programme had 1, 964 participants out of which 159 were researchers. The majority of participants were IT experts and engineers/technicians. The top three nationalities were Ukrainians (550), Russians (331) and Byelorussians (180). In addition 1800 family members of participants were registered and in total 995 permanent residence permits were obtained (www.imigracecz.org, www.mvcr.cz).The main reason for termination as noted by the Ministry officials were that a new system of economic migration to the Czech Republic is 'under construction'. It is planned that all high-qualified workers will be given similar advantages like participants in the project, which means, a possibility to apply for permanent residence in a shorter period. The officials also noted that a new regulation being prepared although they did not have details about it at the time of the interview: 'A new system is being prepared. The goal of the new system is the facilitation of the possibility to obtain permanent residence in Czech Republic for qualified foreigners. But there are no details'.

In December 2007 the Czech Republic implemented the Council Directive 2005/71/EC on a specific procedure for admitting third-country nationals for the purpose of scientific research. Since then third-country researchers and their families can apply for a Scientific Visa. The Scientific Visa is available for public as well as private research organisations and applies to researchers hosted by the Czech research organisation for carrying out a research project (based on the Hosting Agreement). The advantage is a simplified procedure and shorter processing period for a long-term residence permit. An organisation wishing to join and to host third-countries researchers must apply for approval from the Ministry of Education, Youth and Sports - if approved it is listed in an official database managed by this Ministry.

Tax conditions for foreign scientific workers are the same as for the Czech employees, on the other hand the third-country citizens are disadvantaged regarding health and social security benefits (for example unequal specific conditions for family members who are not covered automatically by the working contract in the Czech system) - i.e. they usually must have private health insurance with higher premiums and lower benefits.

It seems that one of the key points of the public support programmes in the field HR for R&D for the next years is to increase internationalisation and mobility. As stated in "The Overview on the implementation of the National R&D&I Policy for the 2004-2008" (official attachment to the National R&D&I Policy for 2009 -2015) points out that the preparation of highly qualified R&D specialists cannot be organised without a satisfactory mobility and its support.

In 2009/2010 several funding programmes in the field of HR have been prepared by the Ministry of Education, Youth and Sports ("Action plan" for human resources):

- Mobility Support Programme - oriented on sending researchers on short-term internships to partner institutions
- Programme "Return" (called NAVRAT in Czech) - for researchers/specialists returning back to the Czech Republic after a stay abroad. Support to their re-integration into the Czech research institutions, continuity of the career.
- Program "ERC CZ" - indirect support to the realization of ERC grants - improving conditions and funding for realization of individual ERC projects at Czech research institutions. For projects that are positively evaluated in the ERC calls but do not obtain EU funding.

Recently, European Research Council (ERC CZ) and RETURN programmes have been approved for the period 2012-2019. ERC CZ aims to support frontier research projects which have been successful in the ERC grant evaluation but could not be financed directly by the ERC. The RETURN programme aims to create conditions for the return of excellent researchers to the Czech Republic. The programme aims to make international mobility easier by providing funding for new laboratory equipment for a returning researcher and financing a specific research team of 5-7 people. It is complementary to the OP EC. Especially in 2012 and 2013 it will be aimed at those institutions which are not covered by the OP EC, which means for the first two years it is targeted to the institutions in Prague.

Further, in March 2011, the Ministry of Education, Youth and Sports has increased the budget up to 60 mln Euros for the support measure 2.3 Human Resources in R&D Priority Axis 2 tertiary Education, Research and Development within the Operational Programme of the EU. The last round has been launched and will finish in April 2011.

Finally, the Ministry also considers programmes for better involvement of graduates in research and development in SMEs and continues the programme of grants for talented PhD students from third countries at public HEIs. It also continues the grants based on bi-lateral agreements with foreign countries and the support programme for short-term mobility. For example, bi-lateral agreements with Austria foster short-term institutional visits between the two countries.

3.2.2 Trends

The number of incoming foreign researchers has increased in the Czech Republic, especially for researchers from non-EU countries. However the attractiveness of a research career in the Czech Republic for foreign nationals is relatively low due to complicated administration of visas and the often non-competitive level of earnings compared to the average in the EU-15 countries.

National Statistics show, that in 2005 Czech universities and research institutes had 24 200 researchers who were Czech citizens and 942 foreign researchers. Out of the total number of foreign researchers, 413 work for research institutes and 529 for universities. Given, that researchers with Czech citizenship constitute 7 948 for research institutes and 16 252 for universities, it is possible to conclude that research institutes have more international researchers as compared to the total number of researchers working in this type of institution. In terms of the nationality of foreign researchers, the overall majority came from Slovakia (488), followed by Ukraine (79) and Russia (64). The interviews with the Euraxess centre showed that the most requests for information and assistance in 2009 came from Ukrainians, Russians and Indians. In total, looking at the occupation structure of employment of foreign nationals in 2008, among the professionals group, foreigners made up 4.4 % of all professional employees in the Czech Republic[43].

- International researcher mobility is perceived as important mainly for building networks and for new experiences
- Researcher mobility is usually based on personal networks and is a bottom up process
- Job advertising and hiring is not always an open process (Euraxess Centres' role is crucial)
- Incoming researchers are usually from outside the EU (besides Slovakia): Ukraine, Russia and India, the overall percentage of international researchers is higher in research institutes than universities
- Some research domains have to look for industrial partners abroad but access and real cooperation opportunities are limited
- Reasons for returning from abroad are mostly personal

10-17% of researchers with Czech nationality (n=339) live abroad as shown in the Kostelecky and Bernard (2008) study of researchers and PhD students of Czech origin who worked or studied abroad or who went abroad for a minimum of 9 months. Main destinations for Czech scientist migration were USA (51%), West Europe (43%) and other (6%). Within Western Europe, the most popular destinations are Germany, the UK, France and Switzerland. An important finding from this study has been that the probability of return decreases with an extended time of stay. Among the motivations to go abroad (n=333) the most important ones were: new experience (83%), increase of qualifications (57%), work conditions (43%), specific topics of research (38%) and increased income (33%)[44].

Among the main perceived benefits of a stay abroad (n=126) were acquiring new knowledge (83%), building of professional contacts (75%) and increasing professional language competence (69%).

3.2.3 Incoming international mobility

3.2.3.1 Barriers

The respondents from interviews and focus groups have indicated a number of barriers for incoming researchers in the Czech Republic. The barriers are somewhat different for foreigners coming to work in the Czech Republic and for returning researchers of Czech origin. As shown in the Kostelecky and Bernard (2008) study, the main barriers against returning to the home country are income, career opportunities and social milieu. The studied mobile researchers of Czech origin think that personal

43 National Training Fund (National Observatory of Employment and Training. The Competitiveness of the Czech republic –Quality of Human Resources. 2008-2009. Prague: National Observatory NTF Czech Republic, Research Centre for Competitiveness of Czech Economy, 2009.

44 Kostelecky, T. and Bernard, J. International Policy Approaches to dealing with Brain Drain. The Institute of Sociology of the Academy of Sciences of the Czech Republic. Prague: MISEP meeting of experts, 2008.

reasons would be the most important for returning to their home country (56%, n=112) while the main arguments against returning to the Czech republic are personal income (85%), career opportunities (48%) and social milieu in research in Czech Republic (46%)[45].

The main barriers for the incoming foreign researchers as revealed in the focus group discussion are the low level of academic salaries in the Czech Republic, complicated immigration procedures, bureaucracy and language barriers. Salary ceilings were mentioned as a strong barrier if institutions want to attract top scientists from abroad.

Interviewed researchers felt very strongly about the language barriers in fillingout the documents for foreign police, delays, and finding their way in the institutional bureaucracy in their respective institutions. Foreign language proficiency and professionalism in the human resource departments at institutions were questioned. Apparently there is not enough institutional support for the incoming foreign researchers at universities or research institutes (with some notable exceptions, as for example, witnessed from the interviews in the Institute of Chemical Technology, Prague, where the procedures for helping foreign researchers have been institutionalized). Interviews further revealed a lack of transparency in hiring procedures and openness of the labour market in the Czech Republic as a strong barrier for foreign highly qualified researchers. Quite a few respondents referred to the Czech science system as ‘a closed system –which means it is normal to study in the same place and country and to stay there’ (Senior Researcher, Research institute). The focus groups’ discussants thought that it is difficult for an outsider to ‘get into the system’ since many local academics are waiting for the higher positions in their institutions.

Further perceived barriers were employment of partners and social welfare for the families of incoming researchers. In general, uncertainty due to lack of continuity of contracts was perceived as a problem. Too much uncertainty is a big barrier for mid-career professionals with families who come from abroad. This could be part of the reason why in the view of focus group discussants the universities prefer short-term visits from top scientists and professors rather than hiring them long-term. In their view, the mobility policy and long term funding to attract foreign top scientists should take the dimension of continuity into consideration.

3.2.3.2 Facilitators

The main reasons to return for researchers of Czech origin are personal reasons, schooling of children, family, and cultural proximity[46]. National and institutional policies fostering ties with expatriate scientist networks abroad could help to attract this target group of qualified researchers. As noted by the Euraxess Centre, a number of facilitating factors such as services with Czech language training, facilitation with the visa procedures or institutional orientation could be helpful measures for foreign-born incoming researchers. Further, information provided via Internet sites and other means of communication about new openings, for example, was seen as helpful by the focus group discussants and some interviewees. Therefore, such initiatives should be fostered and financially supported. Here is a short overview of the centre:

45 Kostelecky, T. and Bernard, J. International Policy Approaches to dealing with Brain Drain. The Institute of Sociology of the Academy of Sciences of the Czech Republic. Prague: MISEP meeting of experts, 2008.

46 Kostelecky, T. and Bernard, J. International Policy Approaches to dealing with Brain Drain. The Institute of Sociology of the Academy of Sciences of the Czech Republic. Prague: MISEP meeting of experts, 2008.

The "Czech Mobility Centre" or as today it is called Euraxess Centre[47] was created in 2005 as a pilot project of the ASCR supported by the 6RP ERA MORE. From 2008, it is funded by the Ministry of Education within the EURPO programme. The mission is to help incoming researchers and Czech hosting research organisations in matters related to the scientific stay in the CR. It provides to incoming foreign researchers information about job opportunities in the Czech Republic, advice and assistance on visa procedure, social security, taxes and other practical aspects of everyday life in the CR. Currently the network is represented by two main centres and seven regional contact points. The Euraxess Centre is a step in removing barriers of international mobility. As before its creation, there was no such service centre, researchers could only count on help of the hosting organisations

3.2.4 Outgoing international mobility

3.2.4.1 Barriers

Main barriers both at universities and research institutes as mentioned by discussions in the focus group and interviews include policy, organizational and personal barriers. The key concern of most respondents was the lack of national strategy on how to attract talented academics to the country. In this respect, the absence of horizontal cooperation between ministries and different departments was emphasized, since the issue of mobility includes various spheres, such as education, social welfare, immigration and science.

Organizational barriers include restrictions to leave for a longer periods of time from universities or research institutes, administrative difficulties, and financial barriers which in the view of focus group participants results in the lack of long-term mobility. Financial barriers include a lack of matching funds and no long-term mobility grants. Only the example of a European FP 7 project in South Moravia was mentioned where the region provided matching funds to participate in the European project. As seen from the HR Survey of university deans and institute directors, 47.6% of public research organizations see the lack of funding to go abroad as a very strong barrier, compared to 33.3% at university faculties.

On the positive side, the survey results suggest that both universities and research institutes have only weak barriers in terms of foreign language knowledge and international contacts for outgoing international mobility (See table 7).

At the same time, the knowledge of foreign languages was not seen as a strong barrier for outgoing international mobility. From the HR Survey, 65.9% of research institute respondents who saw barriers for researcher mobility thought limited knowledge of foreign languages was a weak barrier, while 41,7% of university deans were of such an opinion. For the international contacts, only 20,5% of research institute respondents saw it as a strong barrier, while at universities, one quarter of the respondents saw it as a strong barrier. Thus, no international contacts is less of a barrier for research institutes than for universities, which may mean that research institutes are more active in networking with their foreign colleagues than university faculties.

47 Czech Mobility Centre/Czech EURAXESS Centre (www.euraxess.cz)

Table 7 Barriers for international R&D staff mobility (%)

Barriers	At Universities				At PROs			
	Weak	Medium	Strong	N	Weak	Medium	Strong	N
No funding to go abroad	37,5	29,2	33,3	24	28,6	23,8	47,6	42
Limited knowledge of foreign language	41,7	37,5	20,8	24	65,9	11,4	22,7	44
No international contacts	45,8	29,2	25,0	24	68,2	11,4	20,5	44

Source: CHEPS HR Survey

The main concern for interviewed researchers as well as focus group participants however was the anxiety of losing their job after the departure to an institution abroad. This was seen as a main obstacle for long term outgoing mobility. Researchers are afraid to lose their positions. This was mentioned especially in the case of public research organizations, as research institutes are not necessarily willing to keep the positions waiting for long and there is no tradition of sabbatical leave. They also contended that institutions would not like qualified people to leave. Some respondents pointed out that it also very much depends on the manager of the institute. Partly due to this, most respondents were interested in short–term mobility (less than three months). However, such short visits abroad were not seen as optimal to gain experience in working on research projects. As indicated by half of the respondents in the HR Survey in both university faculties and research institutes, institutions provide support for short travel abroad to increase academic networks, such as attendance of conferences. As seen from the table 8, more than 50% of respondents from both types of organizations have indicated that they provide funding to go to international conferences (table 8).

Table 8 Availability of institutional financial support to attend conferences (%)

University vs. Research Institute		Frequency	Valid Percent
University	Yes	13	54.2
	No	11	45.8
	Total	24	100.0
PROs	Yes	26	36.0
	No	24	64.0
	Total	50	100.0

Source: CHEPS HR Survey

Provision of information about possibilities for mobility was seen as important but not necessarily well developed. The HR Survey shows that 54% of respondents in university faculties thought consulting on mobility was available, while in research institutes only 36% of respondents were of this opinion, which indicates that consulting on financial opportunities for mobility is less available at the research institutes than at universities (see table 9).

Table 9 Institutional consulting about mobility funding schemes (%)

University vs. Research Institute		Frequency	Valid Percent
University	Yes	13	54.2
	No	11	45.8
	Total	24	100.0
PROs	Yes	18	36.0
	No	32	64.0
	Total	50	100.0

Source: CHEPS HR Survey

This maybe partly due to the fact that universities have international offices, while institutes are usually smaller organizations and do not as a rule have officers specializing in internationalization.

Another organizational barrier indicated by interview respondents from universities was related to teaching. Teaching workloads and responsibilities were seen as a constraint since it is difficult to find a substitute for teaching, or to get an exemption from teaching in a particular semester. This was especially true for junior academic staff who teach in English –since their teaching is more difficult to substitute due to varied levels of knowledge of English among the academic staff at universities and among different generations of academic staff. Sabbaticals are not a common practice and 'research leave' is very difficult to achieve.

A range of personal reasons preventing international mobility was also mentioned both in the HR survey and in the focus group discussions and interviews. The reasons were related to family, mortgages, and the need to settle down.

Lastly, culture and tradition play a strong role in preventing long-term outgoing international mobility. HR Survey respondents noted the conservatism and lack of dynamism in the higher education system. Focus group discussions revealed that inbreeding is rather high in academia, "people stay there until they die". Respondents thought that the higher education system in the Czech Republic is reinforcing this historical pattern, where there is a long line of researchers waiting for a particular position, thus it is very difficult to go abroad and 'lose' one's place in the line. As noted by the Euraxess Centre respondent:

> *"The mindset has to change. There are some developments- people who return have their group and are stimulating their people to go. While the tradition won't let them go – and if juniors are not motivated by seniors to go –they won't".*

3.2.4.2 Facilitators

Despite numerous barriers to outgoing mobility, there are a number of facilitators as revealed from the data. Universities and research institutes already have increased international collaboration networks and visibility. This is a positive development taking into consideration that all interviewed incoming researchers noted that they came into the Czech system through personal contacts.

The participation of the staff in mobility schemes and international projects has increased. For example, due to CZ CERN programme and CERN internal funding – interviewees noted that around 200 Czech origin researchers are in one or other capacity working in CERN and participating in experiments there. The participation of

Czech research teams in the EU Framework programmes has also been increasing (it had a 16-17% success rate in FP6 programme)[48]. A further example of a European mobility-funding source is the Marie Currie or European Research Council grants. The grantee of a Marie Curie scholarship noted that her salary is satisfactory. She noted that "Marie Curie grants are fine wherever you go and in Czech Republic the salary is higher than a professor's salary in the Czech university" (Postdoc, University). ERC grants can be a big facilitator to bring in internationalization in laboratories and institutions. Recently, the Czech government has signed the agreement for the ERC CZ grant and RETURN grants–which is a positive step towards providing longer term funding for researchers. Further, interviews revealed the Regional Reintegration Fund to be a good example of an initiative at the regional level to support international mobility. More concretely, the example of the South Moravia region, which provided 60% of matching funds to participate in the FP7 programme, was mentioned as an exemplary model to follow for other regions to attract highly qualified scholars.

At the organisational level, universities mostly have international offices that provide information on mobility opportunities not only to students but also to staff. Further institutions as well as the government and the ASCR provide some funding for short-term mobility, such as conference attendance. As noted earlier, already some examples are seen in institutionalized counselling and help for incoming researchers with visa procedures and language problems. Focus group discussion also revealed that institutions in general are willing to host international scholars and expatriates who can teach for a short period of time. However, the lack of resources in terms of salaries has been a dominant theme: 'they will have you if you are willing to work for free'.

3.3 Cross-sector researcher mobility

3.3.1 Policy context for cross-sector researcher mobility

The importance of research-industry R&D co-operation is emphasised in most national strategic documents. It is addressed also by concrete measures of the National Research, Development and Innovation policy 2009-2015.

Nevertheless, there have been national programmes supporting industrial R&D, which provide direct support to private-public R&D collaboration between research institutes and private sector enterprises, as for example, the TANDEM programme administered by the Ministry of Industry and Trade. The IMPULS programme, administered by the same Ministry, is complementary to the TANDEM. The programme provides support to R&D with a strong focus on projects with a short-term application and commercialisation potential. This programme was followed by the TIP programmes, which does not necessarily require cooperation between industry and universities, but allows for it. As seen from some examples, public research institutions that were active in TANDEM and IMPULS continue in a similar manner to collaborate with industrial firms under the TIP programme as well. Strengthening collaboration between public research institutes and private sector is emphasised as one of the main goals of the programme Alpha and the programme Centres of Competence operated by the Technology Agency.

An opportunity for improving knowledge circulation between the public, university and private sectors is related to using the Structural Funds. During 2004 - 2006, a total of 16 science and technology parks, 20 incubators, and 11 centres of technology transfer were granted financial support from PROSPERITA programme of the Operational Programme Industry and Enterprise. Currently, there are around 15 centres for technology transfer in the Czech Republic. The majority of these centres operate within universities or specialized intermediary organizations. The majority of

48 Albrecht, V. and Vanecek, J. Assessment of Participation of the Czech Republic in the EU Framework Programmes. Prague: Technology Centre of the Academy of Sciences of the Czech Republic, 2000.

science parks, business incubators, technology transfer and innovation centres in the Czech Republic are associated in the Science and Technology Park Association (SVTP). Currently, according to the SVTP database, there are 13 accredited science parks in the Czech Republic, 22 non-accredited parks and 13 other parks being prepared. However, quite a number of these science parks are mainly focused on leasing office space without providing other business services. From this point of view, innovation businesses would appreciate especially technology transfer services, contact mediation and advice on IPR issues.

The programme KLASTRY (Clusters) represents another tool supporting inter-sectoral R&D co-operation and is funded from the Structural Funds. The programme is aimed at creating formalised alliances among enterprises, higher education/research organizations and other entities (e.g. regional authorities). Another programme managed by the Ministry, the PROSPERITA (Prosperity) programme provides support to R&D projects of businesses as well as universities or public research institutes.

Within the OP R&D&I, the Priority Axis 3 “Commercialisation and popularisation“ is also very relevant for the improvement of knowledge circulation. The objective is to support the use of research results by establishing technology transfer points and offices in research institutions, or the creation of instruments to fund the proof of concept stage for technologically-based projects. The allocation for the priority axis is €250m, i.e. 10 % of the OP budget. The first Tecnology transfer offices could be supported through this programme from the second half of 2011 / beginning of 2012.

In 2009, the MEYS launched 7 “individual national projects” improving the tertiary education and R&D&I systems in the Czech Republic. These projects are financed through the OP Education for Competitiveness. One of them, “EF-TRANS” aims at setting up and bringing into effect knowledge transfer between R&D institutions and industry. A simple system of knowledge transfer is being created, with a special accent on patent and licenses applications, intellectual property, spin-offs and active cooperation between research institutions and industry.

3.3.2 Trends

Inter-sectoral mobility between public research organizations (including universities) and businesses has been a long-lasting weakness of the Czech R&D system. Very weak linkages between business and public research are reflected in a low share of private resources in GOVERD and HERD – in 2009, the business sector had a 9.8 % share in GOVERD (€49m) and only a 1.1 % share in HERD (€4m). Compared with highly developed countries, a very small number of spin-offs has been set up at universities and public research institutes.

Human resource mobility between sectors has been limited, since as noted by respondents in interviews and focus groups, it is difficult to ensure an academic career if one leaves for business and industry. The example of successful entrepreneurs who left academia shows that often for financial reasons, former academics who are successful entrepreneurs do not intend to come back to academia full time. At most they do occasional teaching.

In general, inter-sectoral mobility depends highly on the discipline and the industrial sector. Some fields more than others have been active in collaborations using the ministerial funding schemes, such as TANDEM, IMPULS or TIP; these include material sciences, biochemistry or nuclear energy.

3.3.3 Barriers

The movement of R&D staff from university or public research institution to private sector R&D or manufacturing is limited. HR Survey data shows a number of barriers for the inter-sectoral mobility of academics and researchers. According to respondents at universities, 50% think that a strong barrier for inter-sectoral mobility is linked to inbreeding. It is easier to be promoted staying at university and one third of the respondents think, that this is a weak barrier for inter-sectoral mobility. In the research institutes 33,3% of respondents perceive it as a strong barrier, and 35, 7% perceive it as a weak barrier. A further barrier, which is perceived as strong by 42,1% of research institute respondents, is related to the lack of contacts in different sectors. At universities, this barrier is perceived as strong only by 26% of respondents. In universities in fact nearly 40% of respondents think that "no contacts between different sectors" is a weak barrier. Finally, "no career opportunities in other sectors" is perceived as weak, medium or strong by nearly a third of respondents. However, there is a slightly higher percentage thinking that it is a strong barrier compared to those who think it is a weak barrier (see table 10). These findings confirm the views expressed in the focus groups, which indicated the barriers for academic career progression in the case of exit to industry and limited contacts with industry (especially in some fields where industry is limited in the Czech Republic such as in life sciences).

Table 10 Barriers for cross-sector R&D staff mobility in the Czech Republic

Barriers	At Universities				At PROs			
	Weak	Medium	Strong	N	Weak	Medium	Strong	N
No career opportunities in other sectors	28,6	38,1	33,3	21	33,3	30,8	35,9	39
No contacts between different sectors	39,1	34,8	26,1	23	26,3	31,6	42,1	38
Easier to be promoted staying in one organization	29,2	20,8	50,0	24	35,7	31,0	33,3	42

Source: CHEPS HR Survey

Other identified barriers from the researcher's point of view include the differences in the duration of projects between industry and academia, which limits for example, linking industrial projects to PhD projects. The unpredictability of business and markets has been indicated as another important reason. For example, one institute director indicated, that out of 9 projects with industry through IMPULS, TANDEM and TIP funded by the Ministry of Industry and Economic Affairs, five projects had to have the work plan changed due to withdrawal the industrial partner. This was either due to unrealistic profit expectations of an industrial partner, or due to the inability to meet the obligations of matching funds as promised from the side of an industrial firm. None of those projects however included exchange of human resources.

The focus group discussions with R&D entrepreneurs have revealed a number of perceived barriers from the point of view of industry for inter-sectoral mobility. The most common concern was the difference in the worlds of academia and industry in terms of work speed and targeted problem solving. The preparation of graduates was a concern for entrepreneurs, since in their view PhD candidates and postdoctoral researchers lack soft skills, problem solving capabilities and entrepreneurial spirit. In their view, the graduates have to be trained in the companies when they start working in order to be able to adapt to the pace and specificity of work in a particular company.

3.3.4 Facilitators

The HR Survey reveals that institutions can facilitate the cooperation of R&D staff with different sectors. For example, 62,5% of university deans in the sample have indicated that they provide information on cooperation with business. This high percentage shows the willingness of the deans to engage their academic staff in cooperation via project work and student training. The institute directors, however, have much lower inclination to do so – only 26% of them have been providing information to their researchers about possibilities to collaborate with industry (see table 11).

Table 11 Organization provides information on cooperation opportunities with business (%)

University vs. Research Institute		Frequency	Valid Percent
University	Yes	15	62.5
	No	9	37.5
	Total	24	100.0
PROs	Yes	13	26.0
	No	37	74.0
	Total	50	100.0

Source: CHEPS HR Survey

Provision of information is not the only possible facilitator at the organizational level. The availability of matching funds for collaborative research projects is another important incentive used by universities and research institutes. As seen from the HR Survey, in both types of institutions only about 40% of respondents think they provide matching funds for collaboration. This indicates a rather low level of co-financing of collaborative projects, thus, this incentive mechanism is not fully used (see table 12).

Table 12 Organization provides matching funds for collaborative research projects (%)

University vs. Research Institute		Frequency	Valid Percent
University	Yes	10	41.7
	No	14	58.3
	Total	24	100.0
PROs	Yes	21	42.0
	No	29	58.0
	Total	50	100.0

Source: CHEPS HR Survey

Finally, another facilitator for inter-sectoral mobility as identified in the literature is temporary leave from a research organization to go and work in a company. As shown by the HR Survey, the practice of temporary leave is not prevalent at universities and research institutes. Similarly as was previously seen in the case of international mobility, the concept of sabbatical leave is not institutionalized (see table 13).

Table 13 Organization gives temporal leave to work in another sector (%)

University vs. Research Institute		Frequency	Valid Percent
University	Yes	4	16.7
	No	20	83.3
	Total	24	100.0
PROs	Yes	8	16.0
	No	42	84.0
	Total	50	100.0

Source: CHEPS HR Survey

However, some examples of research leave could be found, especially among well-established scholars. This can be exemplified by a story of a nuclear physicist who in fact had a one-year leave from his research institute to work as a consultant in industry. In his view his case was exceptional basically due to the fact that he is a renowned and established researcher, who has published in top journals, has worked at a research institute for many years and is very much appreciated by his colleagues. He negotiated one-year leave with his research institute director. However, since he wanted to prolong his contract with the company, he had to quit his position at the research institute.

3.4 Inter-institutional mobility

There is a long-standing collaboration between institutes and universities; most of researchers working at institutes are the graduates of those universities and they still teach at universities. At the same time, university academics like to use the equipment available at research institutes. As indicated in the focus group discussion, universities in the Czech Republic do not have strong research groups, experience and tradition in experimental research compared to the research institutes. But at the same time they are evaluated based on the number of publications and they want to be involved in research, thus collaboration with the institutes is helpful.

Besides the traditional long-standing links of research institutes with partners in their disciplines in the main universities (which can be seen by a high amount of collaboration in national R&D funding project partnerships), also new types of collaboration are established with regional universities (e.g. University of Olomouc coordinated MedChemBio Cluster, which includes partners from industry and Institute of Organic Chemistry and Biochemistry in Prague). For research institutes it is sometimes easier to collaborate with smaller universities (the University of Chemical Technology is an example), than with an old established university which is bureaucratic and all legal procedures due to its size are extremely lengthy. An example provided was Charles University, where every contract has to be signed by the Rector. All interviews and focus group participants have indicated that both old and new collaborations and mobility depend completely on individuals.

The interviews with university academics and research institute scientists revealed a close collaboration between these institutions, especially in externally funded projects and PhD students working part-time in the institutes and doing their PhDs at universities.

Due to these historical conditions, mobility of young PhD graduates to institutes is rather high. However, as indicated in the interviews, it is not common to move from one university to another or to collaborate between two universities, especially those having similar disciplines – since they are usually competitors. It is also highly unlikely for an academic to move from a more prestigious institution, such as Charles University to a lower prestige institution outside Prague.

3.5 European good practices

Availability of funding is a crucial factor fostering or hindering mobility. Decisions to become mobile as seen from the Pan European study was related to the possibility to obtain funding for own research (IDEA Consult, 2010). This a major fact for non-mobility decisions among the non-mobile researchers. More than half of the non-mobile researchers have mentioned the inability to obtain funding for research as an important hampering factor for mobility. A further important factor for mobility was language.[49] This study also found that in terms of motivations to return, the main reason for the EU researchers to return from the US have been personal reasons.

In Europe, three fourths of the studied researchers in the European wide survey have always worked in the public sector. Another 10% is currently in the public sector, but with a different history (either from the public sector via the private sector and then back, or from the private to the public sector). Overall, 85% of researchers in all regions are currently employed by the public sector. Only 3% have always worked in the private sector, and another 3% is currently working in the private sector but was formerly in the public sector. This means, that the large majority of the studied researchers in Europe have not been participating in the cross-sector mobility, which is in line with the situation in the Czech Republic.

In Europe, the promotion of researcher mobility has been facilitated both at the policy as well as institutional levels. National governments either through ministries or research councils have been promoting mobility through a variety of grant schemes. This includes short-term and long term visits abroad, for example. Schemes facilitating postdoctoral stays abroad can be seen as a good example. In the Dutch context, the Netherlands Science Foundation (NWO) administers a programme as part of its researcher mobility programmes called Rubicon[50]. It funds recent PhD graduates from the Netherlands to go to a top research university or institute for a period from 12 to 24 months to expand the area of expertise and to increase the networks. The grantees are obliged to return and work in the Netherlands upon the completion of the grant. The amount of the grant corresponds to the monthly salary of a researcher in the Netherlands.

Institutional vision, strategy towards researcher mobility and concrete action lines may significantly enhance the attractiveness of institutions to foreign top researchers.. The focus leadership approach towards researcher mobility in the research organization or university means increasing administrative capacity and professionalizing administrative staff to facilitate researcher mobility. One example of European best practice in this respect is the University of Oslo's recent project "International research in focus (Ifif)", 2006-2010[51]. In 2006, the management of the University of Oslo decided to prepare a holistic approach to the reception of foreign researchers at the university in order to support the strengthening of their international research standing. Given that the university was receiving 1000 researchers from abroad, and 25% of their researchers were foreigners, the facilitation of their reception has become a big logistical undertaking. The holistic concept for reception of the foreign researchers was developed and endorsed by the university leadership in 2008. This meant that a number of measures were incorporated in the human resources department activities. Measures implemented at the central university level include assistance via a helpdesk for international researchers and hosts, website for international researchers, a foreign researchers housing provision scheme, Norwegian language courses for foreign researchers and their spouses, social and cultural events for foreign researchers, an institutional database of the citizenships of foreign researchers, and competency building at the central, faculty and departmental levels regarding the implementation of the project. The initiative of the Ifif project facilitated the creation of the Euraxess local contact point in 2009 at the University of Oslo which shows the level of professionalization of this university in the area of internationalisation in the European context.

49 IDEA Consult study on mobility patterns and career paths of EU researchers. Final Technical Report 3: Extra-EU mobility pilot study, 2010.

50 NWO Rubicon programme: http://www.nwo.nl/nwohome.nsf/pages/NWOP_6H2G7R

51 Available at University of Oslo: http://www.uio.no/english/for-employees/organization/ifif/index.html

Another good European example of institutional and regional cooperation to attract highly skilled talent is the Catalan Institution for Research and Advanced Studies (ICREA)[52] in Spain. It is a foundation supported by the Catalan Government and guided by a Board of Trustees. It was established in 2001 to recruit top scientists for the Catalan R&D system in order to boost Catalonia's competitive position. The ICREA initiative, operating in consort between the universities and the Catalan government, is a dedicated head-hunting and recruitment agency to identify high quality people to come to work in Catalonia – whether of Catalan/Spanish origin or not. Unlike similar schemes in other countries, the positions are for permanent full-time positions funded from the public purse.

Successful candidates must be capable of leading new research groups, strengthening existing groups, and setting new lines of research on the right track. ICREA has hired a total of 249 researchers in different areas of research up to 2010: 31% in life and medical sciences, 28% in experimental sciences and mathematics, 11% in social sciences, 15% in humanities and 15% in technology. The programme has been able to attract these researchers with a contract system differentiated from university civil service conditions and with considerable flexibility (recruitment, salary, conditions of service, etc.).

ICREA brings to the Catalan innovation system top researchers who play an active role in the university. They collectively attract more than their costs in research funds from outside the region. ICREA researchers have higher average publication rates than researchers in Catalonia in general. They have also applied for 42 patents since 2004 and launched 3 start-up firms. In the OECD review opinion (2010), the ICREA programme represents a highly innovative new approach in the Spanish higher education and science system.

3.6 Conclusions and recommendations

Promoting human resources in R&D through researcher mobility and building the human capital of Czech science system is extremely important. The study of researcher mobility has indicated the following current strengths in the system when it comes to promotion of mobility:

- Researcher mobility is on the R&D policy agenda
- Strong family relationships – a strong reason to come back to CR
- Some good examples of human resources cooperation between universities, research institutes and industrial enterprises (e.g. Material Sciences, Aeronautics, Chemistry)
- It is common for researchers from institutes to work at universities and vice versa – there are possibilities to build on existing networks in both types of institutions and profit from them for mobility purposes

However, due to the historical path-dependencies as well as socio-economic developments, differences in cultures between science and industry as well as demographic realities, there are a number of weaknesses that may be identified:

- Bureaucratic procedures for immigration coupled with low professionalization of HR staff at institutions
- Relatively low salaries and salary ceilings

52 OECD Higher Education in Regional and City Development. The Autonomous Region of Catalonia. Paris: OECD, 2010; : ICREA (Institución Catalana de Investigación y Estudios Avanzados) (Catalan Institution for Research and Advanced Studies), Available at www.icrea.cat/web/home.aspx

- No explicit strategies for promotion of researcher mobility in the institutions, especially no promotion of cross-sector mobility
- No coordination between ministries regarding promoting international and cross-sector researcher mobility
- No tradition in cooperation between academia and industry in human resources, different perceptions of work styles
- Limited transparency in hiring procedures and limited inter-institutional mobility
- Language barriers for incoming international researchers

Based on the above limitations and given the context of Czech R&D&I system, the following recommendations are proposed in the order of importance

1. Create an explicit inter-ministerial strategy and action plan on how to coordinate immigration (visas and permits), pension schemes and mobility promotion activities both at universities and ASCR research institutes.
2. Stress the human resources dimension in university-industry collaboration schemes besides infrastructure development and the creation of technology transfer offices.
3. Increase the transparency of hiring in the R&D system via requirements to advertise the new positions nationally and internationally in media and on the Euraxess jobs and other international portals.
4. Use a comprehensive approach to attract foreign top researchers as well as expats back to the Czech Republic by combining financial and 'soft' mechanisms – support to families, housing, institutionalised help with visas, residence permits (e.g. translation services at the institutions within the international offices).
5. Create subsidies for Czech academic staff to go abroad for longer periods (post-docs) with the requirement to return to the home country upon completion of the programme.
6. Professionalise international relations office staff to facilitate advising researchers on mobility opportunities and facilitating transition for incoming researchers.
7. Market Czech Republic R&D system's strengths and institutions internationally; pro-actively recruit people in the domains which are crucial for the future.
8. Support further and expand the Euraxess Centre in the Czech Republic.
9. Provide Czech language courses to foreign researchers working at universities and ASCR institutes as part of the integration portfolio.

4. Doctoral training

4.1 Introduction

The present system of doctoral education in the Czech Republic emerged from the system of scientific training established in the 1950s according to the Soviet model in which the ASCR played a central role. The research training involved a kind of employment in a research institute of the ASCR. The content of this form of scientific training was practically identical with doctoral training elsewhere, including the defense of a doctoral thesis. Graduates in this system were awarded the degree of "Candidate of Sciences '(CSc.) by the Commission for Scientific Degrees.

Since 1990 universities are legally allowed to provide doctoral education and to award the degree of "doctor". This "dual system" of scientific and academic degrees lasted until 1999 when a shift took place in the direction of universities that obtained the full responsibility for doctoral education and were entitled to award the degree. However, the research training capacity of the ASCR persisted and nowadays there is much collaboration between universities and research institutes of the ASCR in providing doctoral programmes. Students can undertake a part, and sometimes a major part, of their doctoral research at a research institute. In this case they remain officially registered at the university, which is also entitled to award the doctoral degree.

This section is organized as follows. First the main characteristics of doctoral education in the Czech Republic will be reviewed. These concern the structure, the funding, the recruitment of candidates and the relationship between universities and ASCR institutes. Next some aspects of the doctoral process will be discussed on the basis of our surveys and the interviews. This is followed by an overview of the major strengths and weakness of doctoral education. The findings will be placed against current European developments regarding doctoral training. The section concludes with a number of policy recommendations.

4.2 Characteristics of doctoral education in the Czech Republic

4.2.1 Structure and form

The most common form of doctoral education in the Czech Republic is what internationally has been termed the "apprenticeship model" of the student-supervisor relationship. Doctoral students enroll with a professor as supervisor to work on a highly focused research project predominantly on an individual basis. In the HR Survey more than 80% of the respondents indicated that doctoral studies are individually organised. Structured programs do occur to a much lesser degree, more than 35% indicate that such structured programs are very seldom offered.

This is related to the strong decentralization of Czech higher education where all the major decisions concerning recruitment, content of the doctoral education, and qualification criteria are determined at the faculty and more often at the departmental level.

Such a strong individualized system, however, does not imply that any structure is lacking. On the contrary and although there are differences between institutions, disciplines or subject fields, there are some common elements underlying most doctoral studies.

At present doctoral studies have been accredited as three-year or four-year programs (the latter for mainly in the technical disciplines) on a full-time or part-time equivalent basis. Part-time or 'combined' students are those who are employed elsewhere and wish to obtain a doctoral degree and usually can take a longer period.

Commonly students have to follow a sequence of activities:

- Study part consisting of a number of compulsory courses, a selection of optional courses, language course (non-Slavonian language). All these courses have to be completed with an examination
- Sate doctoral examination
- Scientific training: participation in a scientific research project followed by defence of a dissertation.

Topics for doctoral research are normally issued by supervisors and discussed and approved by Boards of Study Programmes and the Scientific Board of the faculty concerned. It is possible that students suggest their own topic, but it is common that for a student to be eligible for funding these have to be related to the research grants available or the programmatic aims of the professor or research group. Most often topics are listed by (potential) supervisors.

Although a doctoral programme as such does not exist, students in principle have their individual study programmes (ISP) as agreed between the individual student and the supervisor. These ISP's contain the research topic, the courses and other obligations during the trajectory. The study part of the ISP is complete when they pass the intermediate examination and the state doctoral examinations successfully.

The committee for the state doctoral examination and the defense of the thesis can be composed of both researchers from the ASCR and from the HE institutions.

Students who are not able to finish their dissertation in the normal time can continue in the combined study path. The only obligation they have is to complete all the examinations, to finish their dissertation and to publish their results. Data are shown in the following table:

Table 14 Development of total number of doctoral students, presence and combined study paths

	2004	2005	2006	2007	2008	2009
Presence PhD students	331	445	419	454	436	463
Combined/ distant studies	1300	1380	1514	1674	1728	1654

Source: Technology Center.

Current legal regulations neither require nor clearly support the participation of doctoral students in the work of their home university, although in most of the cases students do work in the sphere of teaching and research (including laboratory work, carrying out complicated calculations, experimental work, the 'pedagogical practice' involving teaching some courses per semester). This is seen as an important part of their training for their academic career and to obtain teaching experience in laboratories and undergraduate courses.

The scientific training consists of active participation in a research project, state doctoral examination and writing the dissertation. Doctoral students who do their research work at an institute of the ASCR have to meet the same requirements as the other students, they also have to pass the same state examinations, although they may spend the larger part of their studies at the institute for their experimental work.

Another requirement is that candidates are obliged to publish at least one scientific article in order to obtain a PhD. Of all directors questioned in the survey 85% of the university directors indicated that this is the case, whereas 74% of the directors of AS institutes stated that this is required. Some departments ask for three publications or two publications in high impact journals, one of them as a first author of a major paper. For several students this is a heavy burden and may lead to a delay of the doctoral process.

4.2.2 Funding

The financing of doctoral education is based on a variety of resources. The major part comes from the state budget as a formula-based grant to institutions (a sum of a per capita subsidy and a research subsidy that is based on research performance measurements). Most respondents do not consider this as a sufficient amount and emphasise that additional government budgets are very important.

Other sources are domestic grant agencies as well as other grant sources, the internal grant agency at the university (also existing on faculty level), contributions from industry and occasionally sponsorships.

Students receive their income from the institution in the form of doctoral scholarships. Other sources such as business, industry and foundations play a negligible role.

How the institution divides the funds available for doctoral students is dependent on the number of students, number of professors and the research output of the faculty or department. Institutions are free to vary the amount of the scholarship, for example for different years of study, or related to individual assessments. It appears that institutions make use of this flexibility to provide extraordinary doctoral scholarships or extra bonuses to reward excellent students or to motivate them to achieve high performance, for example for publishing an article in a foreign journal, or organizing scientific activities.

4.2.3 Recruitment and selection of doctoral students

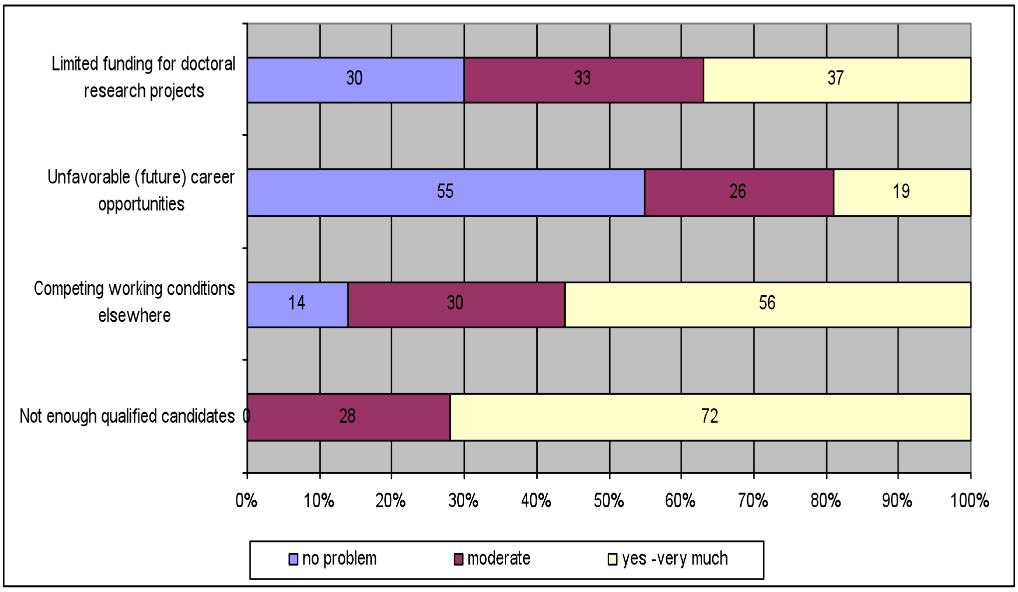
When applying for a PhD position very standard admission procedures exist. This includes interviews about motivation and capability, CV, and the quality and topic of the MA thesis. The potential supervisor c.q. the research group concerned has often a decisive say in the admission committee that makes a recommendation to the dean for a formal decision.

In addition it is not uncommon that additional criteria are used to assess the suitability of the candidates, such as mathematics and physics testing, oral examination or a presentation to the selecting committee or the PhD Board of Study Programmes. In a few cases mention was made of candidates who had to submit a research plan or write a research essay as a basis for their research including a theoretical background and appropriate methods. Potential doctoral students sometimes work some time with their potential tutors to assess their potential for doing doctoral research before actually entering the programme.

Last but not least, for most programmes a language test (mainly English) is part of the admission procedure. These highly selective admission criteria suggest that the number of applicants may well exceed the positions available and that the institution can select the most suitable candidates.

Given this highly selective admission system we asked in the questionnaire to directors/deans whether the institution is able to attract sufficient qualified candidates and to what extent they have difficulties in finding them. Figure 7 summarises the main problems.

Figure 7 Major problems to find suitable doctoral students (%)N= 74.



Source: CHEPS HR Survey(question on 5-points scale, 1 and 2 combined (no problem) and 4 and 5 (yes – very much)

It appears that finding enough qualified candidates is a major problem, also strongly confirmed in the different interviews. Generally, only a few candidates announce themselves and the wish was expressed to attract more to choose from.

Also the competing working conditions elsewhere were felt as an important obstacle to find suitable candidates, only 14% indicated this as not being a major problem. Regarding the funding available for doctoral research projects the different views on whether this is a problem or not seem to balance.

Unfavorable (future) career opportunities were seen as least problematic. Presumably there is much confidence that those who are able to finish their dissertation have favorable career opportunities within the science & research system, or if not find employment elsewhere. This is confirmed by unemployment rates that are negligible for PhD holders and which compared to other educational levels are very low.

A very persistent feature in the current system is that universities attract the majority of their students from their own undergraduate programmes. Exact figures were not presented, but at several locations it was estimated that about 5-10% of all students come from other institutions. By far the majority of the candidates are from the own faculty or as was often said: 'We strongly depend on our own breed'. Supervisors often approach their own students of whom they know what subjects they have studied. Some interviewees stated that sometimes subjects taught at other universities differ to such an extent that potential candidates from that university are lagging behind in particular fields (for example catalysis in chemistry). Since additional training would be needed supervisors tend to give preference to their own candidates who they already know: "Universities keep their own students as their treasure". It was also indicated that many supervisors don't accept students they don't know. They have had bad experiences with external candidates as far as their research capabilities are concerned.

On the other hand there was a clear wish to have more fresh blood from outside to enrich the university. But the low mobility is predominantly attributed to the mentality of Czech students. Open recruitment such as publication of vacancies on the websites is becoming increasingly the practice, mostly by the more reputable research institutes. As a respondent put it, this would create a sphere where students can say

"Ah, this is a topic I would like to do research, that is not done at my university, so I will go there".

4.2.4 Relationships between universities and ASCR institutes

Doctoral students can undertake part or their major research work and receive their research training at an ASCR institute. However, they remain officially registered at the university that then confers the degree. In some cases we found a very fruitful collaboration between universities and the institutes. There are many common projects and many researchers at the institutes have a teaching position at the university at the same time, which makes the connection rather close. They regularly act as supervisors of doctoral students and operate in departmental councils responsible for the quality of doctoral education. The collaboration on both a formal and informal basis can be quite intensive and mutually beneficial.

It was stressed that young PhD students are very important for the work of the institutes and it is impossible to do without them. In the institutes there is more focus on one kind or direction of research and most of the time researchers work in project teams. At universities it may be more dependent on the individual student working with the supervisor.

Mention was also made of tensions - especially as far as the funding and respective research credits for doctoral education are concerned. Regarding funding, there is a perceived difference of the remuneration for doctoral students. Universities have the right to distribute the scholarships from the state budget according to their own criteria. This means that universities can vary the remuneration to their students especially when students participate in projects that yield additional funding.

ASCR institutes can also offer additional funding for research work, but among the ASCR institutes the view prevails that the conditions are generally less favourable compared to what universities can offer. Because of the higher scholarships offered and other benefits students tend to prefer staying at the university. Particularly in fields where a shortage of students occurs, the research institutes feel in a disadvantaged position.

However, examples were also found of joint doctoral programme or discipline accreditation where the ASCR can, on the basis of agreements, use money to finance doctoral students both from education allowances and from specific university research funds.

Regarding the research credits, universities receive the credentials for the publication despite the fact that the student has done most or all of the research in an AS institute. There are occasions where the doctoral diploma indicates that the research was promoted by the university but the research was conducted at the research institute. In other cases universities claim the affiliation of the doctoral students in their publications (thus receiving the research credit points), thereby withholding from the institutes any reward for their efforts. This is equally important for the ASCR because of their evaluation process (see below). Some ASCR institutes do not feel they are in an equal position and many expressed their view to return to the position prior to 1990 when they had an independent position to provide doctoral studies.

Given these conditions, the view was expressed that the ASCR should take steps in the legislative sphere to award doctoral degrees by the ASCR as well. Rather than pursuing this path, a policy strategy would be to strengthen the model of cooperation between the ASCR institutes and the universities focusing on their mutual benefits. In section 5.5 European examples will be presented of how both types of institutions cooperate and solve practical problems.

4.3 Doctoral process

The doctorate is generally achieved through individual study and research. The candidate must find a supervisor and discuss the selection of a topic. They work mostly on a on a one-to-one relationship and the whole doctoral process is planned and implemented individually. Their research can be part of a larger project, which enables them to work in a larger team.

We asked in our survey what is included in the individual study programme (ISP) and how the process is being monitored. In many cases the ISP contains the general framework of the programme, research plan and elaboration of a research topic, the terms for particular exams, laboratory plans, and the like. It distinguishes different research phases in which students have to meet “milestones” with the required minimum of points. These may include publication activities, attendance at conferences or seminars, planned presence on projects, and other activities or assigned tasks. Individual initiatives from students are also expected. Apart from the necessary courses leading to the state examinations, the availability to develop academic writing skills as well as language training was often mentioned.

The monitoring of the doctoral process may be carried out by field expert councils, but it is also common practice that this is a matter between the individual students and their tutors, often on the basis of informal kinds of agreements.

In order to move to the next stage of the individual program it is necessary to achieve the minimum requirements and those who do not meet them can be confronted with financial sanctions (e.g. lower scholarships) and can ultimately be forced to quit or to continue on a part-time basis.

4.3.1 Success and dropping out

National figures on the progress of students and graduation rates are hardly available. Only on the faculty and departmental level some figures have been collected, but a systematic overview of the effectiveness of the doctoral system as a whole is difficult to make. Our survey and interviews among directors generally confirm that the excessively high proportion of doctoral students that do not complete their studies is seen as a recurrent problem as well as the high average duration of unsuccessful studies. The respondents indicated that the success rates vary between 25% and 45% and percentages exceeding 50% are more the exception than the rule. Quite often reference has been made to the existing system of formula-based block grants that universities receive for doctoral education and consequently it is in their interest to increase the number of students[53].

Asked if allocating these stipends to so many students was a waste given the low graduation rates, it was put forward that this is mainly a concern of the individual students themselves. It was taken for granted that several students start their doctoral studies, although they were not so sure about their future research career. During the process the selection process is quite severe and the annual progress evaluations will sort out those that continue to receive stipends and those that are cut off, enforcing them to find additional resources or to take up paid jobs.

In HR survey we asked about the reasons why students are dropping out and in what stage of the doctoral process. Those who quit their doctoral studies do this mostly after having already worked for a long period on their dissertation. About half of the respondents indicate that this is the most critical period for these students to continue. Table 15 provides an overview of the major reasons.

53 Czech Ministry of Education, Youth and Sports (2009) White Paper on Tertiary Education. Prague, p. 50

Table 15 Most important reasons for students dropping out (N=74)

Successful start in another career/ finding new employment	65%
Heavy workload due to a position outside HE or research institute	48%
Lack of sufficient funding	37%
Lack of sufficient knowledge or abilities to work on PhD	33%
Raising children/ pregnancy	33%
Heavy workload due to a position in HE or research institute	20%

Source: CHEPS HR Survey

The switch to start a career elsewhere is the most important reason. This can be connected with the general funding level of doctoral studies or having received a negative evaluation, but also candidates may feel more attracted to other careers than the academic one. Other possible reasons such as change of research topic, change of supervisor or the possibility that supervisor's demands were too high do not play any role of significance.

The fact that those students that quit do this mostly after already having worked a long period on their research raises questions about the selective mechanisms during the doctoral process. Some respondents said that although there is already a severe selection at the start, it is very difficult to assess at that time whether students are good or not and this can better be demonstrated after the first year. In other cases the Board of Professors welcomes at the start very precise formulated research topics rather than coming with a broad idea and waiting one year before starting with the research.

Students who do well during the process are eligible for additional grants or bonuses to improve their working conditions. Other (smaller and temporary) grants are available, mostly on a competitive basis, for example to organize seminars or to attend international conferences, to present their work to an international audience and the like. Also mention was made of smaller university funds to support talented students and to offer financial awards to students who show a high performance.

An attractive way of funding is exemplified in the following frame:

> A more or less independent research institute (belonging to a faculty of science of a large university) always connects PhD positions with current research projects, including several 7th EU Framework projects. This means that students are not working in a vacuum, but are always working with other researchers related to that project. Students know that they are part of this larger project and if they perform well they can be financially rewarded. This makes them less dependent on the government stipend (which stops after four years) and gives them more security in order to complete their PhD after the regular time has expired.

Other initiatives to improve the financial conditions of doctoral education come from regional authorities. For example, the Southern Moravian Innovation Centre and International Mobility Center developed a concept of operational funds to support human resources including doctoral students in their first year with an extra stipend.

Although these examples of the possibilities of additional grants make the picture of doctoral funding more positive, there remains a general concern that the funding is too low and not competitive to attract high-level doctoral students. Especially when doctoral students have to rely completely on government stipends, the financial conditions are vulnerable and people may drop out and search for other jobs.

4.3.2 Specialist versus broader doctoral training

A topical question that increasingly is being asked in many international debates on doctoral education is whether doctoral training is and should concentrate on a very specific and narrowly defined research topic or should encompass a broader focus including interdisciplinary perspectives and a broader set of skills.

A director of doctoral education in a science faculty emphasizes the strong one-to-one relationship of the doctoral process. In his words:

> *There are other courses, but supervisors do generally not recommend their PhD students to take courses that are outside the faculty… it is more convenient for the student to take the subjects that are taught here at the university because of the topic. In our system we try to use what the supervisor is expert in and not to distract students…So the main time is really dedicated to experimental work to understand the whole equipment system.*

This view has been exemplary for others who emphasise in the doctoral process the concentration on one particular topic. They tend to see other activities not related to this as a waste of time that could better be spent on research. The dependency on one supervisor reinforces a more specialist research focus.

However, other views have been expressed as well. A director of a research institute puts this as follows: "I rather appreciate a broader portfolio, the reason is that we are living in a very turbulent world. You never know what's going to happen next. In a stable world it is very good to have an in-depth education…"

Similarly a research center belonging to a faculty of science promotes a broader approach. Although being connected to one supervisor, students are encouraged to co-operate and to consult with others in some adjacent field. Often students are participating in overlapping projects, which facilitates a multidisciplinary approach. This is much stimulated through the weekly seminars in which all students of the faculty "who have something with chemistry" have to attend and to present their work to all their fellow students. In this way they are trying to combine their knowledge and to stimulate interdisciplinary approaches.

4.3.3 Transition of PhD graduates to the labour market

The issue of specialist and broad training also arises in the context of preparing PhD graduates for an academic career or to provide them with a broader portfolio of competences that can be useful in other employment sectors. There are no aggregated data of graduate destinations available, although some departments keep track of their own graduates.

For doctoral degree holders a research position at their own institution is the most important employment outlet. In our survey more than 75% of the respondents consider this the case whereas 58% indicate that a position at another university or public research institute is important. In these respects respondents from universities and research institutes do not differ. Doctoral education is predominantly seen as a preparation for a future career at the university or for a research career at a research institute.

However, the chances of finding employment after graduation at a university or research institute is not very favorable and many PhD graduates feel more or less blocked in their academic career. As many of them are dedicated to their research work and would like to continue in basic research, they don't see many alternatives.

Generally the academic labour market is not considered favorable for PhD graduates and the number of new vacancies is rather limited in universities and even more so in ASCR institutes. These institutes have a limited in- and outflow of researchers. Apart from the replacement of leaving staff there are few possibilities to employ PhD graduates, since the budget of the ASCR remains rather constant.

At AS research institutes the system of postdocs is not well developed and it is difficult to support a postdoc on a grant. There is a possibility that graduates can join the institute for a number of years receiving a low salary, but this is temporary, and depending on vacancies that are arising in the meantime. There is a preference to send students first abroad to obtain experience and next to recruit the best ones back after some years. There is much confidence that if the institute provides good working conditions and a good research team these people will return, even though the salaries are low compared to international standards. Special fellowships and Ministerial programmes (e.g. RETURN) are offered to attract people to come back to the research institute and provide some extra salary. However less support is available for developing a new research line.

Other employment possibilities are in R&D&I positions in the private sector. Of the respondents in the survey 36% consider this as an important destination. There is a difference for university respondents who consider this relatively more important than their counterparts from the AS research institutes. Generally the disconnection is felt from both sides. The specialist character of graduates who dedicated 4-5 years to a very specific problem and hope to continue in the same specific research have difficulty to change their research field or to make the step towards an industrial setting. These research cultures are experienced as being too different.

On the other hand, it is believed that employers in industry are not so interested in PhD's since they believe that PhD graduates are too specialized and too much focused on basic research which makes them less attractive compared to Bachelor and particularly Master graduates. It should be added that the possibility of finding employment in industry differs between disciplines and that particularly SMEs are gaining from PhD's. Often reference was made to the position of many companies in the Czech Republic that have increasingly been owned by international firms which have taken away most of their R&D departments to their home countries.

Several interviewees expressed the wish to increase the number of doctoral students. This is not only in those fields where shortages occur, but also in other fields. The pool of students increases and the best ones can be attracted for an (academic) research position. At present there are quite some students who tend to postpone their decision about their career and these are often not the best ones to keep for research.

Introducing more severe admission criteria would be more economical, but respondents would prefer to introduce more strict selection procedures during the doctoral process. Some paradox is felt between the pressures to have more doctoral students at the same time that there is an overproduction of PhDs especially as far as prospects for an academic career are concerned.

4.3.4 National and international collaboration

The funding of doctoral education includes the possibility of students to participate in national and international activities. Financial support (including EU support) is available:

- For active participation of students at conferences, summer schools or shorter stays abroad,
- For inviting foreign faculty into doctoral seminars,
- For organizing workshops with (inter-) national faculty and/or PhD candidates, education and training (developing soft skills etc.).

Students have to apply for these funds, but generally they are very much stimulated to make use of them. It is seen as very valuable to broaden their perspective, to meet other researchers outside their own institution and to present their material to an international audience. There are national programmes to support mobility and short stays abroad (see section on research mobility), but as more universities are involved in these programmes, relatively less students from the own university can make use of them.

The wish to attract international doctoral students is high on the agenda of some institutes, albeit rather difficult because there is little financial support available. The largest part of foreign students comes from Slovakia. Efforts have been made to provide a scholarship to them on the basis of a few temporary programs (from MEYS), Erasmus, own mobility funds, or from own project grants. Increasing the number of international students is seen as important for the development of doctoral education in the Czech Republic.

The fear of brain drain was noted in a few cases, when an institute prevented their students from being exposed to a foreign institute for a longer time fearing that they would not come back. Most often this was not seen as a concern: "we always encourage them, also to go for a longer time and if they come back they come, if they don't, its fine".

A challenging phenomenon is the initiative of some universities to allow a co-tutorial system, which means that a doctoral student can be supervised by two supervisors from two universities in the Czech Republic. This has been extended on an international scale, both with universities in other European countries but also outside the European Union. This provides excellent opportunities for the students to benefit from international experts. The departments encourage this collaboration very much and there are signs that this is expanding. Through the Erasmus Socrates Programme a Czech research institute has a contract with universities in the UK, Sweden, Spain, Portugal and other countries to exchange doctoral students with stays up to several months long.

4.4 Issues and concerns

In the HR Survey we asked what are considered the most important strengths and weaknesses of doctoral training in the Czech Republic. The answers show a very varied picture, indicating that conditions and practices differ substantially between institutions or disciplinary areas. Despite these differences we can summarise the main answers as follows.

Generally much reference was made to the quality of the study programmes, the clearly defined regulations regarding the set requirements throughout the whole PhD process. Another strength - most often mentioned by directors of AS research institutes - is the possibility to participate in concrete research projects and being 'organically connected' with a larger research team through which candidates can attain much research experience. This also enables them to become familiar with utilizing sophisticated technical equipment (where this is available, at other locations the available technical equipment is considered insufficient). Especially the concentration on research during the larger part of the doctoral process was mentioned as an advantage compared to situations where candidates are charged with other activities at the same time.

The tradition of the individual approach between student and tutor was also considered as strength, leaving much room for individual creativity. At the same time others mentioned that this is dependent on the availability of good tutors, which is not always the case. Some indicated that there are a limited number of excellent tutors to guide candidates through the process. The contact meetings can vary substantially and supervisors mainly in higher positions tend to have limited time available or are too occupied with their own research interests. A recent PhD graduate, now an assistant at a university, put this as follows:

> *"Usually each PhD student works on his own and it really depends on your supervisor. If you get a good one everything is good. But if you get somebody who is not so experienced or too busy to give you his time and knowledge you are screwed, because you have to work out all on your*

> *own and there is no way to force your supervisor to do better. …So I think the system is quite good, but it is really personally dependent"*

Major weaknesses of the current system concern the following:

1. *The funding:* Most often the financial support students receive was mentioned as a major weakness. This is broadly considered as too low, hardly sufficient for living and students are often forced to accept other jobs. This may affect negatively their study progress and is often a reason to leave the system or change to a part-time status. The combined mode of study may lead to a prolongation of the standard length of study and many of them drop out.

   The same may happen to students who are financed with a research grant the duration of which is shorter than the time needed to finish their degree. Additional grants or scholarships may help but only for the duration of the project. A significant increase in financial support is seen as necessary to improve the position of doctoral students.

2. *Quality:* There is a general feeling that the quality of doctoral students has decreased in recent years. As indicated before institutions have problems to attract suitable students and there are not enough qualified candidates. Some attribute this to the low mobility of students from one university to another and the dependence on local applicants. Others consider the knowledge background from MA studies rather weak which becomes critical when the PhD is increasingly seen as a continuation of a Master degree. Also language skills are considered too low.

   Due to the Bologna process there is a trend to increase the number of students in higher education who all are expected to attain a complete university education. Many of them have limited capacity and this has, according to the respondents, a negative impact on the quality of education on higher levels. This entails that in doctoral education more knowledge elements have to be covered than before. On the other hand, complaints were noticed that students are often overloaded with too much course work and that some examinations are hardly related to the doctoral research of the students.

   It was also pointed out that there are differences in the quality of PhD candidates across institutions. Some institutions have high-class research and this is reflected in the level of doctoral education, whereas the quality in other institutions is not that high and the PhD research leaves much to be desired. When the number of applicants is relatively low, professors tend to be less strict in their admission and evaluation criteria because they still need doctoral students for their own work, or may offer them a part-time job on which they can survive. Considering the financial constraints these differences in quality would provoke debates on the macro-efficiency of the doctoral system and the choices to be made on the central institutional and national level.

   Respondents from AS institutes expressed their concern that the ASCR is no longer allowed providing its own PhD studies and that the universities have the monopoly to award degrees. This appears to be an unresolved situation and leads to controversies in the relationship between universities and ASCR regarding the training of and responsibilities for doctoral students. In their view the ASCR should be enabled to provide their own doctoral programme and award their own PhD degrees.

3. *Involvement of industry:* Another point concerns the observation that there is little cooperation with industry and generally insufficient financial support from the private sector. Companies are very reluctant to provide additional funds for scientific research as they consider this as an important task for the public sector. From the side of employment firms two major factors were put forward that hinder cooperation:

- Topics of doctoral research are seldom leading to relevant research outcomes; they just function to finish the PhD.
- Students have insufficient ability to work in research teams or to participate in international research teams.

From the side of institutes cooperation is seen as difficult because of the disruption of the Czech industry and the fact that R&D&I capacity has been moved to foreign countries. This has reduced the demand for researchers. In addition it was stated that some enterprises indeed offered cooperation, "but we do not want to work with them, because of their practical demands and the fact that the benefits are too low". A perceived very strict distinction between what basic and applied research encompasses seems an underlying factor in limiting collaboration.

Despite these hindrances from both sides, some collaborative forms of doctoral education with R&D&I participation are emerging, especially with smaller companies. One faculty mentioned that about 10-15% of doctoral research projects (mainly in technology) is taking place in the context of an industrial project, with a second supervisor from industry. According to several respondents in the survey this would have potentially a much higher impact. The opportunity to work in a collaborative environment would also help to facilitate mobility among sectors and the employment of PhD graduates in R&D departments of industrial enterprises.

Strengths and weaknesses

The major strengths and weakness are summarised in the following overview

Strengths:

- **Tradition of high level and high requirements (publications)**
- **Support for (international) visits, conferences**
- **Individual Study Programmes, annual evaluations**
- **Possibility to participate in research projects linked to grants**
- **Benefit from university and ASCR at the same time**

Weaknesses:

- **Dependency on individual supervisor**
- **(Public) funding level insufficient, it forces students to accept other jobs**
- **Low completion rates**
- **Overloading with coursework/ duties not related to student's research**
- **Difficulty in attracting high quality students – too dependent on local applicants**
- **Little collaboration with industry/private sector**

4.5 European good practices

4.5.1 The Bologna Process

On the European level doctoral training has received increasing attention mainly in the context of the Bologna Process. Since the Berlin Communique (2005) several documents expressed the need for reform doctoral training as the third cycle of higher education in order to foster the competitiveness of European Higher Education and Research Areas. The communication to the Commission on "Researchers in the European Research Area: one profession, Multiple Careers" notes the continuing diversity and variety of research training and conditions of doctoral education. It also suggests making the training of researchers of greater relevance for a variety of careers than in the past and advocates a number of recommendations:

- Enhance the employability of researchers by including in the training both core skills and wider employment related skills;

- Review the structure of training for researchers and integrate doctoral progammes into the Bologna process;
- Develop organized training within the framework of doctoral programmes;
- Pay attention to the quality of supervision and provide access to a supervisor at all levels of the training;
- Integrate doctoral students into the research environment but also highlight alternative careers and provide doctoral students with as many contacts as possible;
- Assure the financial situation and the social security rights of doctoral students;
- Analyse the status of doctoral students and provide a better overview of the characteristics of doctoral education and research training opportunities in Europe.

The following Bergen Communiqué confirmed the central role of doctoral education to link the European Higher Education and Research Areas. The core component of doctoral education is the advancement of knowledge through original research. It goes on to state that

> *Considering the need for structured doctoral programmes and the need for transparent supervision and assessment, we note that the normal workload of the third cycle in most countries would correspond to 3-4 years full time. We urge universities to ensure that their doctoral programmes promote interdisciplinary training and the development of transferable skills, thus meeting the needs of the wider employment market. We need to achieve an overall increase in the numbers of doctoral candidates taking up research careers within the EHEA. We consider the participants in third cycle programmes both as students and as early stage researchers*[54].

These recommendations are generally indicative for national policy developments and find much support from the European University Association (EUA). The view that the normal workload should correspond to three to four years of full-time study and the importance of research training as an integral part of the third cycle find broad acceptance. Thus, in nearly every country, doctoral programmes include some form of research training (including theoretical courses) on either a compulsory or optional basis in addition to individual research.

Nevertheless some major issues on doctoral education remain. These concern the aims and value of doctoral education and training, and the status of doctoral candidates and their position in the organization.

4.5.2 Status and position

The inclusion of doctoral programmes in the Bologna process led to the definition of young researchers as students in the "third cycle of higher education". In most countries they have a double position: they are defined as students and as young researchers at the same time making a contribution to research.

However, they have nowhere a full-fledged recognition as scientists at the start. The EUA survey among the Bologna Process member countries indicates that, out of 37 participating countries, in 22 countries the status of a doctoral candidate is mixed, which means that doctoral candidates are considered both as students and employees. In 10 countries doctoral candidates are seen only as students (among them CR), and in

54 Bergen Communiqué (2005) The European Higher Education Area – Achieving the goals (www.bologna-bergen2005. (p.4)

three countries only as employees[55]. Among the latter are the Netherlands but it should be noted that the Dutch system of research trainees has actually a double-face of employee and student that is expressed in the salary-scale with a built-in deduction for the training and supervision received.

The EUA emphasises that, whatever the status of a doctoral candidate, it is crucial that s/he is given all commensurate rights as this causes difficulties regarding funding and transferability of social security. Overall in Europe:

- 20% of the total of doctoral candidates have employment contracts and full security for mobility
- A third of mobile researchers obtained total coverage of their expenses

4.5.3 Emergence of research schools c.q. graduate schools

A relatively recent development is the emergence of more structured forms of doctoral education and its concentration in a specific organizational setting. The EUA survey shows an increasing trend towards the development of structured programmes and doctoral/graduate/research schools, alongside existing models such as traditional individual training or 'stand-alone' structures (like the Individual Study Programmes –ISP in Czech Republic). Some of them are institutionally-based like the graduate schools, others are supra-institutional and function on a national basis (like research schools in the Netherlands). Obviously, such structures should demonstrate added value to solve existing problems, in particular for improving the position and quality of doctoral education, clearly defined responsibilities and transparent procedures.

The developments in Germany are a case in point to reform the training of doctoral students. Since the 1990s the German Conference of Rectors and Presidents of universities (HRK), other institutions and the German Science Council suggested to introduce a model of graduate colleges at a number universities in the form of thematically-oriented research groups. Since then the need to reform the training of doctoral students continued to exist. Apart from the very specific conditions in Germany, the following problems were identified which can be recognized in other national contexts.[56]

- Doctoral candidates "are at risk of overspecializing, especially in cases in which they are assigned a narrow marginal sub-domain in a large–scale project and have inadequate supervision.
- In subject areas that require less or no third-party funding (e.g. in the Humanities and the Social Sciences), doctoral students often work in isolation with inadequate supervision. Consequently, academic dialogue is underdeveloped and candidates often fail.
- Traditional forms of supervision, like seminars for advanced students are in many cases inadequate, because of their informal and loosely structured character, and non-interdisciplinary approach.
- The range of services required of teaching/research assistants, who are at the same time doctoral students, prolongs their studies.
- In periods of a bleak labour market, doctoral students tend to secure their income by accumulating consecutive posts and grants, which, in turn, tends to reduce their chances on the labour market.

55 European University Association. Doctoral Programmes in Europe's Universities: Achievements and Challenges. Brussels: EUA, 2007.

56 Hochschulrektorenkonferenz (HRK) Zum Promotionsstudium. Entschliessung des 179. Plenums vom Juli 1996. Compare also Klaus Hüfner, Germany, In: J. Sadlak (ed.) Doctoral Studies and Qualifications in Europe and the US: Status and Prospects. CEPES/ UNESCO Bucharest 2004.

In the view of the HRK the graduate schools (or '*Graduiertenkollegs*') would serve as a model for the elimination of the existing structural weaknesses "which have already impaired the international position of German universities in the worldwide competition for young academics and scientists"[57].

Different organizational models were explored ranging from the establishment of a graduate school within a single faculty or interfaculty schools within one university or a research school covering several departments at different universities i.e. inter-university research schools. Evaluations so far show that students from graduate colleges graduate at a younger age and interrupt or drop out to a lesser degree than those in the traditional apprenticeship model.

In other countries similar developments have taken place. In the UK graduate schools have already been in place for a longer time. Finland and Sweden have had their national graduate schools since 2001, Austria followed Germany in due course. The Netherlands opted for the inter-university research schools organized around a particular discipline, research theme or a cross-disciplinary research. At present, however, the graduate schools at the university level are emerging at the same time. These organizational models are not felt to be incompatible and can co-exist alongside each other and can be mutually supportive. Their appropriateness depends on local circumstances and field-specific conditions[58].

Although across Europe various models have been implemented, the benefits as viewed by the actors involved can be summarized in terms of critical mass and expertise:

- Critical mass refers to the fact that there are sufficient students to provide courses efficiently and that there are sufficient other students necessary for productive interaction. The size of the research group, the institute or university determine the size of the environment which will be larger in collaboration with other research groups in the same field.
- Critical expertise refers to the presence of sufficient expertise regarding the doctoral research. The candidate may wish to acquire both in-depth (disciplinary) and broad (interdisciplinary) knowledge. The insights from colleagues from outside have added value for the doctoral process.

Two other arguments for establishing graduate schools are becoming increasingly important:

- Their international profiling and reputation. The graduate school fulfills an important role in external profiling of the research of the university and to attract internationally well-qualified candidates. Several graduate schools have strengthened their international cooperation with foreign institutions that already offer structured doctoral programmes. Most of these joint and exchange programmes exist in the Anglo-Saxon and West European countries.
- The wish to embed doctoral education in institutional structures and strategies and to create a collective mechanism of the university for assuring the quality of research and training in all doctoral degree programmes.

The graduate schools may facilitate the association with centers of excellence and as such may benefit from:

- An effective process for assuring quality in doctoral education
- Evidence of effective organization and leadership

57 HRK, Ibid.p. 16.

58 Kehm, B. Doctoral Education: Pressures for change and modernisation. In: J. Enders & E. De Weert (eds.) The Changing Face of Academic Life, Analytical and Comparative Perspectives. Palgrave Macmillan, pp. 155-171, 2009.

- Involvement in regional or international networks
- Encouraging cooperation and supporting specialization and differentiation, and priority setting in terms of national R&D&I policy
- The importance of ensuring adequate resources for student support, facilities and supervision.

4.5.4 Labour market for PhD graduates

As in the Czech Republic the doctoral degree in Europe is mainly considered as a research degree preparing for a career in universities or research organisations. However, in many countries the number of graduates has increased – and continues to increase – to such an extent that universities and research institutes are not able to absorb them all. Many PhD holders have to find employment outside academe and the question arises whether employers are interested in offering them jobs in which their high qualifications can be utilized.

As was mentioned before the Czech labour market is not in favour of PhD graduates, the main reason mentioned that most international companies have moved their R&D departments outside the CR. But also in other countries there is a concern about the employability of PhD holders outside academe and it is questioned whether doctoral students are well prepared for this job market. This question is linked to a growing concern about their high level of specialization: doctoral students are believed to be educated and trained too narrowly, they lack key professional skills to be attractive to future employers, and they are ill-informed about employment opportunities outside academia[59].

Given these criticisms, it is important to monitor PhD graduates on the labour market and to do this on a continuous basis. It appears that data regarding PhD first destinations is not easily accessible in the EU. Figures from Germany show the transition of PhD holders to the labour market[60]. At the time of graduation the majority found a job according to their qualification, only 5% were unemployed. Of all those who graduated from the graduate schools (*Gradiertenkollegs*) 49% started their academic career in higher education, 21% in R&D outside academe and 31% were self-employed and did work not related to research or education. Those who graduated in the traditional way were more often self-employed than graduates from the graduate schools.

Figures were also collected of PhD holders in Germany 40 months after their graduation. Those working in higher education decreased to 43%, 21% were employed in R&D outside academe, and 36% were not working in R&D functions. The figures show differences between fields of study.

- In the humanities, social sciences and life sciences more than half of the graduates were employed at a HE institution (54%). In sciences and engineering subjects this was much lower (39% and 29% respectively)
- Working activities not related to research were less often mentioned by graduates from life sciences (29%) and most often by those from sciences (40%).
- PhD–holders from the graduate schools in engineering have been significantly more employed in R&D outside the higher education system than those from

59 Nerad, M. The PhD in the US: Criticism, facts and remedies. In: Higher Education Policy, vol. 17, no.2, pp.183-199, 2004.

60 The following figures are based on Enders, J. & A. Kottmann Neue Ausbildungsformen – andere Werdegänge? Ausbildungs- und Berufsverläufe von Absolventinnen und Absolventen der Graduiertenkollegs der DFG. Deutsche Forschungsgemeinschaft, Bonn, 2009.

other fields. For graduates from the humanities and the social sciences this employment hardly occurs (12%).

The different sectors in which PhD holders find employment are presented in the following table:

Table 16 Employment sectors of PhD holders in Germany from graduate schools compared with other PhD holders, 40 months after graduation (%)

	Humanities/ Social Sciences	Life Sciences	Sciences	Engineering	Total
PhD from Grad Schools (N)	130	50	161	85	426
Public sector	72	58	47	32	53
Non-profit sector	7	12	4	7	7
Private sector	22	30	49	61	41
Other PhD holders (N)	283	84	263	83	713
Public sector	65	58	41	41	52
Non-profit sector	9	18	4	6	8
Private sector	26	24	55	53	40

Source: Enders and Kottmann, 2009.

The comparison between subject fields shows that especially graduates from humanities, social sciences and life sciences are mostly employed in the public sector, whereas the majority of those graduated in science and engineering are employed in the private sector/industry. Systematic conclusions about those graduated from graduate schools and other PhD holders cannot be drawn.

This kind of data can be used to monitor the transition to an academic career or to other forms of employment. It highlights the need for greater consideration of what doctoral students are being trained for including careers in jobs outside the academic labour market as well as how well this is being done.

4.5.5 Collaborative forms of doctoral education

In recent years there has been a move to complement the emphasis upon original research with other elements designed to maximize the benefits of research study for the student and to combat social and intellectual isolation. For example, in the UK the 'new Route PhD' is designed to integrate taught elements into a PhD programme without in any way affecting the requirement for candidates to make a contribution to knowledge through an original thesis. A similar approach is evident in the '1 + 3' masters plus PhD programmes pioneered by some of the UK research councils. The UK research councils through the Research Councils Graduate Schools Programme have promoted and provided training for funded PhD students, much of it designed to help applying the skills of a researcher in other contexts[61]. Other doctoral qualifications, generally in professional subjects, award doctorates in professional practice which contain both a substantial taught component and a requirement for the completion of a project which demonstrates a significant contribution to practice.

Across Europe collaborative doctoral education is of growing importance given the increased focus on innovation through R&D in order to advance towards a more knowledge-based economy and the reality that a majority of PhD holders are destined for careers outside academia in both research and non-research positions. "Collaborative Doctoral Projects" or "Programmes" involve collaboration between a

61 http://www.qaa.ac.uk/public/COP/draft/CircularCL0408.htm

university, a doctoral student and a company. The role of industrial partners relates to supervision, funding, placements, data provision and network facilitation. These University-Industry Partnerships were the subject of the project DOC-CAREERS: from innovative doctoral education to enhanced career opportunities"[62]. A main objective of this project has been to build constructive dialogue with and among stakeholders engaged in collaborative doctoral education. This project identified a variety of approaches to collaborative doctoral education, such as the strategic level of engagement in the parental organizations, role of the industrial partner, selection of the doctoral research topic, additional admission requirements, formal agreement (including IPR) and the legal status of the doctoral candidate. Their particular attention was given to employability perspectives outside academia and relationship to mobility, and to acquired skills, including those described as transferable skills.

For companies the general shift from the 'closed innovation' model to 'open innovation' is seen as a good means of bringing the public and private research sectors closer together while also raising standards. The project emphasized the importance of tracking doctorate holders' careers, a practice that is not widespread at the institutional level. This data tracking includes exploration of the skills and competencies that PhD graduates require to inform doctoral programmes and hence attractfuture doctoral candidates.

4.5.6 Relationship between universities and the ASCR

The question whether ASCR research institutes or other institutes outside the university should have the right to award PhD degree seems to be an enduring issue. The decision in the late 1990s to abandon the dual system of scientific and academic degrees, however, puts the Czech Republic in line with what is predominantly the practice in most West European countries. In most countries extra-university research institutes including institutes of academies of science have the right to train doctoral students in cooperation with a university that in its turn confers the degree. This is the common practice for example at the Max-Plank institutes in Germany, the research institutes of the academies of science in the Scandinavian countries or the Netherlands. A brief reference to the Dutch situation will suffice to illustrate how both types of institutions can benefit from each other.

The Royal Netherlands Academy of Arts and Sciences (KNAW) is an umbrella organization for numerous national research institutes. These research institutes, which are active in the humanities, the social sciences and the life sciences serve as national expertise centers in their field. The national natural science institutes are associated with the Netherlands Organisation for Scientific Research (the research funding organization NWO). All these institutes can employ doctoral candidates on the basis of pay scales exactly equivalent to those common at universities, however, the dissertation defense always occurs at the university which confers the PhD degree. Several senior researchers at the institute have also a professorial position at the university which makes them eligible to award the degree. Arrangements concern the compensation for the research investment of the institute, credit points for publications, use of equipment and so on.

Creative arrangements have been developed for both to benefit, for example if three candidates from a KNAW research institute graduate at a university, this institute 'receives' a fourth student for free, completely financed by that university.

Regarding the lower quality of doctoral research in the Czech Republic as perceived by the ASCR and the dispute on publication credentials, the Dutch case can be illustrative. One of the central strength of the Dutch national research system is to produce high-level research publications through collaboration between the various

62 European University Association. Collaborative Doctoral Education. University-Industry Partnerships for enhancing knowledge exchange. Brussels: EUA DOC-Careers Project, 2009.

research institutions and to make optimal use of the complementarity of their respective knowledge and expertise[63]. As said before, collaboration in the Netherlands takes place through nationally operating research schools in which doctoral candidates are taking part. These research schools are subject to quality assessment procedures as established by the KNAW. Since these schools have an important function for training doctoral students, the quality and transparency of their training and supervision and their attractiveness, capacity and throughput are important criteria for accreditation.

Until recently this recognition from the Royal Academy (KNAW) was the only formal procedure for an external assessment of doctoral programmes. Since 2009 it has been established in the Standard Evaluation Protocol (SEP) - this is the protocol used to assess all scientific research undertaken by universities as well as by institutes of KNAW and the research council NWO - that doctoral education forms an integral part of the research assessments. The most important motivation of incorporating the doctoral programmes in this SEP is that in this way not only the doctoral programmes within research schools, but all doctoral programmes are subject to this external assessment[64]. The Royal Academy agrees with this and by participating it can exert its influence on the quality procedures and guarantee that a high level will be maintained.

This Dutch case illustrates a very fruitful collaboration between universities and the Academy research institutes in the development of doctoral education.

4.6 Conclusions and policy recommendations

Against the background of the previous analysis of both the doctoral education in the Czech Republic and the overview of international trends the following policy recommendations are made. These are presented in a priority order.

1. **Improve the remuneration of doctoral students**. *A combination of different resources is seen as most effective, such as targeting specific priority areas, stimulating collaborative forms of doctoral education, the quality of the programme or the balance between supply and demand of PhD graduates on the labour market.*

   Many respondents mentioned the level of funding as one of the crucial problems of doctoral education in the Czech Republic. The amount is believed to be too low and cannot compete with salaries earned elsewhere or with international (West European) standards.

   The most important source is government formula-based funding to institutions Students are dependent on this money for a restricted time which is often not adequate for the time to degree. This scholarship can be supplemented by grants from other sources, commonly determined by the faculty or institution concerned on the basis of the progress of students. Many respondents argued strongly in favour of a significant increase in the financial support for doctoral students. There are various ways that this could be achieved. Apart from increasing the general budget for doctoral training other options were suggested:

   - To reduce the number of students in order to distribute relatively higher scholarships to less students on a competitive basis. Decisions may depend on the quality of programmes and the balance between supply and demand of PhD graduates on the labour market.

63 Nederlands Observatorium van Wetenschap en Technologie, 'Wetenschaps- en technologieindicatoren 2008' (NOWT, 2008).

64 KNAW Samen Slimmer. Het belang van interuniversitaire samenwerking bij de promotieopleidingen. (Smarter together. The relevance of inter-university cooperation in doctoral education), 2009.

- To increase the weight of PhD graduates in the funding formula (output rather than input funding).
- To allocate funds on the basis of targeting specific priority areas or research that has a clear focus on R&D&I areas.
- Stimulating collaborative forms of doctoral training, for example through the introduction of tax breaks, the availability of corporate scholarships or other payments of the costs related to R&D&I.

Some of these measures such as output funding would emphasise the interests of the institution that their students do not exceed the standard length of study and to improve the quality of supervision. Other options would make the funding more competitive. There is no confirmation from international science studies that competitive funding as such will be the key to better scientific results than are achieved by institutional funding. A combination of these different resources seems more effective. There is some evidence that excellent research groups are able to tap a greater diversity of financial resources than other groups. This means that the acquisition of different funds – often on a competitive basis – has a positive effect on the quality and output of the research group[65].

Reference in this report to some examples of good practice illustrates how such a combination of resources may work. Particularly when students are working on innovative projects funding can be applied in flexible ways. These practices should be encouraged in the Czech Republic.

2. **Strengthen the internal and external quality assessments of doctoral education**. *Despite the general high level of doctoral education, the quality varies in the system as a whole. Although some structures are in place, the quality assessment of doctoral programmes should be more integrated into institutional policies and HR strategies.*

   Doctoral studies in Czech Republic have been accredited as three to four year programmes and can be taken on a full-time or part-time basis. Generally speaking the quality of doctoral education is quite high and students are expected to accomplish a high level of research including course work and the publication in peer-reviewed journals. These standards combined with regular assessments that function as an internal selection mechanism guarantees that the system turns out well-qualified researchers.

   Despite this general high level, the quality varies in the system as a whole. Concerns have been expressed about the quality both of PhD candidates on entrance and during the doctoral process. Also the apprenticeship model whereby student and supervisor work closely together on the basis of an individual study programme makes the student dependent on individual supervisors, their capacities and personal (research) interests. There are structures in place, such as the Board of Study Programmes and the Scientific Board, but it has been questioned whether these ensure the quality of doctoral studies. Many students exceed the standard length of study or drop out, albeit that the causes can vary including factors that are beyond students' control, such as an overload of other activities. Therefore the quality of doctoral studies should be more integrated in institutional strategies and policies. This would include that universities and other organisations in which doctoral students work reward good supervision and ensure that these principles are reflected in their human resources strategies and staff appraisal processes.

65 Weijden, I. van der, M. Verbree, R. Braam & P. Van den Besselaar. Management en Prestaties van Onderzoeksgroepen. Den Haag: Rathenau Instituut. [Management and Performance of Researchgroups], 2009.

On the international level there is a trend to develop internal and external quality assessments of doctoral programmes and incorporate these as an integral part of the research assessment exercises.

3. **Strengthen the relationship between universities and AS research institutes.** *There is currently much cooperation although also controversies have been noticed. Rather than taking legislative steps to have PhD degrees awarded by the ASCR as well, it is recommended to strengthen the model of cooperation between universities and AS institutes utilizing their respective strengths. Other European countries provide examples to find creative solutions for practical problems.*

   Although there is much collaboration between AS institutes and universities in providing doctoral education, there appears to be a continuous controversy about the right to award PhD degrees and several respondents advocate changes in the legislation position of ASCR to make this possible.

   In most West European countries it is common practice that institutes of the academies of science have the right to train doctoral students – and do so on a large scale - in cooperation with universities that in turn have the sole right to award the PhD degree. This right has seldom been disputed and more energy has been put into combining forces and utilizing the respective strengths of all institutions involved. Creative arrangements have been established in the sphere of publication credits and compensation for the research investment by the ASCR institutes.

   As the international experiences suggest the collaboration between universities and ASCR should be strengthened as much as possible. Their mutual role should be expanded on a joint basis in the management, evaluation and financing of doctoral education. ASCR institutes are currently operating in strong scientific environments from which doctoral students can benefit in an optimal way.

   Through international networks such as *All European Academies* (ALLEA) and the *Global Network of Science Academies* (IAP), common interests can be promoted as well as to strengthen the role of individual academies in their own country. The Academy of Science of the Czech Republic is currently a member of these networks.

4. **Develop critical mass in doctoral education.** *This can be achieved by creating larger settings where students are confronted with a broader range of knowledge than in the prevailing master-apprenticeship model. Structured forms of graduate training that are emerging in Europe such as graduate schools and research schools are means to achieve such critical mass.*

   The master-apprentice relationship characterised by individual supervision and research work for the dissertation has been the prevailing model for doctoral education in many countries. This model has some disadvantages especially when supervising capacities or research infrastructures are not sufficiently available. On the international level a development can be observed towards more structured forms of graduate training in order to increase critical mass and critical expertise. In Europe various models have been implemented varying from graduate schools on the institutional level to research schools in which different universities and research institutes collaborate and are focused on one disciplinary or thematic area. In these larger settings students are confronted with a broader range of knowledge and specialisations than in the master-apprenticeship model where they often operate in a rather isolated way. Where critical mass is achieved, research training will be more concentrated which enables a more effective use of public funds and priority setting in terms of national R&D&I policy. Another advantage is the international visibility to attract international students. A few examples in the Czech Republic were found where, although not strongly institutionalised, there exists much collaboration between institutions, a practice that should be encouraged as much as possible. Also a bundling of forces in specific research institutes like CEITEC in the Brno region should be mentioned.

Different solutions may be appropriate to different contexts. These range from graduate schools in larger universities to regional, national and international collaboration between universities and/or research institutes.

5. **Encourage the international orientation of doctoral education.** *The current initiatives and co-supervisor arrangements with universities abroad should be expanded where possible. This is an important instrument for recruiting international students and increases the compatibility among doctoral programmes internationally. These initiatives should be supported by policy, for example by providing adequate funds or research grants.*

   Some institutions in the Czech Republic are, given the limited amount of resources, successful in attracting international students, or indicate that they would like to be more effective on this market. In most doctoral programmes students are encouraged to gain international experience by enabling them to attend international conferences or shorter stays abroad.

   Initiatives have also been taken to establish international joint doctoral programmes and co-supervisor arrangements with universities abroad within the framework of their broader international research strategies. Especially for smaller countries like the Czech Republic this international orientation and recruitment of doctoral students from abroad is an important instrument for recruiting high quality candidates and a vehicle to combat inbreeding. These initiatives should be supported by policy, for example through providing adequate funds.

   This international orientation includes a consideration of the current practices and requirements for obtaining a PhD degree in the Czech Republic against those in other countries. An increased compatibility among doctoral programmes would be conducive to international collaboration of doctoral education and would facilitate mobility.

6. **Increase labour market consideration and monitoring of PHD graduates.** *The growing relevance of PhD graduates on the labour market implies that it is important to know what doctoral students are being prepared for as well how well this is being done.*

   In the Czech Republic there do not seem to be standardized monitoring procedures for PhD graduates. At the faculty level there is some monitoring, but data on the central institutional level or national level are very limited. Careers within academia and public research institutes are limited as are post-doc appointments.

   The Lisbon agenda promotes the idea of educating and training more researchers to meet the needs of the knowledge intensive sectors outside academia. This entails the need for greater consideration of what doctoral students are being prepared for as well how well this is being done.

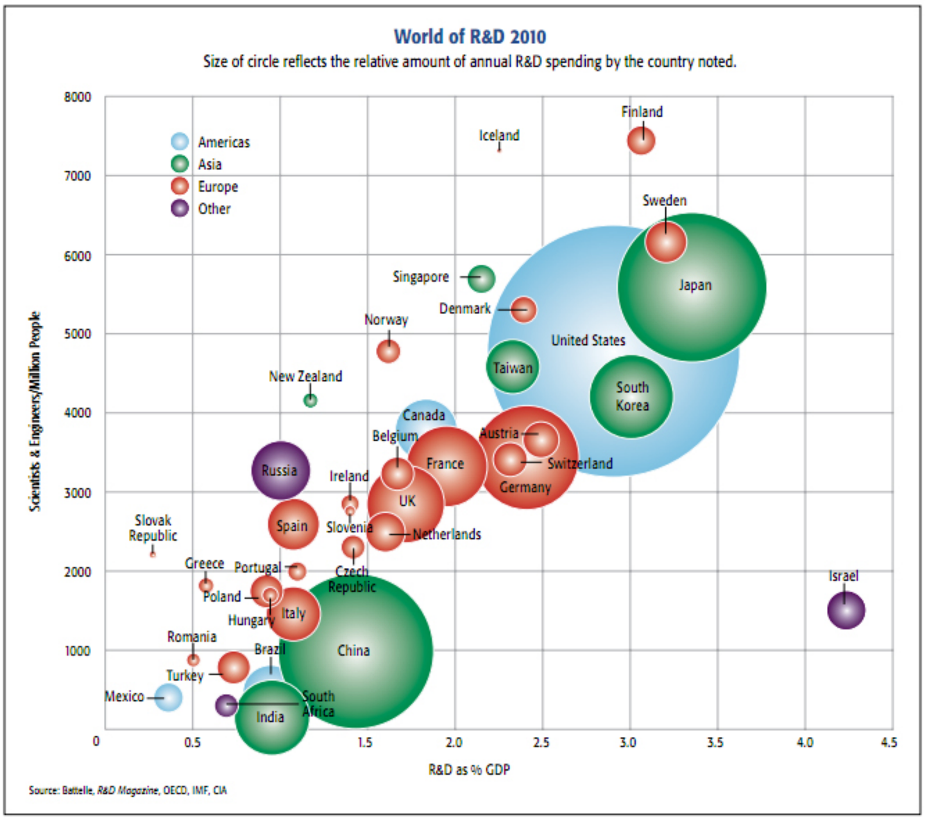
   This raises the question of what skills and competences are needed for professional research careers inside and outside academia and whether doctoral education is an adequate preparation for them. Issues concern the focus on specialist research training or the broader research experience and the identification of transferable skills to be developed during doctoral training to enhance further career development opportunities. Collaborative forms of doctoral education that are emerging in Europe could well be beneficial to this identification. This makes the tracking of doctorate holders' careers increasingly important. This data tracking includes exploration of the skills and competences that PhD graduates require informing doctoral programmes as well as their rates of return.

5. The HR Challenges of potential new fields for R&D&I and current investments in R&D&I infrastructure

5.1 Introduction

A critical question to ask around science's contribution made to human resources is in whether investments in science are building the future Czech workforce. Since 1991, there has been a tumultuous upheaval in the Czech economy with profound consequences for how industry absorbs highly skilled researchers, which are the human capital 'product' of the research system. However, these changes have also affected the nature of the research system in a rather disruptive way, which the new policy seeks to remedy. At the same time, the current labour force is not necessarily the desired labour force of the future, as the Czech Republic seeks to make a second transition into an advanced manufacturing economy. This section is concerned with understanding the future prospects for innovation-led growth in the Czech Republic in the context of European regional policies, which will both provide substantial resources for innovation support but can be invested only to a limited extent in the capital city, Prague. As the figure below shows, the Czech Republic stands at a critical point in its economic transition. The country stands between those countries that invest heavily in R&D and have relatively advanced economies, and more emerging economies, with relatively low investments in science, technology and innovation, and a relatively low proportion of highly skilled workers in their labour market.

Figure 8 The Czech Republic's place in the 'World of R&D 2010'



Source: http://www.urenio.org/wp-content/uploads/2011/03/Global-RD-2010.jpg

Although the Czech Republic's position has substantially improved in the last two decades, its reliance on trade and inward investment cannot allow for complacency. The Czech Republic cannot sustain a competitive position based solely on its low labour costs, but must maintain technological leadership, ensuring that there are the appropriate skills for sustaining innovation in mature sectors and developing new competitive sectors. In pursuit of this overriding economic policy objective, science policy clearly has a role to play There is a pressing imperative to ensure that the Czech Republic ensures that the substantial investments in R&D activity are effectively translated into innovations which create new growth sectors to sustain the Czech Republic's impressive post-socialist transition.

This section is concerned with understanding the contribution which the Science policies of the Czech Republic are having on this wider process of economic transition, and in particular, the human resource challenges of potential new fields for R&D&I and the current investments in R&D&I infrastructure.

1. What are possible new industrial fields for the application of R&D&I and what could this mean for the regional distribution of organisations employing researchers?
2. How could this relate to the major new investments in research facilities and technological parks (through the operational programmes of the structural funds)?
3. What are the human resource challenges of these possible developments?

5.2 Analysis of research questions

It is important at the outset to be clear about the focus of this chapter. This chapter explores how one particular and very important policy intervention, through the Operational Programme Research and Development for Innovation, will affect the Czech Republic's capacity to adapt around its third industrial transition. If the first industrial transition was collectivisation (1950-1990) and the second was privatisation (1990-2010), then the third industrial transition can be regarded as the impacts of globalisation and the knowledge economy. What is important to note is that this transition may be positive or negative: there may be an offshoring of manufacturing activities undercutting traditional Czech sectors (negative) or technological intensive sectors may upgrade and adapt to these new conditions. This chapter therefore seeks to examine the direction in which the OP R&D&I is driving the Czech transition, and to provide recommendations on managing the policy process to maximise its positive contribution.

Given the focus of this report is the human resource dimension, the focus of this chapter is in particular on the provision of high-level skills (at a post-graduate, post-doctoral and senior researcher level). The chapter explores how current investments in industrially-related R&D are related to wider processes of business innovation in the Czech Republic, and the impacts that this is having on the new industrial transition through which the country is progressing. What is important is not to assume a linear model of innovation, and assume that investments in R&D&I automatically translate into firm-based innovation. It is necessary to explore the underlying dynamics of how new sectors emerge, and the role of public innovation in that process. To this end, this chapter raises 4 operational questions which structure this analysis:

1. Are the new investments helping the Czech Republic to move up the curve?
2. Are the investments ensuring increased R&D spend produces increased technological employment?
3. Does the regional geography of public R&D investments in the Czech Republic matter?
4. Does the current Operational Programme run the risk of creating Cathedrals in the Desert isolated from the industries they are supposed to serve?

This section is concerned with trying to understand the impact that the new EU regional policies this will have on the Czech Republic as investment preferentially flows to institutions outside the Prague region. To provide a sensible answer to this question, the section considers the extent to which this is (or is not) out of step with the general technological development trajectory of the Czech Republic, and where are likely to be located the likely future regional growth poles for emerging high-technology industries. Understanding these impacts requires teasing apart a number of distinct dynamics in order to be able to make an informed estimation of the wider impact of the Structural Funds investments.

- The regional economic geography of the Czech Republic
- The dynamics of high-technology economic development in the Czech Republic
- Key labour market and mobility dynamics for emerging high technology sectors
- The regional impacts of the Structural Funds investments in the Czech Republic
- The human resource impacts of the European Centres of Excellence and Regional R&D Centres.

This section begins by setting out the situation regarding structural funds in the Czech Republic. The substantive analysis begins with an overview of the regional economic geography of the Czech Republic in historical perspective, outlining a regional economic hierarchy, from the Capital region, growing second-order cities, peripheral cities, declining industrial regions and remote agricultural areas. The section then turns to consider the dynamics of the Czech Republic's high- technology economy, noting that the country is at an important turning point, and the question is in generating sufficient critical mass to sustain a transition to an advanced knowledge-based economy. Thirdly, the section explores the extent to which regional variables are a factor in labour market dynamics, and the level at which in the Czech economy making the next transition; high-level skills will be a controlling variable. Fourthly, the chapter explores what the likely regional impacts

5.3 The evolving Czech high-technology regional economy 1990-2010

In order to be able to evaluate the likely impacts of these changes it is first necessary to have a more detailed understanding of the regional distribution of high-technology activities in the Czech Republic, their economic development dynamics, and how patterns of demand for high-level skills may influence those activities. The Czech Republic is a small European nation that has since 1990 become a very open and flexible economy, heavily dependent on trade and inward investment for the sustainability of its economic dynamism. At the time of writing, the Czech economy is recovering from a dip that bottomed out in 2008-09, driven by a fall-off of demand in the manufacturing sector (15%). Unusually, the Czech economy was not hit by the financial crisis, as the finance sector continued growing during this period (6%)[66].

Although common to begin analyses of the Czech economy from the Velvet Revolution, the origins of these regional disparities go much deeper. The regional geography of the Czech Republic has its roots in an industrialisation process that began under the Hapsburg Monarchy; although Slovakia only began industrialisation in the post-war period, a functional industrial distinction was evident in Bohemia and Moravia prior to WWI. As in Germany and Poland, the coal-rich seams of Silesia were the focus for the first wave of industrialisation around coal extraction and engineering. Under communism, there was an acceleration of the industrialisation process and a centralisation of control activities around Prague. In the post-war period, Northern Bohemia emerged as a strong centre of chemicals and relating heavy manufacturing activities. This was located close to major East German (DDR) economic centres of

66 http://www.czso.cz/csu/2010edicniplan.nsf/engt/3400222E66/$File/04_1111-10_Souhrn.pdf

Dresden and Chemnitz, whilst an automotive industry emerged in central Bohemia. During the communist period, the second city, Brno, declined in relative terms, as did other cities serving as service centres for agricultural regions in the South West and Central Moravia.

The end of the communist period brought about a traumatic transition process from which the Czech Republic has only recently adjusted. Transition involved a substantial programme of privatisation as well as liberalisation measures designed to position the Czech Republic for its eventual accession into the European Union. The effects of privatisation were mixed; for regions that were strongly dependent on heavy industry, privatisation brought with it deindustrialisation, with uncompetitive and inefficient industries shedding labour heavily: this was particularly concentrated in North West Bohemia and Moravia-Silesia, regions which at the same time underwent a reindustrialisation from foreign investment seeking access to extremely low cost labour, a reindustrialisation that has been followed by a second wave of retrenchment as foreign employers move further eastwards as Czech wages rise. Whilst South West Bohemia found itself close to the buoyant markets of Bavaria and Austria, North West Bohemia found itself in the dead-end of Germany's de-industrialisation, whilst Moravia-Silesia failed to receive any kind of cross border impulse from Polish Silesia, which also entered a parallel process of decline.

The consequences of privatisation were not entirely negative. Those more efficient and modern industries that were privatised continued to thrive and develop. The most notable of these is the automotive sector, with at its heart the Czech industrial flagship Skoda. Sold to Volkswagen with clauses requiring continued investment in production facilities along with a highly educated and extremely inexpensive labour force have seen the sector thrive to the point where almost 20% of the Czech manufacturing economy is in automotives (Czechinvest, 2011). There is widespread consensus that this process is now largely concluded, and the question remains of the future trajectory of these successful privatised businesses, whether the new owners will continue new cycles of investment and sustain their competitive position, or they will experience de-investment and asset sweating.

The other side of liberalisation of the Czech economy was the attraction of significant sums of inward investment. Although slightly later to start attracting inward investment than Poland, Slovakia and Hungary, from the mid 1990s, FDI gross inflows grew at an accelerating rate, peaking in $12bn in 2005 and levelling off at around $10bn by 2008; in 2008, the total stock of FDI in the Czech Republic stood at a per capita level of $11,000, or around $12bn in total (Fifekova & Hardy, 2010)[67]. The main reasons for the attraction of FDI were the good value which Czech workers offered, relatively highly educated and autonomous with relatively low wage levels; much FDI-related employment is in the manufacturing side of production, although there some higher order technical functions, including technical development and some innovation. The question for the coming years is whether the Czech Republic can upgrade the quality of its FDI, and shift away from being a low-cost (or at least good value) location towards being a value-added, high-cost location with relatively high levels of innovation.

67 http://www.czechinvest.org/data/files/fdi-project-report-1981-en.pdf

Table 17 FDI flows supported by Czechinvest, Q1-2 2008, by sector, jobs created and deal value

Type of investment	Jobs created	Investment (€m)
Manufacturing	4542	613.9
Shared services	4587	46.6
Technology centres	540	51.3
Total	9669	711.8

Source: Czechinvest, 2009[68]

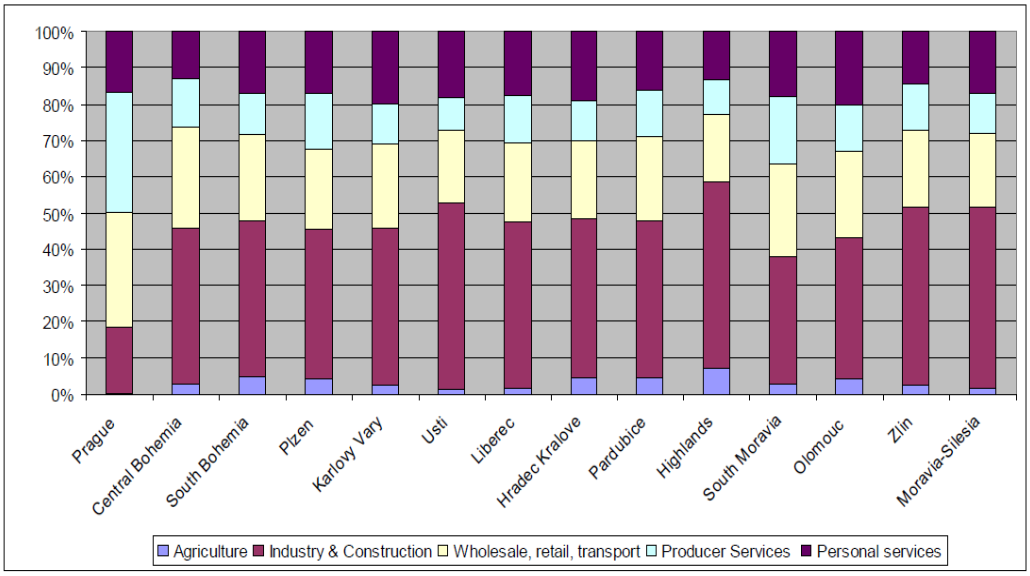
The Czech Republic is therefore strongly dependent on FDI for its economic structure, and the success of regions corresponds closely to their success in attracting and benefiting from inward investment. North West Bohemia and Moravia-Silesia were much less successful in attracting FDI because of their existing industrial infrastructure and polluted environments, whilst greenfield locations in the south and west, near to major European transport connections and Bavaria/ Austria became important locations for FDI. FDI also further benefited Prague because much of the inward investment was in the service sector, in real estate and financial intermediation, activities, which were concentrated in Prague as the primate capital city.

The aggregate affect of these facets of transition has been a huge concentration of the national economy around the Prague region, high order FDI going to Prague with low cost manufacturing to much of the rest of Bohemia, and substantial disinvestment in the former manufacturing regions. The main winning region[69] from the transition process has been Prague, which continued to diverge from the remainder of the country, latest figures suggesting that Prague is the sixth richest European region, after Inner London, Luxembourg, Brussels, Groningen, and Hamburg, placing it ahead of Paris, Stockholm and Vienna (2008). There is a strong degree of functional specialisation; Prague is the national service centre for both business and to a lesser extent consumer services; the Highlands & South Bohemia are the main rural regions, whilst Ustí, Highlands, Moravia-Silesia and Zlín are the largest manufacturing regions.

68 http://www.czechinvest.org/data/files/fdi-project-report-1981-en.pdf

69 More detail on the boundaries and geographies of Czech regions is provided in Appendix B..

Figure 9 Regional employment by sector and region, 2008



Source: Czech Statistical Office, 2011[70]

This level of concentration can be measured through the Regional GDP dispersion index; in the table below, data is presented from countries with a similar population to the Czech Republic as well as the EU27 as a whole. What this table shows is that the Czech Republic has not been unique in terms of this centralisation – whilst Belgium and Portugal have remained with strongly uneven regional GDP distributions, Greece as well as the EU as a whole have showed a trend towards growing divergence

Table 18 The Dispersion of Regional GDP per inhabitant, EU + selected MSs, 1995-2007

Year	Czech R	Portugal	Belgium	Greece	EU27
1995	16.8	26.9	27.5	13.3	-
1996	16.5	26.1	27.4	13.0	-
1997	18.2	26.3	27.4	12.6	-
1998	20.8	27.0	27.5	12.8	-
1999	22.2	26.2	27.4	13.3	25.4
2000	22.8	27.3	28.4	22.8	35.5
2001	24.4	27.0	28.4	23.9	35.2
2002	24.7	26.9	28.4	25.8	34.5
2003	24.9	27.3	27.8	26.7	34.1
2004	24.3	27.6	28.2	27.6	33.4
2005	25.1	28.1	28.3	27.3	33.4
2006	25.4	27.1	27.9	26.3	33.0
2007	26.5	26.6	27.9	28.8	32.7

Source: Eurostat[71]

70 http://www.czso.cz/csu/2009edicniplan.nsf/engt/340019F1C6/$File/137009-ENGLa1.pdf

What this situation demonstrates is the role of Prague as the co-ordinating centre for the Czech economy, with significant numbers of headquarters located in the capital, accounting for the concentration of activity in Prague, and its failure to spill-over into the Central Bohemian region. A key growth challenge for the Czech Republic in the coming years is to diffuse this growth burst across the rest of the country, balancing not weakening Prague's strength in the European urban hierarchy with reducing inflationary pressures arising from an extremely buoyant and dominant capital city. The depth of that challenge is illustrated below by the table, which shows regional GDP indices (where EU27 average is 100). Prague is so far ahead of other regions that continuing the Czech Republic's economic success is dependent on ensuring that the remainder of the country feels the benefit of this growth.

Table 19 Regional GDP by PPS, Czech regions

	1997	2000	2003	2006	2008
Prague	130	136	154	162	172
Central Bohemia	64	64	69	73	74
South West	69	63	67	71	68
North West	65	56	60	61	62
North East	67	62	63	64	65
South East	66	61	66	69	74
Central Moravia	63	56	58	60	64
Moravia Silesia	63	53	57	64	69

Source: Eurostat[72]

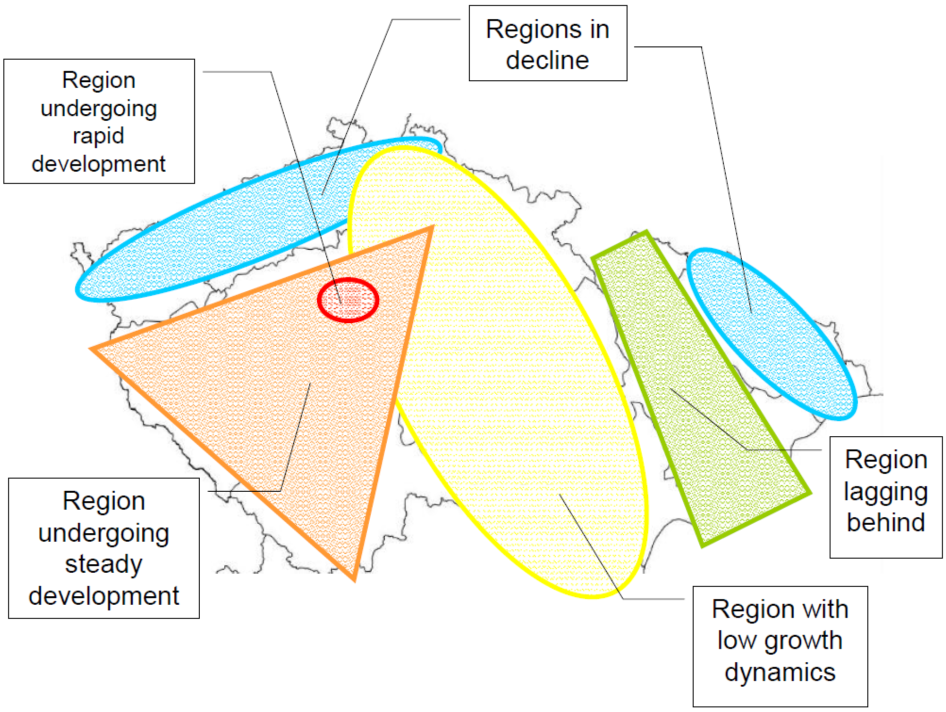
Skokan (2006)[73] presents a five fold regional classification of Czech regions which give an insight into where are the 'hot' and 'cold' spots in the Czech economy. Clearly, the main hot spot is the Prague region, which has continued in the last decade to accelerate away from the rest of the country. The area surrounding Prague has been the next most successful region, South West and Central Bohemia undergoing what Skokan (2009) calls steady development. The South East and North East – a central belt to the east of Prague are relatively static in terms of their economic development potential. Central Moravia – Olomouc and Zlín – remain lagging behind, because of their relative remoteness and peripherality from the main growth centres. Finally, the old industrial centres of Moravia-Silesia and the North West, centred around Ústí nad Labem and Karlovy Vary, remain in a situation of relative decline, with high unemployment rates and relatively low levels of expenditure. This situation is shown in the figure below.

71 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tsdec220

72 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tgs00006

73 Skokan, K.Innovative Concepts in the Regional Policy of the Czech Republic 2006. Published in: Finansowanie rozwoju regionalnego. Wydawnictwo Wyzszej Szkoly Bankowej w Poznaniu (2007): pp. 301-320. http://mpra.ub.uni-muenchen.de/12375/1/MPRA_paper_12375.pdf

Figure 10: The main regional spatial structure of the Czech Republic's economy



Source: After Skokan (qv).

In terms of changing the divergence trajectory that the Czech Republic has followed in the last fifteen years, there is a need to strengthen areas outside the main core region, Prague, Central Bohemia and the South West, without undermining Prague's strength and attractiveness as a service core for central Eastern Europe. A spatial analysis would suggest a need for a polycentric hub region in the central belt area (North East, South East) capable of supporting a dynamic urban hierarchy in Central Moravia with developing functional linkages to the dynamism of Lower Austria, Vienna and the Bratislava city region. The revitalisation of the North West and Moravia-Silesia is a substantial longer-term challenge which will in all likelihood be more influenced by the longer-term evolution of the Czech economy than by direct ameliorative interventions in the short-run, as persistent problems in revitalising old industrial regions in longer-standing EU member states have demonstrated (such as the *Italian Mezzogiorno*).

5.4 The functioning of regional innovation systems in the Czech context

In the context of this highly uneven patterning of economic development potential in the Czech Republic, it is necessary to understand how important these regional environments are to innovative businesses in order to be able to analyse what can best support improving overall levels of innovation activity at a regional and a national level. It is necessary to make a short explanation of current theories in innovation policy in order to create a framework for analysing whether the changes currently underway are strengthening or weakening the Czech Republic's transition towards emerging market areas. The basis for this framework is understanding the increasing importance of innovation to competitiveness: for firms to succeed, they have to be able to develop new products, processes and technologies, but this is a hard process and part of a firm's capability lies in their ability to find partners who can supply them with the necessary resources.

The regional dimension to this is that it has been empirically established that there are some regions in which there is an abundance of innovative resources; firms who are there attempting to innovate find it easier to access the necessary resources. This in turn means that at the meso (regional economic) level, innovation performance, productivity growth and economic success are higher than in other regions. However, it has also been empirically established that the presence of innovative resources are not enough to stimulate innovation and drive economic success. There must also be innovative businesses who are habituated to the use of those resources; regions which have a large multi-national corporation which refuses to work with regional supply chains, then the quality of the regional innovation environment will make little difference either to the success of that firm or to the decision taken within the firm whether to continue investing into economic activities.

There is an important question therefore to be asked about the practices of innovative businesses in the Czech Republic. Firstly, business R&D in the Czech Republic is dominated by the foreign-owned sector (59%) (Hebakova, 2010[74]), which tends to mean large multi-national corporations in mature industrial sectors, primarily the automotives but also more recently into emerging sectors, increasingly targeting technological development and innovation activities as well as manufacturing activity. Knell & Srholec (2006) using Community Innovation Survey data are able to demonstrate that MNCs in the Czech Republic are not an important source of innovation for local companies[75]. Secondly, the locally-owned sectors are not an important player in innovation activities, although they are active in collaborating with others to access the resources necessary for innovation. The table below shows the percentage of innovating SMEs in the Czech regions who collaborate with others as part of their innovation process.

Table 20 Innovative SMEs collaborating with others as % all innovating SMEs

Region	**%**
Prague	0.55
Central Bohemia	0.62
South West	0.55
North West	0.48
North East	0.48
South East	0.54
Central Moravia	0.60
Moravia Silesia	0.49

Source: Regional Innovation Scoreboard, 2010[76]

The theory suggests that the location of innovation support assets is important in a regional environment supporting innovative activity from its regional business base. A number of the experts interviewed noted that this relationship did not hold in the Czech Republic. The first point to make here was that there was no tendency to work primarily with locally-located partner businesses. The table below, taken from Zizalova (2010) reports a study of 106 innovative high-technology businesses in the Czech Republic, and reports their commercial linkages that support their innovative activities. Less than one quarter of foreign-owned businesses (the driver of the Czech R&D base) reported commercial linkages within a region as significant for their

74 http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=69&parentID=65&countryCode=CZ

75 http://www.merit.unu.edu/MEIDE/papers/2007/KNELL_SRHOLEC_Innovation%20cooperation%20and%20foreign%20ownership%20in%20the%20Czech%20Republic.pdf

76 http://www.proinno-europe.eu/page/regional-innovation-scoreboard

innovation activity; by contrast, more than a third reported relationships with partners in other Czech regions and other EU member states as contributing to innovation. This highlights the fact that the locus of innovation partnership in the Czech Republic is not purely regional, but operates at the national level, with over one-third of foreign firms, and nearly 45% of all firms, reporting linkages in other regions as important for their innovation activities.

Table 21 Share of commercial linkages as innovation source by partner geographical location

	All companies	Foreign owned companies
Home town	8.0	9.6
Home region (outside town)	27.8	13.0
Other CR	43.2	38.7
EU25 (without CR)	19.2	35.0
Other Europe	0.5	0.7
Other world	1.3	1.5

Source: Zizalova (2010)[77].

Zizalova also reports mutual R&D investment by innovating businesses, again from the same 106 company survey, by the kind of activity those R&D resources were invested in. This again clearly demonstrates that there is a much higher propensity to invest in (to buy R&D services from) partners in other Czech regions than in the home region, by a factor of at least 50%. This data is shown in table 21 below.

Table 22 Share of mutual R&D investment by geographical location (%)

Sector of investment	Home region	Other CR	World
Own enterprise (other branch plants)	11.7	8.4	6.0
Other private enterprise	12.6	31.2	1.7
Public research institutes	2.5	4.0	1.2
University	9.2	11.1	0.5
Total	36.0	54.7	9.4

Source: Zizalova (2010 *qv*)

These findings – a relatively high level of extra-regional collaboration - can be explained through three parallel but separate effects. The first is that there is a "Prague" effect: as we will show in the following section, the centre of the Czech R&D economy is the capital region. The effect that this has on innovation is that firms seeking the most reasonable partners for co-operation have a tendency to seek partners in Prague simply because that is where the most R&D partners are located. Prague therefore has an important role as a linchpin of the Czech R&D economy. Secondly, there is an FDI effect – given the importance of foreign investors in the national R&D effort, it is clear that their natural locus for innovation collaboration will be either other plants within their corporate family or within their global supply chain.

Finally it is important not to ignore the third effect, which is a "small country" effect; the Czech Republic is a relatively small country and easy to travel around, making interaction with partners located in the country as a whole easy. The east of the

77 Zizalova, P. "Geography of Knowledge-based Collaboration in a Post-communist Country: Specific Experience or Generalized Pattern?" European Planning Studies, 18 (5) pp. 791-814, 2010. http://www.informaworld.com/smpp/content~db=all~content=a922906906

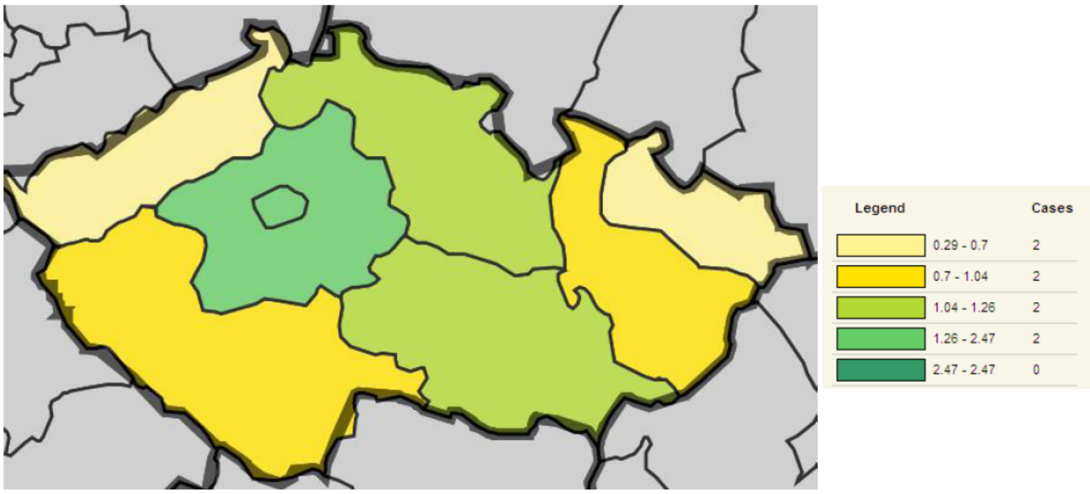
country is the exception to this, with relatively poor infrastructure links to the west and Prague. The infrastructure network is centred around Prague, which means in practice that co-operation between partners in the east and the west is not always easy.

5.5 The regional dynamics of innovation and growth sectors in the CR

The reason for the significance of this in terms of understanding the contribution that the regional policy will make in the light of the science system evaluation is to understand the likely regional growth dynamics of high technology in the Czech Republic. At the macro-perspective, it is likely that the transition towards an advanced manufacturing economy will continue. Taking a meso-perspective – the level of the regions – the key to industrial development that supports this wider shift is the emergence of regional innovation environments outside of Prague that acquire their own innovative momentum and offer attractive *milieux* for high-technology businesses. This will create the environment within which individual firms will respond to their own competitive situations through innovation.

The regional geography of high technology in the Czech Republic mirrors to a certain extent the Czech regional economic geography, as shown in the figure below. Table 8 also provides figures for R&D expenditure by Czech region for the last seven available years. The basic pattern is the same as that of the economy as a whole (and of course they are not entirely independent) with a Prague-centred core coupled to the central belt, an outer core in the South West and Central Moravia, and a periphery of the declining old industrial regions. However, what this graph and data highlights is that there is a higher level of dispersion of R&D activities in the Czech Republic than would be explained by wealth differentials alone.

Figure 11 The regional geography of R&D in the Czech Republic, 2008



Source: Eurostat[78]

78 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00042&plugin=1

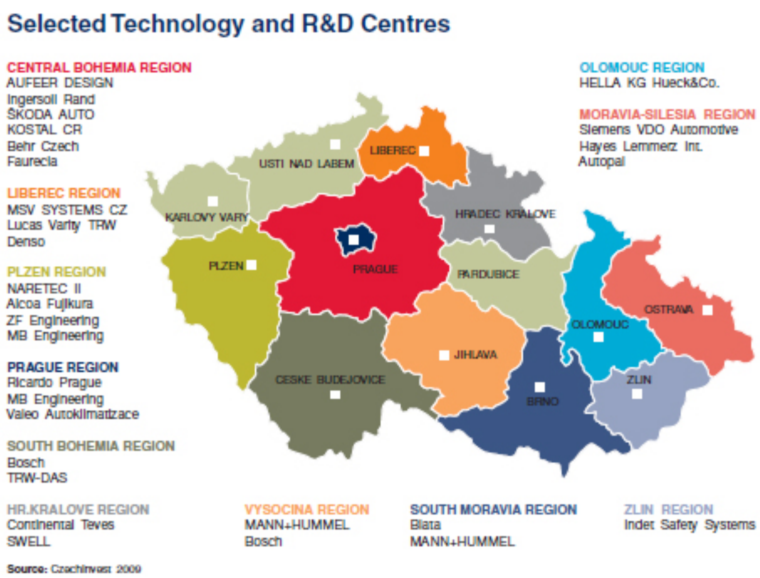
Table 23 Gross Expenditure in R&D (GERD) by Czech region, 2002-08

	2003	2004	2005	2006	2007	2008
Prague	1.83%	1.74%	1.92%	2.01%	2.21%	2.42%
Central Bohemia	3%	2.94%	2.58%	2.43%	2.77%	2.47%
South West	0.59%	0.65%	0.64%	0.66%	0.87%	1.04%
North West	0.28%	0.25%	0.3%	0.24%	0.25%	0.29%
North East	0.8%	0.78%	0.9%	0.98%	1.07%	1.11%
South East	0.98%	1%	1.04%	1.11%	1.26%	1.26%
Central Moravia	0.62%	0.89%	0.74%	0.69%	1.05%	0.88%
Moravia Silesia	0.78%	0.6%	0.98%	0.78%	0.71%	0.7%

Source: Eurostat[79]

The most notable difference here is the relative importance of Central Bohemia when measured in terms of Gross Expenditure on Intramural R&D (GERD). This figure measures the total expenditure on R&D within activities located within that region, as a proportion of the economy as a whole. To give a sense of perspective to this, it is necessary to be mindful that the target for the ill-fated Lisbon agenda was for all regions to have reached a level of 3% by 2010. As the table shows, Central Bohemia reached that level by 2003, and since then, has performed at about that level, always outperforming the central capital region. This can be understood as a Skoda effect, with the high levels of expenditure within Skoda and its supply chain, and the automotive sector in the Czech Republic more generally.

Figure 12 The location of selected R&D and technology centres in the Automotive sector, Czech Republic.

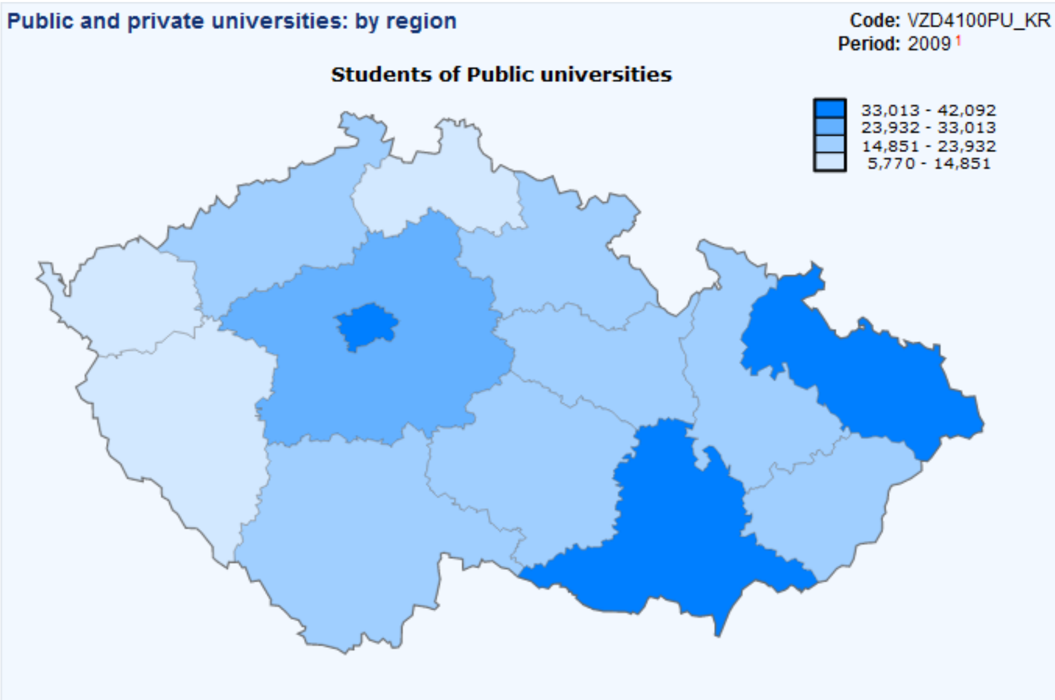


Source: Czechinvest (2011)[80]

79 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00042&plugin=1

One area where the Czech Republic's geography does not follow a concentration around Prague and Central Bohemia is in terms of the numbers of students in public universities. Although there is a strong concentration of private university students in Prague, the same does not hold true for public universities, and as Figure 8 below shows, South Moravia and Moravia-Silesia actually have more students at university than in Prague. The private university situation is relatively easy to explain. In the Czech Republic, as with many emerging economies, private universities are restricted to business-related courses since the cost of other disciplines, such as medicine, engineering – are too high for private universities. As the demand for business administration is heavily concentrated around Prague, it is unsurprising that the Prague region should provide the lion's share of university students. Over half of the private universities are located in Prague (24 of 45) and therefore the patterning of private higher education in the Czech Republic is clearly very sensitive to market demand.

Figure 13 Public University student regional distribution, Czech nationals by home residence, 2009.



Source: Source: http://vdb.czso.cz/vdbvo/en/tabparamzdr.jsp?voa=mapa&cislotab=VZD4100PU_KR&vo=mapa&kapitola_id=17

The table below provides the regional distribution of student numbers in the Czech Republic, according to their home region of residence. In some senses this is a useful measure, because student mobility in the Czech Republic is relatively low, and many students tend to return to their home region (and indeed many study in their home region). This helps to provide a sense of the likely future labour pools for emerging industries. The one area where it does not follow the model of the existing regional economic geography of the Czech Republic is the number of graduates being produced in Moravia-Silesia; although that area has been in steady economic decline since the post-socialist transition, 42,000 residents from Moravia-Silesia are currently

80 http://www.czechinvest.org/en/automotive-industry

studying. Therefore this might produce the basis for an industrial transition towards a highly-skilled economy, if sufficient new employment opportunities can be found to ensure that there is a retention of these graduates in the north east. However, there is clearly here a risk of 'brain drain' of these highly skilled graduates from the north east and South Moravia to the currently booming regions of Prague and Central Bohemia.

Table 24 Regional Distribution of Universities and Student numbers by Czech Region 2007

Region	**Universities**	**Public**	**Faculties**	**Total**	**Public**	**Private**
Czech Republic	71	26	139	354,711	307,987	47,374
Prague	32	8	38	51,146	38,975	12,332
Central Bohemian Region	3	-	1	35,933	27,327	8,688
South Bohemian Region	5	2	9	22,475	20,445	2,067
Plzeň Region	1	1	8	16,24	14,649	1,626
Karlovy Vary Region	1	-	1	7,506	5,77	1,763
Ústí nad Labem Region	1	1	7	22,648	18,966	3,721
Liberec Region	1	1	6	12,474	10,864	1,632
Hradec Králové Region	1	1	5	17,929	16,506	1,453
Pardubice Region	1	1	7	16,997	15,784	1,234
Vysočina Region	2	1	-	18,185	16,727	1,472
South Moravian Region	13	5	27	40,181	36,72	3,522
Olomouc Region	3	1	8	23,031	20,833	2,241
Zlín	2	1	6	23,588	22,076	1,534
Moravian-Silesian Region	5	3	16	45,967	42,092	3,931

Source:
http://vdb.czso.cz/vdbvo/en/tabparamzdr.jsp?voa=mapa&cislotab=VZD4100PU_KR&vo=mapa&kapitola_id=17

This pattern also holds true when considering the regional distribution of Ph.D. students in the Czech Republic. Of a total of 23,500 Ph.D. students, 48% are located in Prague, 25% in Brno, with the only significant other Ph.D. concentrations being found in Moravia-Silesia and Olomouc. Only the Highlands region (Vysočina) and Central Bohemia have no Ph.D. students, although Usti and Karlovy Vary have *de minimis* numbers of Ph.D. students. If one calculates location quotients for students (Ph.D. and Bachelor-Master), the greatest concentration of students relative to contribution to national economy is indeed in Brno; Prague and Olomouc are also comparatively over-represented in the numbers of students. Moravia-Silesia and Plzen have an LQ>1 in terms of Bachelor-Masters students, and in the remainder of the regions there is a comparative under-concentration of students relative to the contribution those regions make to the national economy.

There are two overarching messages emerging here. The first is that the uneven geography of R&D in the Czech Republic is intimately bound up with the distribution of students, and in particular those stagnating and remote rural regions lack the human resources for science and technology to make their own transition. However, the second point is that the provision of students and their human capital contributions are not alone sufficient to drive this transition process. Whilst both Moravia-Silesia and Plzen have a relative oversupply of graduates, Plzen as a region is doing comparatively well in terms of innovation, science and technology, whilst

Moravia-Silesia faces problems in terms of the retention of these resources, and the attendant risks of brain drain towards the capital city region.

Table 25Regional distribution of students undergraduate/ postgraduate 2005/06

	Bachelor/ Master	**Phd Science/ Technology**	**Phd Other**	**Total**
Prague	115241	5920	5279	126440
Central Bohemia	1036	0	0	1036
South Bohemia	10844	292	178	11314
Plzen	16177	553	435	17165
Karlovy Vary	3091	22	0	3113
Usti	8937	36	0	8973
Liberec	7481	385	67	7933
Hradec Kralove	1022	13	551	1586
Pardubice	7844	380	45	8269
Highlands	688	0	0	688
South Moravia	65714	2614	3254	71582
Olomouc	17500	263	1091	18854
Zlin	9236	151	97	9484
Moravia-Silesia	34972	1443	458	36873
	299783	12072	11455	323310

Source:
http://www.msmt.cz/uploads/OP_VaVpI/Zakladni_dokumenty/OP_RDI_final_EN.pdf

An alternative perspective comes by considering the student distribution by residence rather than by location of origin. The following table and graph use the data for the percentage of the population in a region which are at university as a percentage of the regular population of that region. This provides a useful map of the concentration of university activity relative to the general population, and this follows the same pattern, with concentrations of students around Prague and Brno, with secondary hotspots around Moravia-Silesia and Western Bohemia. The table below also shows how the figures have changed between 2001 and 2009, and what they point to is the massification of Czech higher education, with a doubling of overall participation rates in every region, with rates increasing highest in the south east and Moravia Silesia.

Figure 14 Percentage of population at university as % population 20-24ys

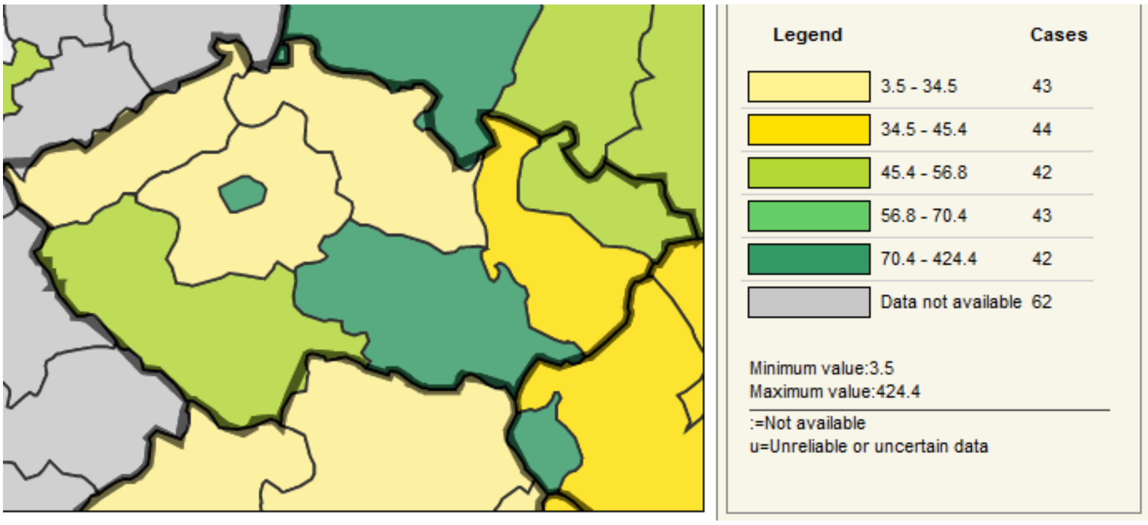


Table 26 Percentage of population at university as % population 20-24ys

	2001	2009
Prague	103.4	187.5
Central Bohemia	2.5	5.9
South West	23.2	46.4
North West	10.3	21.5
North East	18.6	34.0
South East	36.7	77.4
Central Moravia	19.4	39.6
Moravia Silesia	26.9	55.4

5.6 Human resources for emerging opportunity sectors in the CR

In understanding where likely growth sectors are going to emerge in the Czech Republic, and their human resources potential, it is necessary to build up a complete picture of the current human resource base and understand how that will evolve into the future. The human resources necessary for emerging opportunity sectors in the Czech Republic can be considered at a number of levels. These are listed below from the lowest skill level necessary upwards.

- Operational skills necessary for employment in basic production activities (in manufacturing or services) in these emerging sectors
- Advanced manufacturing and technician skills necessary for high-level, value-added, pilot and prototype activities in emerging sectors
- Innovation and R&D skills necessary for new product, process and technique development within Czech locations
- High level managerial/entrepreneurial skills necessary for creating high-technology start-ups to absorb and embed new technologies in Czech innovation systems

– *Operational skills necessary for emerging high-technology businesses*

  The operational skills necessary for employment in emerging sectors broadly correspond to the existing education levels. There are a total of around total of 5.2m employees in the Czech Republic (ESA95)[81]. Interviews with experts noted that there was a sense that the relative cost-competitiveness of operational employees in the Czech Republic was declining. It was reported inward investors sought out the Czech Republic as a location for high-quality but above all low cost manufacturing activities. As operational labour costs have risen, there is a question about whether productivity growth can be sustained to ensure that the Czech Republic remains a value location for investors whilst making the shift into an advanced manufacturing economy.

– *High-level skills necessary for emerging high-technology businesses*

  In terms of the next level of skills required, what Eurostat term "Human Resources in Science and Technology" can be calculated. This is the percentage of employees who have either a third-level (advanced technical or degree-level) education or have experience of working in a sector where such a qualification is required for employment. Taking this narrower measure of the potential labour force for emerging technology areas, there is a strong regional pattern to these resource allocations that broadly follows the pattern of the national economy as a whole. Prague is exceptionally strong, with over one half of employees having a third-level qualification; along this, there is the South West, South East and Central Bohemia where well over one-third of the labour force have a third-level qualification, and then in the North West, one of the Czech Republic's declining industrial regions, only one-quarter of the population have the skills or experience to qualify them in the high-technology economy. The distribution, and its evolution over the last decade are shown in the table below.

Table 27 Human Resources in Science and Technology, Czech Republic, 1998-2009

	1998	2002	2005	2009
Prague	45.8	50.4	53.9	57.1
Central Bohemia	22.1	25.4	30.6	36.2
South West	28.4	28.9	30.5	35.2
North West	23.9	24.4	25.6	27.7
North East	26.7	26.3	30.6	32.4
South East	31.6	30.8	34.5	39.1
Central Moravia	25.6	26.8	29.8	32.8
Moravia Silesia	26.7	29.5	29.6	33.5

Source: Eurostat (2011)[82]

81 http://www.czso.cz/csu/2009edicniplan.nsf/engt/7A003C99FA/$File/13710926.xls

82 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00038&plugin=1: "the percentage of the total labour force in the age group 15-74, that is classified as HRST, i.e. having either successfully completed an education at the third level or is employed in an occupation where such an education is normally required. HRST are measured mainly using the concepts and definitions laid down in the Canberra Manual, OECD, Paris, 1995"

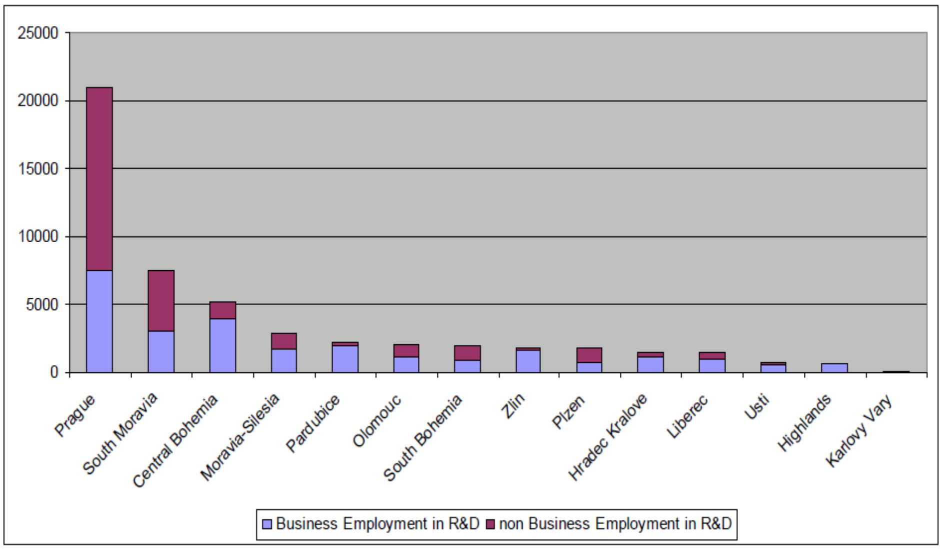
– *R&D skills necessary for emerging high-technology businesses*

A third level of scientific resources are provided by the figures for employment in R&D activities, shown in the figure below which shows all employment, differentiated between positions inside and outside of the business sector. In viewing these figures, it must be remembered that this sector covers only 50,000 employees in a labour market of more than 5m, meaning that these R&D positions cover only 1% of the workforce. Nevertheless, these positions are critical for the upgrading and path-switching in enterprises necessary to help the Czech Republic complete its transition towards an advanced manufacturing economy. The figure below shows the regional distribution of R&D employment in the business and non-business (university and government) sectors.

What comes through very strongly in this figure is the dominance of the capital, Prague: in 2008, 40% of all employment in R&D was located in Prague. However, and unlike the pattern suggested by the GERD figures, the second region in terms of R&D is South Moravia, with 15% of all Czech employment in R&D, over twice that of the third region (Central Bohemia). But when one distinguishes between business and non-business R&D, a more complex story emerges. Whilst Prague is clearly the centre of university and government (public sector) R&D, accounting for 54% of national public R&D, it only accounts for 29% of private R&D employment. Central Bohemia (15%) and South Moravia (12%) are also important centres of private R&D activity.

It is clear that Prague is at the centre of a relatively dense web of innovative and R&D activities of national significance which are strongly based on a concentration of public R&D activities. Central Bohemia also contributes to that cluster of activity, although it has a much greater relative concentration of private R&D than either Prague or the Czech average, and that Central Bohemia's activities also contribute to that cluster. There is a second research, development and innovation pole, centred around Brno, in the region of South Moravia, which is significant in terms of the numbers of people employed, and absolute R&D expenditures.

Figure 15 Employment in R&D by Czech region, 2007



Source: Czech Statistical Office (2011)[83]

83 http://www.czso.cz/csu/2009edicniplan.nsf/engt/340019F1C6/$File/137009-ENGLa1.pdf

There is clearly an imbalance between the distribution of public and private R&D employment. It is possible to extrapolate a surplus or deficit of public sector R&D jobs that would be present in each region if the total number of public R&D jobs in the Czech Republic were distributed according to the distribution of private R&D employment[84]. From this extrapolation, we can see that the regions which are 'oversupplied' with public R&D jobs (given their private sector R&D activity) are South Bohemia, South Moravia and Prague, whilst Central Bohemia, Pardubice and Zlín have far fewer public R&D jobs than would be warranted by their business R&D employment. Even discounting for the fact that a case could be made for including Central Bohemia within a Greater Prague region, it is clear that public R&D employment is more concentrated in the large cities, and particularly in Prague, than the private distribution of R&D would lead one to expect.

Table 28 Balance of public R&D jobs extrapolated from private R&D regional distribution

Region	**Public R&D employment balance**
Central Bohemia	2081
Pardubice	1299
Zlin	1097
Moravia-Silesia	625
Liberec	593
Hradec Kralove	536
Highlands	506
Olomouc	314
Usti	310
Plzen	113
Karlovy Vary	102
South Bohemia	-315
South Moravia	-534
Prague	-6729

Source: authors' own calculations.

– *Entrepreneurship and entrepreneurial research skills for new high-technology ventures*

The interviews with key respondents in the Czech Republic suggested that there are problems around the highest level of skills, that of entrepreneurs able to set up companies. This was a small part of a wider problem around high-technology entrepreneurship in that there were also very few resources for entrepreneurs to establish businesses and difficulties for locally-owned firms in emerging into breaking into the supply chains of global companies

84 The point of this extrapolation becomes clear in the final subsections where the contention is analysed that the Centres of Excellence and Regional Centres programme risk undermining the contribution which the Czech Republic science base makes to the emergence of new high-technology sectors in the Czech Republic.

operating locally. Part of this is a high-level skills question, and in particular, proportionally low higher education participation rates in the Czech Republic (Teruel & De Wit, 2011[85]). Key respondents identified that a key bottleneck for the growth and success of high-technology start-ups firms in the Czech Republic was more likely to lie around graduates rather than in post-doctoral or higher researchers.

A number of respondents commented on the almost total absence of high-technology venture finance for new ventures, as well as problems in the environment for Intellectual Property that contributed to that. Acs & Szerb (2011)[86] list Venture Capital as the worst variable in the Czech Republic for entrepreneurship, above knowledge of entrepreneurship and higher education as the other two weakest characteristics (the strengths being openness, globalisation and attitude to risk). For high-technology venturing, it is not just the absence of funds which is the problem.

There were uncertainties over who owned the IP that emerged from university and ASCR research laboratories. High-technology start-ups based on exploiting analytic knowledge-base[87] IP could not easily legally establish that they owned what they were in effect asking investors to fund. Likewise, the absence of substantive post-doctoral positions with career development prospects in research groups meant that high-technology firms exploiting synthetic knowledge-base innovations in existing research teams were asking investors to invest in developing knowledge in research staff whose contracts often had extremely short life-spans, and whose commitment to long-term partnerships with high-technology ventures was sorely in doubt.

It is important therefore not simply to reduce this absence of entrepreneurial skills to something that can easily be addressed through entrepreneurial coaching. Evidence suggests that entrepreneurial behaviour in high-technology ventures in the Czech Republic might be 'irrational' given the problems that exist in starting a business from the local knowledge base. Part of improving entrepreneurial performance is a question of improving individual skill levels (particularly opportunity recognition, networking and entrepreneurship skills for entrepreneurs as well as skills in working in start-ups for employees). However, and arguably more important is also improving a number of these environmental variables, including venture support provision, effective mentoring from successful entrepreneurs, and clarifying the IP position for publicly-funded research in ways that does not create disincentives for start-up activities.

85 http://www.accountancynieuws.nl/Uploads/Files/EIM_2.pdf

86 Acs, Z. & Szerb, L. Global Entrepreneurship and Development Index: 2011, Cheltenham: Edward Elgar, 2011.

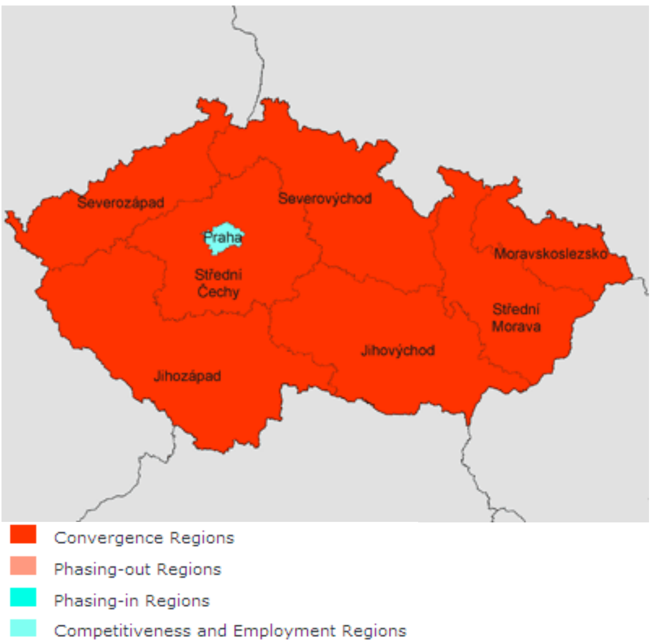
87 This uses the classification developed by inter alia Asheim & Gertler to categorise the way in which academic knowledge is used. Analytic knowledge typically emerges from hard science and is based on the findings from that research which often can be codified and patented, such as the discovery that a chemical compound has particular in vitro medical properties. Conversely, synthetic knowledge typically emerges from engineering and involved techniques and tricks which emerge through the research process which have a wider value, and are not easily patented, and therefore need exploiting by implementing in solutions. Asheim, B. & Gertler, M. "The geography of innovation: regional innovation systems" In: J. Fagerberg, D. Mowery and R. Nelson (Eds), The Oxford Handbook of Innovation, Oxford University Press, Oxford , pp. 291–317, 2005.

5.7 Structural funds in the Czech Republic

The Czech Republic joined the EU in 2005 along with nine other new member states, and since that point, it has been eligible to participate in the Structural Funds. The Structural Funds aim is to facilitate the working of the Single Market by helping to support those regions who temporarily lose out through restructuring to improve their competitiveness and support the convergence of their income levels upwards to the European average. European Structural Funds follow a programming period in which there are multi-annual periods for which strategies are developed, following a common logic, administrative procedures and rules. The Czech Republic joined the EU towards the end of the 2000-06 programming period which finished in 2006 (and which under the '+2' rule all funds had to be expended by 2008).

In this first period, all of the Czech Republic except for Prague was eligible for Structural Funds under Objective 1. Prague had a GDP per capita of 135.5% of the EU15 average, which under the then-rules of the Structural Funds rendered it ineligible for Objective 1 funding, for poor regions[88]. 9 of Prague's 22 districts were eligible for Objective 2 funding (at a much lower level), covering 350,000 of the city's 1.2m population. This situation evolved slightly in the next programme period; all regions outside Prague were eligible for convergence funding, funding for the poorest regions to allow them to benefit from the Single Market; Prague was eligible for competitiveness and employment funding only, a much smaller fund for all other regions to address specific structural problems. This situation is shown in figure 16 below.

Figure 16 Eligibility for EU Structure Funds, by region, 2007-2013



Source: CEC (2011a).[89]

The figures involved in the Structural Funds are considerable; a total of €25.8bn EU funding is being invested outside the Prague region, and only €500m in the Prague

88 http://ec.europa.eu/regional_policy/country/prordn/details.cfm?gv_PAY=CZ&gv_reg=ALL&gv_PGM=383&LAN=7&gv_PER=1&gv_defL=7

89 □eská republika: Eligible areas under the Convergence Objective and the Regional Competitiveness and Employment Objective http://ec.europa.eu/regional_policy/atlas2007/czech/index_en.htm

region. Of this, a total of €80m is available for all innovation support activity in Prague, and the total sums that will be able to support national centres of excellence in the Prague capital region (regional competitiveness and employment) are therefore tiny (€500ms) et against what is available for the non-Prague regions (€25.8bn for convergence regions)[90]. The total allocation of Structural Funds to the Czech Republic in the 2007-13 programming period is given in table 11 below, funding coming from the Cohesion Fund (*CF.*), European Regional Development Fund (ERDF) and the European Social Fund (ESF).

Table 29 Funds for the Czech Republic (€bn), 2007-2013

Objective	**Fund**	**EU**	**National public**	**Total**
Convergence	CF	8.8	1.5	10.3
	ERDF	13.4	2.3	15.8
	ESF	3.6	0.6	4.2
Total Convergence				*25.8*
Regional Competitiveness and Employment	ERDF	0.3	0.04	0.3
	ESF	0.2	0.02	0.2
Total regional Competitiveness and Employment				*0.5*
Total European Territorial Cooperation*	ERDF	0.4	-	0.4
Total		26.7	4.6	31.3

Source: CEC (2011b)[91].

This report is concerned with evaluating the Czech's R&D system, and in light of that goal, there is one Operational Programme for the Structural Funds in this programme period that is particularly salient, namely "R&D for innovation". This Operational Programme allocates over €2bn of European funds, with a national matched funding contribution of €350m to the development of research assets which support the competitiveness of the Czech economy. The total financial envelope of this programme is €2.4bn. The scope of the required national matched funding contribution means that €365m have to be allocated from existing national budgets. Given the entire public budget for R&D is CZK32bn (2009, €1.32bn) the €52m which have to be found annually for matching for this Operational Programme are a significant proportion of the total budget. There is therefore very limited scope for funding activities in these fields in areas that are not eligible for the Structural Funds (i.e. Prague).

90 Operational Programme 'Prague': Programme under the Regional Competitiveness and Employment Objective, http://ec.europa.eu/regional_policy/country/prordn/details_new.cfm?gv_PAY=CZ&gv_reg=ALL&gv_PGM=1027&LAN=7&gv_PER=2&gv_defL=7;

91 http://ec.europa.eu/regional_policy/sources/docgener/informat/country2009/cs_en.pdf

Table 30 Breakdown of financing Operational Programme, R&D for Innovation, 2007-2013

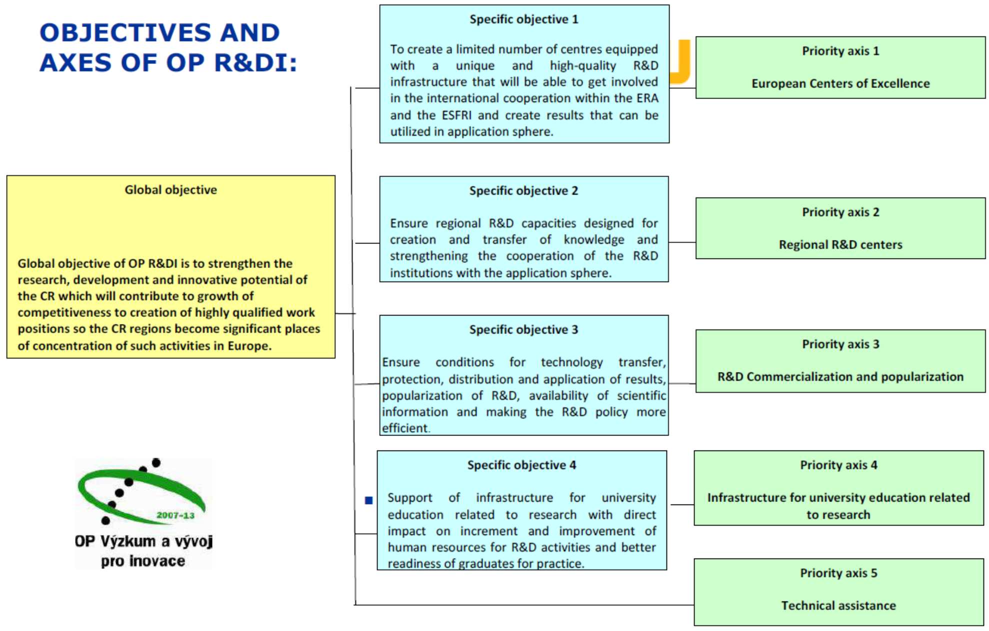
Priority Axis	EU Contribution (€m)	National contribution (€m)	Total public contribution (€m)
European Centres of Excellence	685	121	806
Regional R&D Centres	685	121	806
Commercialisation and Popularisation of R&D	213	38	251
Research Infrastructure for University Education	414	73	487
Technical Assistance	472	13	85
Total	2070	365	2436

Source: CEC (2011c)[92]

The table above alludes to the fact that this Operational Programme operates through five priority axes, each of which have a separate budget line allocated to them. The lion's share of the budget is taken by Objectives 1 and 2. Objective 1 involves the creation of Centres of Excellence which represent substantial scientific infrastructures, are well-networked within European scientific programmes, and which contribute to national competitiveness through promoting innovation. Objective 2 involves building an infrastructure of regional technology transfer centres which ensure that businesses located out with the Centres of Excellence regions nevertheless have access to the technologies developed within the research base, again helping to raise national competitiveness by stimulating innovation. The remainder of the programme, excepting technical and administration areas, is related to supporting technology transfer more generally and providing resources to improve graduate labour market readiness. The main areas for the programme are shown below.

92 Operational Programme 'Research and Development for Innovations' http://ec.europa.eu/regional_policy/country/prordn/details_new.cfm?gv_PAY=CZ&gv_reg=ALL&gv_PGM=1245&LAN=7&gv_per=2&gv_defL=7

Figure 17 Specific Objectives Operational Programme, R&D for Innovation, 2007-2013



Source: Durr, 2009 2011[93]

A key element of the Operational Programme reflects the unusual reality that not all the country is eligible for these investments in science and technology. The objectives of the OP are framed in a way to emphasise that the point of the investments in R&D&I are to drive both regional competitiveness as well as to strengthen the Czech science system as a whole.

> *"The global objective of the OP R&DI is to strengthen the research, development and innovation potential of the Czech Republic that shall contribute to its economic growth, competitiveness and to the creation of highly qualified workplaces so that the Czech regions can become important locations for the concentration of these activities within Europe"*[94].

The issue in the context of this section is whether that direction of investment under the Operational Programme (and including national annual commitments of the order of €800m) will strengthen or weaken the Czech Republic as a whole. Key respondents suggested that the resources made available from the national budget would not be additional to other resources for knowledge exchange. That is equivalent to saying that this Operational Programme effectively determines the Czech "Research, Development and Investment" (knowledge transfer and valorisation) policy for the period 2009-2015 (the period during which the resources can be spent). This might effectively mean, were it to be true, that the Czech Republic would have adopted a research, development and innovation plan which largely excluded Prague. To get a better sense of the 'resource gap', the resources that Prague receives for the promotion of innovation under the Objective 2 funds (c. €100m) must also be included in the reckoning. The table below shows how the total funds made available for Research, Development and Investment would also be allocated to between Prague and the rest

93 Support of R&D by EU: Czech perspective: http://www.czelo.cz/dokums_raw/Jakub_Durr_1.pdf

94 http://www.msmt.cz/file/5299_1_1/

of the country if they followed the pattern of regional population, employment and GDP (none of the regional OPs outside Prague include RTDI activities).

Table 31 The potential funding gap, OP R&D&I, Prague and Rest of CR, 2007-2013.

	By Population	By Employment	By GDP
Prague	-€183.5m	-€321.7m	-€505.3m
Rest of CR	€183.5m	€321.7m	€505.3m
Total CR	0	0	0

Source: authors' own calculations.

Thus, when talking of a funding gap – if one accepts the logic that Prague must also be invested in as much as the remainder of the country, in line with the contribution Prague makes to the national economy - then the maximum funding gap which exists is around €70m per annum.

But, it has already been shown that the Prague city region has a public employment in R&D *surplus* of 6,800 jobs with respect to the rest of the country (beyond that predicted by private R&D patterning). Czech Statistical Office data shows that the direct contribution of an employee in Prague is €38,800, which means that

- There is already a net annual subsidy to public sector R&D employment in Prague of €260m
- Operational Programme R&D&I does no more than ensure public expenditure supporting private expenditure in R&D&I benefits all Czech regions
- This point also holds if Central Bohemia is included with Prague to form a single region.

5.8 The HR impacts of the Centres of Excellence and Regional Centres

A final area consideration is the impact that the Centres of Excellence and Regional Centres will have on the Czech high-technology labour market, and in particular the additional capacity that this will create for industries seeking to make the industrial transition. In order to explore this, it is necessary to have a heuristic both for the geographical distribution of these centres, and also to consider the likely human resource impacts that these centres will have. Clearly, much of the impact of these centres on emerging industries will come through formal technology transfer, knowledge transfer and knowledge exchange through consultancy, licensing, patenting, collaborative research and equipment sharing. These kinds of impact fall without the scope of this chapter and indeed this report in its entirety, which is exclusively concerned with the human resources elements of the Czech science system.

The first element of the heuristic of the policy impacts is that a number of existing research centres of excellence (11 in total) and regional centres (36 in total) will be created. It is too soon in this whole process to be able to effectively judge what the regional impacts of these centres will be. However, a number of factors suggest that a number of critical problems in this kind of programme have been avoided which in turn will lead to later being benefits produced by these centres. The first is that there has been a sensible allocation of resources: there has been a relatively high degree of concentration rather than a 'salami slicing' of resources and their patterning suggests that it follows a logical pattern – that of the underlying regional geography of science in the Czech Republic as a whole. It seems particularly sensible that Brno features so centrally in both the CoE and RC schemes, given its existing scientific strengths as well as the experience of South Bohemia's sub-national administrations in developing regional innovation system policies and strategies; a good foundation has been laid for South Bohemia to become a flagship region in terms of delivering the intentions of the OP.

Secondly, mechanisms have been found to ensure that Prague has been able to access the resources in some limited cases, which appears to fit with the spirit of the Operational Programme as a whole and the needs of the Czech Republic. Thirdly, the various centres do appear – at first glance – to follow existing scientific infrastructure and to help ensure investment in the science base which further contributes to the Czech scientific transition. Finally, the geography of the resource allocation comes some way to helping correct the current regional imbalance in the Czech science system, namely the over-concentration around Prague: the costs of sustaining this over-concentration into the future are likely to be very high and to stimulate undesirable effects elsewhere in the Czech Republic, such as continuing outmigration of highly skilled employees from the old industrial regions.

The second element of the heuristic is to understand the human resources implications of these centres and the way they manage their staff. They will receive a substantial amount of funding for a multi-annual period, which will be used both to support fundamental research as to apply research findings in partnership with industry. The balance between these will vary between the two kinds of centre as well as within the group dependent on the relative state of the public and private research base. These centres will employ staff at a variety of levels, senior/ professorial, post-doctoral and post-graduate, and these staff will all have targeted career development programmes so that their time in the centres improves their human capital levels, both in terms of their capacities for excellent research as well as working in partnership with industry. There is therefore considerable potential for these centres to contribute to the human capital formation process in the Czech Republic.

It is important to note that three different sectors are involved in the delivery of the OP centres: university departments, ASCR institutes as well as private research businesses. Therefore it is important to note that there will be different human resources processes at play in each centre, reflecting both the different sectors and their governing laws, as well as differences in the way that they choose to organise their activities. It is clear that one human resource impact will be to create significant numbers of jobs: in 2008, total employment in R&D was 51,000 for a gross expenditure of CZK 54bn. That means that one can expect on R&D job to be created for each CZK 1.06m expended (c. €42,500). This means that around an additional 2,700 jobs annually may be created over the lifetime of the programme (assuming full additionality alongside negligible displacement and deadweight effects).

The impact of these jobs depends on the extent to which they are genuinely additional and in particular unblock the problems identified in the functioning of the Czech high-technology labour market. A clear problem in this regard is short-term funding for contracts leading to employment insecurity for postgraduate and post-doctoral researchers. On the one hand this stimulates brain drain from the Czech Republic to countries offering more secure employment; on the other hand, it undermines the formation of intellectual property that can be protected and developed to stimulate new high technology centres. Part of this is an issue that has emerged throughout this work-package, regarding the legal status of postgraduate and post-doctoral researchers. The challenge here for the centres is in using the considerable flexibility that abundant resources brings not only to maximise the volume of activities in terms of human resources, but maximise the human resource benefits. That is to say that it is important to ensure that just as resources are concentrated in a limited number of centres, resources should be concentrated in more limited numbers of positions. This will ensure that those recruited have the opportunity to work effectively on research programmes rather than having to seek additional funding and supporting their own salaries through the sale of near-to-market services and consultancy activity.

A further area where there is a pressing need for improvements to be made in the Czech Republic is in terms of the educational experience of undergraduate and postgraduate students at the masters and bachelor level. This is arguably more important for the next step of the industrial transition process, in securing the Czech Republic's place as a location for high value-added investment in the future. The centres may be able to augment the learning experience if they are able to make students more cognisant of the real-world applications of their studies and techniques and methods for applying high-level knowledge ion practical contexts. The scope for achieving this will vary between some of the centres. Although some centres may be private-sector led and therefore not in a position to provide teaching opportunities for their staff, others are, a good example here being the Centre for Research and Education Unipetrol in Zaluzi.

5.9 Analysis

This analytic section begins from the first conclusion drawn above, that the Operational Programme does not pose a risk in diverting public expenditure away from Prague. Prague is already in receipt of a substantial public investment in R&D activities that greatly leads the proportion of national private R&D effort accounted for in the national capital. It is not therefore reasonable to analyse the Operational Programme on the assumption that it might be undermining the strength of the national capital at the expense of the outlying regions. A case might be made that Prague is dependent on RTDI subsidies at the expense of the rest of the country, and that the Operational Programme will weaken Prague. However, a strength built upon a subsidy that does not clearly correspond to a market failure is a poor strength, and Prague will in the longer term be stronger through this rebalancing exercise. Indeed, a reasonable case could be made for considering how to get a closer regional match between public and private R&D employment, particularly in Central Bohemia, Pardubice and Zlín. The availability of OP R&D&I funding in Central Bohemia will undoubtedly strengthen Prague, given that the Prague region is less than 25km across.

Once that concern has been addressed, a more constructive analysis can begin from the point that what is important is the development of sub-capital regional centres which can help upgrade the quality of economic development the central belt, South Moravia and South West Bohemia. The challenge is in ensuring that the investments in the OP R&D&I contribute to strengthening the high-technology economy of the Czech Republic and open up new economic fields to the country which are increasingly strongly linked to endogenous technology assets. For each of the areas proposed under the OP, the preceding analysis makes it possible to identify the boundary conditions under which they will succeed. Policy recommendations are then made on the basis of what is necessary for those boundary conditions to be achieved. This is summarised in the following SWOT analysis.

Table 32 A SWOT analysis for using OP R&D&I to contribute to emerging technological areas

Strengths:	**Weaknesses**:
Substantial, long-term funding for knowledge exchange activities Good network of public universities outside Prague as bases for CEs/ RCs Existing Regional Innovation Strategies identified how RCs could add value to regional innovation A few regional development agencies with understanding of regional needs	No regional political oversight of national Operational Programme Poorly developed career structures in Czech science for newly appointed staff undermine progressive scientific labour market. Lack of apparent belief in economic potential of regions outside Prague. Short-termism and lack of co-ordination in territorial economic development policy Barriers preventing knowledge in science base being exploited in Czech Republic markets.
Opportunities:	**Threats**:
Move long-standing public RTDI employment bias around Prague towards private pattern Creating high-technology venturing support services in emerging technology areas Creating national network promoting high-technology venturing in Czech Republic. Creating 'market for opportunities': network of entrepreneurs, mentors, financiers, business support organisations, R&D organisations. Qualitatively improving the volume and level of scientific research in the Czech Republic.	Failure to allocate Community Funds leads to a net under-spend of national funds for knowledge exchange 'Salami-slicing' OP funds across 13 regions fails to build critical mass and excellence Maximising employment creation prevents staff from developing human capital and intellectual property in post Reform failure around new venture regulations inhibits emergence of locally owned high-technology firms Opacity in political decision-making discourages long-term investments

- **Centres of Excellence:**

  The Centres of Excellence are intended to be Czech nodes within the European Research Landscape. This means that they need to be sufficiently resourced and of suitable quality to participate in the successor to the European Framework Programmes and EIT activities. They must be attached to universities which are or which aspire to World Class status (Top 300). Currently, the only university meeting this criterion is the Charles University in Prague; therefore, there need to be a number of World Class (or aspiring) Universities in the Czech Republic. The Centres for Excellence programme need be part of a determined push to increase the profile, quality, visibility and attractiveness of Czech science to the outside world. As part of this, these centres need to be working with Czech located businesses to improve their competitiveness, further embed those companies in the Czech Republic, and upgrade the quality of their activities, including their relative employment in R&D&I activities in the Czech Republic.

There is a clear question over which are the potential world-class universities in the Czech Republic, and how many WCUs could a country such as the Czech Republic aspire to have. Belgium has for example 3 top 200 and 5 top 300 universities in the Shanghai Jiang Tong Academic Ranking of World Universities 2010. Therefore there is no reason to argue that the Charles University is the Czech Republic's only potential world-class university. It is clear that if the Centres of Excellence Plan is managed effectively, then it may provide a considerable impulse towards helping building world-class universities in the Czech Republic. In terms of which universities these might be, there are diverse rankings systems in place: in the QS Top 600, Masaryk University and Brno University of Technology are both ranked. The main point here is that it is possible to develop a sensible policy for the Centres of Excellence that contributes to national development goals without those Centres necessarily having to be located in Prague.

- **Regional Centres:**

  The Regional Centres are intended to be activities at the regional level which ensure that useful knowledge is created in the Czech regions and flows out to create economic impact of benefit to the Czech Republic as a whole. A key issue here is that since the regional reforms of 2000, there have been many policy measures attempting to stimulate knowledge transfer and create supportive regional innovation systems. Whilst it would be a simplification to say that these have not succeeded, it is important that the Regional Centres avoid the issues that led to this situation. The failure to develop effective regional innovation strategies in the Czech regions can therefore be regarded as a shortcoming in experience and leadership in regional innovation policy makes[95]. Regional innovation policy fell to regional development agencies, which in many cases lacked the expertise for sensible knowledge dissemination activities, and certainly could not play the role of RIS managers. Faced with a competing array of initiatives and activities, most more tangible and obvious than innovation support, regional innovation systems have been long-neglected in the Czech policy perspective.

  A key role for the regional centres need therefore be in providing appropriate leadership for regional innovation systems. Given the total sums involved (c. €120m per annum to be spent across 13 regs) these Regional Centres cannot control the RISs, but what they can do is act as the focal point for the innovation community. Regional development agencies have in some cases developed regional innovation strategies: regional centres provide the opportunity to come up with a far more systematic approach to regional innovation. The main condition under which the regional centres will be a successful contribution to the Czech national innovation system is if they can produce a more systematic approach to regional innovation, and critically, create a group with a shared understanding of how to identify strategic priorities and then assemble the funding packages necessary to deliver them. This delivery of a systematic approach is also a vital precondition for successful future support for technology transfer.

- **Supporting technology transfer:**

  The third area of the OP – accounting for around 10% of the total budget for the OP – is support for technology transfer. Blazek & Uhlir identify that one of the substantial problems in the Czech innovation system as a whole is formal separation between the various elements of the Czech innovation system. As a consequence of privatisation, the government research organisations that formerly provided applied research either became commercial consultancy

95 Bla☐ek, J. & Uhlí☐, D. 'Regional Innovation Policies in the Czech Republic and the Case of Prague: An Emerging Role of a Regional Level?', European Planning Studies, 15(7) pp. 871-888, 2007.

organisations or disappeared, leaving a huge gulf between the basic research activities of the ASCR and the potential research needs of innovative businesses. However, creating effective technology transfer is not merely a question of creating intermediaries to bridge between different sectors, but supporting the RIS as a whole. Support is necessary to help academic researchers render their knowledge in ways that can be applied (supply side). Support is necessary to help (particularly small and medium-sized) enterprises absorb and exploit that knowledge (demand side). Support is necessary to bring knowledge creators and users together and develop trust between them (intermediaries). Support is also necessary to create the appropriate formal institutional and informal cultural infrastructure to underpin the effective circulation and exploitation of knowledge.

Acs & Szerb (2011) highlight that there are problems in each of these in terms of high-technology entrepreneurship and venturing in the Czech Republic. What is necessary is concerted action to address these different areas in tandem: what is also necessary is a focus on concrete activities where partners are actually interacting and exchanging knowledge for innovation, identifying ways that existing activities & mechanisms can be expanded and generalised. What is necessary for a successful technology transfer policy is to identify what are the key assets and successful innovation support activities in the regions of the Czech Republic, and expend funds to increase the scope of those activities. Co-ordination with the Regional Centres will be necessary because clearly the scope of these investments will make the regional centres focal points of the technology transfer strategy. The way that technology transfer activities articulate with the Regional Centres is an important issue here: it is critical not to create hundreds of diverse activities with no overall co-ordination; rather there need be a clear architecture for innovation support in the Czech republic, identifying the role of Centres of Excellence, Regional Centres and Innovation Support activities, and the pathways by which aspirant and attempting innovators can access public policy support for their innovation.

- **University education infrastructure*:***

  The final element of the OP R&D&I concerns the infrastructure for university research, and in particular in investing in ensuring that the student experience equips the student for the challenges of the future Czech labour market. An element of that is purely numerical, in ensuring that universities have the capacity in their technical departments to ensure sufficient graduates to meet burgeoning labour market demand in the face of persistent criticism in the relatively low numbers of Czech graduates. A number of key respondents have claimed that damage was done to education curricula in the Czech Republic by increasing student numbers in an unfunded way, which led to a purported lowering of academic standards. OP R&D&I funds cannot be used to directly increase student numbers, but thought need to be given to what useful interventions can be made to universities to ensure that numbers of science and technology graduates can be increased without compromising the overall quality of the received education, and ideally even increasing that quality level.

  The Priority Area also makes mention of the need to invest in infrastructures with the capacity provide graduates with employability skills. The evidence would suggest that the challenge is not exclusively in equipping graduates to work in development and innovation laboratories for foreign-owned companies, but also to have the enterprise and entrepreneurial skills to establish and work productively in new businesses. Student, doctoral researcher and post-doc entrepreneurship could therefore form an important element of creating these broader employability skills, and embedding enterprise exposure in the wider student experience. In so doing, one should be mindful of the need to avoid a proliferation of small programmes, and to ensure that there were sufficient organisational pathways to ensure that aspirant student entrepreneurs received suitable support from the technology transfer and Regional Centre elements of the programmes to maximise the growth potential and economic contribution of graduate businesses.

5.10 Policy Recommendations

This section has been concerned with the impact of the Operational Programme Research, and Development for Innovation on the functioning of the Czech science system and its implication for the Czech regions. The policy recommendations in this section are therefore restricted to considering what could be done within the OP to maximise the synergies between the desire for a strong science system, and the desire that that science system underpins the transition of the Czech Republic towards a knowledge-intensive, value-added economy. The logic in these recommendations is to consider how can the four Priority Areas of the OP be managed to maximise the contribution to the Czech science system, without undermining their policy coherence and contribution to regional development issues.

5.10.1 Management of the OP R&D&I

However, there are also some more general recommendations that can be given on the basis of the preceding analysis. Firstly, given the complexity and contentiousness of the OP R&D&I proposal, there is a risk of failing to absorb the full resource complement. There needs to be a clear, long-term commitment from the outset at national and regional levels that the OP R&D&I is a plan that will be followed, with partners given sufficient autonomy and flexibility to ensure that the resources are diverted to activities which *in total* best strengthen the Czech Republic's national innovation system.

Early and effective budget planning is necessary to ensure that the Czech innovation system benefits from the full €2bn community resources made available through OP R&D&I.

The OP RDTI is a national programme that operates in a limited number of regions, and attention needs to be given to both its national and regional dimensions, to ensure that the policy is effectively 'joined-up' with appropriate national and regional policy elements. Some elements are explicitly national – the Centres of Excellence programme – makes a direct contribution to national higher education policy, and efforts towards improving the ranking of Czech universities. Other elements are more regional, including the regional centres and technology transfer activities.

The Programme needs to be implemented so as to ensure that both national and regional stakeholders can participate in decision-making and integrate OP activities in other education, research and innovation activities

The Czech Republic faces having to absorb and expend a huge amount of resources in the OP R&D&I within the time constraints of the Commission rules. There is a risk that administrative pressures lead to one of two negative outcomes. Firstly, a top-down management style in which stakeholders' wishes are ignored and in which OP activities are not integrated in wider regional innovation support. The second problem would be allowing local stakeholders to develop many disparate activities which do not add up to a coherent programme of interventions. However, this is a common problem and there is a wealth of policy experience in other member states and regions in how to ensure that economic development investments in science and technology add value and help to strengthen both national and regional innovation systems.

Programme Managers and other policy makers should make intelligent use of international advisers with experience of previous European innovation policy rounds to 'learn cheaply from their expensive mistakes' and maximise the policy added value of OP R&D&I.

5.10.2 Management of Human Resources in the Regional Centres/ Centres of Excellence

One of the greatest challenges for any research centre is in effectively concentrating resources on a sufficiently limited number of posts to ensure that the staffs have adequate time to complete the tasks. With the new centres, there are the risks that managers feel that they must maximise the numbers of posts they create, in order to create critical mass and ensure that the funds are committed, drawn down and expended. However, given the concerns expressed elsewhere about the particular barriers in the Czech scientific labour market, it is vital to ensure that all employees of these centres have sufficient stability in employment and security of resources to free them from distracting tasks. There is a clear risk that if concerns over long-term financial sustainability of the activities begin in the fore of managers considerations, then the centres will orient themselves towards (short-term) profitable activities rather than the longer-term excellent scientific investments necessary to provide an R&D basis suitable for the Czech industrial transition.

There must be no incentives for managers in centres to maximise the number of staff they employ at the potential cost of career development, researcher involvement in teaching, and continuity of employment within successful research groups.

There is a risk in concentrating resources in centres that those research activities outside the centres suffer from the loss of highly talented individuals. Thus, rather than increasing the overall scope of activity in the Czech Republic, there is a churn and displacement effect with no net value-added for the Czech science system. There is a need to ensure that other elements of the science system remain adequately funded, and that those seeking to advance their careers are not forced to move to centres where there would potentially be other opportunities open to them. Resources therefore for mobility, knowledge sharing, and exchange between the centres, but also the other key actors in the Czech science system are necessary to ensure that the programme substantively upgrades the Czech scientific labour market.

Resources should be made available for researchers not based in the funded centres to access knowledge based there through internships, exchanges and fellowship schemes, to diffuse the benefits of the concentrated research activity through the Czech science system as a whole.

Those funded under the new centres will be employees of particular stand-alone institutions whilst they are being funded to deliver wider national benefits, and strengthen the Czech science system as a whole. There is a strong management of human resources in the Czech Republic, and it is important that individual institutions are not allowed to manage their staff opportunistically to create national monopolies in particular scientific areas. This is particularly dangerous for a national science system as it can lead to myopia and path dependence in particular fields, reduce the self-sustaining nature of the scientific endeavour and leave the national research base open to poaching from foreign research laboratories. If the ‘national leadership’ role of these centres is to be taken seriously, then this will need to be reflected in the HR policies of the various centres. It is important that centres actively incentivise and manage their employees’ national leadership roles just as they incentivise and manage teaching, research and engagement with industry.

Human resources policies for those centres funded under OP R&D&I should ensure that employees funded through this route receive due recognition and are managed to deliver a national leadership/ ‘hub’ function in their field, to strengthen these fields across the Czech Republic as a whole.

5.10.3 Centres of Excellence:

For the Centres of Excellence to achieve their goals in their own terms, then the funds need to be invested in a limited number of centres which facilitate their wider participation in future European research programmes, and which help to better position more Czech universities as internationally visible. There is a need to balance the regional distribution of these centres with their wider national contribution, which suggests that resources need to be concentrated as far as is possible into a limited number of centres with the capacity to absorb the funds. However, concentration decisions raise a risk of project delay in trying to allocate these prize assets, delays that have clear consequences for the absorption of EU funding and the later sustainability of those projects.

Swift progress need be made in identifying Centres of Excellence and in developing scientific programmes and institutions that transcend the existing problems in R&D&I in Czech universities.

There is a risk in the programme that there are crowding out and substitution effects on the national university system. Although world-class universities can strengthen national university systems, strength is also provided in breadth, and it would be extremely inefficient if all researchers in a domain area relocated to a centre of excellence because its conditions were so much more propitious than in other institutions. Thought need be given to using the Centres of Excellence programme to strengthen national disciplinary networks across the public university sector, creating funding and employment stability in other nodes as well as strong central hubs: the UK Spatial Econometrics Research and Innovation Research Centres offers a model for how this can be achieved in practice.

The Centres of Excellence must be implemented in such a way as to strengthen rather than disrupt disciplinary activities elsewhere in the Czech Republic.

5.10.4 Regional Centres:

A key element of the success of the Regional Centres element of the programme is the extent to which they can become ‘more than brick and mortar’. One element of this is that the Regional Centres need to be placed at the heart of the regional innovation policy process if they are to function as ‘regional centres’ in any meaningful sense. In Finland, where municipalities have a high degree of local autonomy, the municipality of Tampere provided its three national centres of excellence, and a locally designated centre, with responsibility for leading the development of cluster support activities across the region as a whole. That real leadership role meant that these regional centres emerged as centres of knowledge about their regional innovation environments, and were well placed to shape regional innovation support activity together with the municipal leadership; they were also able to exercise a leadership and demonstration role outside their specific technological domains. Ensuring that the Regional Centres are not just instruments but real innovation policy actors is vital to ensure that the Regional Centres add value to the technology transfer activities supported under Priority 3.

The Regional Centres theme need be executed to ensure that both national and regional stakeholders participate in decision-making and integrate OP activities in other education, research and innovation activities

The STRIDE programme was particularly instructive of the need to ensure that innovation infrastructure is populated with dynamics communities of innovating businesses and support services. If no thought is given to the sustainability of these communities then any real estate can evolve into standard business parks rather than the desired science quarters with the potential to transform regional economic communities. Lund in Sweden pioneered a ‘concentric circles’ approach to innovation support around its IDEON science park adjacent to Lund University. At the core was the Innovation Bridge organisation which co-ordinated all innovation activities;

IDEON Innovation as an organisation provided services – including brokering general technology venturing services – to new start-ups; the IDEON Science Park provided facilities for high growth firms, and satellite innovation hubs at other faculties, universities and universities of applied sciences in the region were the outermost circle of this activity. The Regional Centre provided the hub that held these various communities together and ensured that the service offer was suitable for the needs of local businesses.

The Regional Centres should ensure that there is a suitable provision of high-technology venturing and innovation support services available, and help to proactively diffuse access to those services beyond the Centre locality into the wider regional hinterland.

5.10.5 Supporting technology transfer:

The issue has already been raised of the absorption problem that the OP RDTI faces in the Czech Republic, namely having enough resources to fund all the projects that might potentially be proposed. The risk is that there is no selection of these projects with the result that the available support activities become confusing and hence less useful for firms (innovation support services aim to save entrepreneur time, so time wasting undermines value). In Piemonte in 200-06, because of a lack of experience in innovation policy, a very wide range of innovation support activities was funded; this was so messy and confusing that from 2007, the decision was taken to focus on six Centres of Excellence across the region, each of which having a specialisation related to the companies with which it was most closely working. A technology transfer programme under OP R&D&I must be mindful of existing innovation support services, and focus on a realignment and optimisation of the existing system rather than allowing a plethora of competing activities.

There is a need to retain a central (national/ regional) oversight of technology transfer activities under OP R&D&I, to ensure that there is not 'project sprawl' and that activities are contributing to strengthening the Czech, and regional, innovation system.

However, there is a caveat to this recommendation: it can be extremely beguiling to encourage single innovation agencies that act as a so-called on-stop shop for innovation support services. The problem with such services is that unless brokerage is extremely cleverly arranged, then there is a tendency for advisers to push innovators towards an available solution rather than synoptically identify the best solution and then work towards acquiring that solution. In the Twente region of the Netherlands, the *Kennispark* (Knowledge Park) has developed the SME Knowledge project: incoming questions from SMEs are screened and the most likely domain for a solution is identified, whether a university, university of applied sciences, student project, innovation adviser, business adviser or a university spin-off company. There is then a separate advice service helping to guide the SMEs in these domains, with each domain having a specific mechanism to ensure that the firm receives an answer – innovation vouchers support university staff, there is an office to arrange student dissertation placements.

In rationalising regional technology transfer activities, care must be taken to ensure sufficient diversity of support activities and to ensure multiple pathways ensuring innovative businesses are guided towards the services that best improve their innovation pathways.

5.10.6 University education infrastructure:

The final set of recommendations concern the focus of this working paper, namely the human capital consequences of OP R&D&I. Clearly, the analysis demonstrates that the greatest bottlenecks around human capital for high-technology growth in the Czech Republic exist around the graduate level rather than post-graduate or post-doctoral researchers. The key informant interviews suggested that the necessary expansion of Czech higher education had come at the expense of the breadth of enrichment activities in the student curriculum, producing well-rounded, experienced and autonomous students able to operate in higher-order functions in innovative businesses. The investments in university education infrastructure should therefore ensure that there is an enrichment of the learning experience as well as an increase in absolute numbers participating. Problem-focused curricular and courses, an increased emphasis on team-working, social placements, Science Shops, student entrepreneurship, long-term externally facing projects (e.g. Solar Challenge), accredited reflective volunteering and student consultancy are all tried and tested techniques for creating students who are through their courses exposed to the kinds of problems encountered in work, and help to increase the value-added by graduates in the workplace. Infrastructure investments should ensure that there is not just the development of new real estate but the development of new pedagogic practices which improve the experience of the Czech graduate.

The Programme should have the ambition to use its investments to transform the student experience in the Czech Republic using reflective, conceptual methods to learn through applying knowledge in real contexts.

There is a role to play for investing in infrastructure for training the next generation of Czech scientific researchers and expanding the scope of the R&D labour market, which currently stands at around 50,000 employees. Other sections in this report have identified on a rational basis the measures that are necessary to ensure that there is good graduate mobility and career progression in scientific careers. These are all lessons that need to be supported by the activities embedded in the university education infrastructure. The key client for these activities are the students rather than the universities themselves, and there is the risk that the investments will prioritise research which is hoped to 'trickle down' into student experience rather than ensuring that there is a 'trickle up' of the best graduates into high-level scientific training pathways. The emphasis should be on establishing clear scientific career pathways and ensuring that there are effective incentives for progression at every stage.

The Programme should form part of ongoing developments in the field of employment conditions for researchers in the Czech science system, and in particular fill particular barriers in current career trajectories.

6. Cooperation and concentration of human resources in R&D&I

6.1 Introduction

The main objective of this component is to analyze the trends in the Czech Republic regarding co-operation between research institutions and industry in concentrating human resources in R&D&I and to identify which factors encourage or discourage such co-operation and concentration.

The main question we focus on is *how human resources are developed and concentrated in R&D&I*. We look at this issue at two levels. The first level is the overall policy and policy intentions concerning the issue – whether and how the issue of concentrating and developing human resources is addressed in strategic documents at the national level. The second level concerns specific activities, measures or supportive programmes in this area and their implementation across the system.

We also look at the issue from two other perspectives:

- First, by looking at *whether and how research and industry co-operate in concentrating human resources in R&D&I*.
- Second, by analysing *whether and how the state (through various instruments) encourages the co-operation between research institutions and industry in concentrating human resources in R&D&I*.

We apply the same typology of industry-science linkages in this sub-package as is used in the work package *Relation between Research and Application Spheres: 'science-industry links' (SIL)*.

The types are as follows:

- Collaboration in R&D (joint R&D activities, contract research, R&D consulting, co-operation in innovation, informal and personal networks),
- Personnel mobility (temporary or permanent movement of researchers from industry to science and vice versa),
- Co-operation in training and education (further professional education, curricula planning, graduate education, PhD programmes),
- Commercialisation of the R&D results of the science sector through academic spin-offs (disclosures of inventions, licensing patents, start-ups of new enterprises)
- Informal links between research and industry such as alumni networks.

In terms of the main aim of this work package, particular attention is paid to the categories related to human resources – *personnel mobility, co-operation in training and education, and informal links*.

The focus of this component combines two independent yet inter-related issues. The issue of science-industry links (SIL) - the co-operation between research institutions (including higher education, governmental as well as private research institutions) and industry - and human resource development. Therefore, this section builds on the findings and recommendations of the SIL chapter but goes into further detail in relevant areas. At the same time it tries to complement issues that are discussed elsewhere in the human resources chapter

6.2 The importance of concentration of human resources in R&D&I

In general, a systematic approach towards human resources development in R&D is required. Highly qualified researchers and academics are essential for high quality R&D systems. In such systems qualified R&D workers on all levels are needed in academia, research institutions as well as in industry.

The most developed countries have been gradually developing an environment which is highly supportive for R&D workers. Various programmes have been developed in order to motivate young people to enter R&D and pursue their careers in scientific fields. The European Union has also paid considerable attention to this issue. Despite some improvement, the EC still argues that "significant weaknesses remain with science teaching in some Member states"[96]. There are still only a limited number of women at the advanced level of science; most universities in Europe do not attract top global talent; and in terms of the number of researchers in the population Europe is still lagging behind the US and Japan.

In cases in which countries have limited "internal" human resources, highly qualified workers in preferential fields are attracted systematically.

Developing and securing human resources for R&D&I is a long term and complex process including multiple activities and measures targeted at different groups. These can include:

- Science communication
- Science learning centres
- Support for students in the technical and natural sciences
- Support for students studying abroad at prestigious institutions
- Participation of people from industry in teaching
- Support for researcher mobility – for researchers to work at excellent centres abroad and then to return to the country
- Support for researcher mobility – for researchers to work for a limited period or part-time in industry
- Support for talented students from abroad
- Support for young and talented researchers from abroad
- Platforms and networks linking researchers and industry

The issue of developing human resources for R&D has been paid increasing attention since 1990. The OECD identified various approaches in different countries targeted at science communication and public understanding of science and technology in general[97]. In most OECD member states there is a trend of decreasing interest by young people in technical and natural sciences resulting in decreasing numbers of young people pursuing careers in science and technology. The EU has also been concerned about promoting science and technology amongst the public in general and especially amongst young people. Important documents have been published[98] and many activities have been funded – for example, the European Week for Scientific and Technological Culture, the European Union Contest for Young Scientists, Researchers' Night.[99].

96 EC, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Europe 2020 Flagship Initiative Innovation Union, Brussels: European Commission, 2010, p.9

97 OECD, Promoting public understanding of science and technology, Paris: OECD, 1997.

98 See for example The Mid-Term Assessment of Science and Society activities 2002-2006 or The Science and Society Action Plan (SASAP).

99 A special issue of research eu, the magazine of the European research area, was devoted to science education in June 2007.

6.3 The importance of concentration of human resources for the CR

The concentration of human resources is very important for the Czech Republic with respect to two major factors in particular.

The first factor is the ambition of the Czech Republic to be an economy based on research and development and innovation. Without effective and comprehensive policy on human resource development, especially in R&D, and its successful implementation it will be very difficult to achieve this ambition. The lack of skilled personnel is seen as one of the main factors hampering innovation activities in general[100].

The second factor is more pragmatic. As discussed in section 4, high quality researchers will be needed in the near future in new R&D Centres (including the so called major projects) supported by the EU Structural Funds - Operational Programme Research and Development for Innovation (OP R&D&I) in the 2007 – 2013 programming period[101]. While financial support is targeted mainly at infrastructure – buildings and equipment - there is limited support for the human resources component – the so called "start-up grant".

In order to function efficiently the centres will need highly qualified and experienced workers as well as young scientists who will be able to take over the projects. Nevertheless, the need is not limited to researchers only. The projects themselves need skilled managers able to run the centres, to communicate with industry/business and to facilitate efficient transfer of knowledge from research into business.

Furthermore, the rules of the R&D&I operational programme are explicit in the area of personnel and staffing. The "technical annex" which is part of all grants, requires every project (centre) to have a range of "modern" human resource policies in place and to indicate how many new working positions will be created through the project.

It is very important to realise that the Czech Republic is in competition with other European as well as non-European countries in attracting top researchers. Since May 2011 the labour market is also open in Germany and Austria for workers from the new EU countries – both had used the right to protect their labour markets for a limited period of time.

6.4 Concentrating human resources in R&D&I in the CR

6.4.1 Strategies and policies on the national level

As already mentioned at the beginning of this section, we distinguish two levels when discussing human resources development in R&D&I with respect to research-industry collaboration. The first level concerns *strategies and policies on the national level.*

It is obvious that the issues of research-industry collaboration and human resources development/concentration have been paid increasing attention in the Czech Republic over the last decade. The importance of this issue has been underlined in many documents, although often in rather general terms.

- The *Strategy of Economic Growth* (2005) was intended to be a strategic document setting out a clear framework for the future direction of the Czech economy. The ambition of the document was to serve as an overall strategy which would be supported by all of the programmes and activities on the national level – primarily the EU operational programmes in the 2007-2013 programming period.

100 Oslo manual: Guidelines for collection and interpreting the innovation data, Paris: OECD, 2005

101 The newly build R&D infrastructure has been already questioned with respect to its sustainability and the impact on public sources – see for example Národní ekonomická rada vlády, Rámec strategie konkurenceschopnosti, Praha: NERV, 2011. http://www.vlada.cz/assets/ppov/ekonomicka-rada/aktualne/Ramec_strategie_konkurenceschopnosti.pdf

A specific section of the Research and Development chapter of the strategy is devoted to human resources development.

- The two major operational programs administered by the Ministry of Education, Youth, and Sports (MEYS) – the *Operational Programme Education for Competitiveness* (OP EC) and the *Operational Programme Research and Development for Innovation* (OP R&D&I) also discuss the issue of research-industry collaboration and human resources.
- Important strategic and analytical documents in R&D were released in 2008 – the *White and Green papers on research, development and innovation in the Czech Republic*.
- There is also a set of measures and documents concerning the "R&D reform" initiated by the R&D Council.
- Finally, the *National R&D&I Policy for 2009-2015* also touches on the issue of research-industry collaboration and related human resources questions.

For example, the *Strategy of economic growth* includes the following statements on human resources for R&D&I:

- *Securing Human Resources for Research Development, and Innovation:* "It has been demonstrated time and again that one of the most serious obstacles hindering the progress of R&D and the intensification of innovation processes is a lack of well prepared, active, and motivated workforce. Researchers are getting older, and young and relatively well educated individuals leave the sector for other fields. A survey of innovation activities in the Czech Republic has shown that companies consider a lack of workers in all education categories as a serious obstacle of innovation. The same has been stated by numerous foreign investors. The situation necessitates a rapid solution. It is therefore necessary to introduce incentives and motivating measures to secure the necessary human resources for R&D and innovation processes".
- *Securing Human Resources for R&D with the Necessary Structure and at All Levels:* "The relative number of researchers per 1,000 workers in the Czech Republic amounts to a half of the EU-15 average. Apart from lower investments into R&D, the situation is affected by the fact that the Czech Republic has considerably fewer university graduates who have completed a natural science and technical study programme in the age category of 20-29 years than the EU-15. As far as these indicators are concerned, the Czech Republic lags behind the EU-25 average significantly. The share of population with university education amounts to 60% of the EU-25 average, and the share of graduates from natural science and technical study programmes totals some 55% of the EU-25 average. A very serious problem is posed by the high average age of research workers, where many fall into the age category of 50-60 years. Only few graduates from doctoral programmes leave the academic world to work in research and development. Many young researchers do not return from study and work internships abroad or leave for other fields. Another serious problem is insufficient preparedness of graduates for team work, management of large research projects or teams, and a lack of basic business knowledge. It is especially necessary to improve material and technical conditions for education and research in natural science and technical study programmes at universities (building laboratories, establishing contacts with practice, etc.) to increase the number of graduates and their expertise. Motivating measures must be instituted with the participation of the corporate sector, which will benefit from a sufficient number of well trained specialists. Universities should create programmes aimed at providing graduates with the knowledge necessary for using and incorporating the results of R&D into innovation of products, technologies, and services. In addition, it is necessary to support the establishing of centres for knowledge management and focusing on this field at universities and public research institutions. Motivating measures and supplementary programmes should be introduced gradually starting in the

2006/2007 academic years. Mobility programmes may increase the attractiveness of the Czech Republic to motivate Czech researchers to return from abroad and skilled specialists from EU and third countries to seek mid-term work internships in the Czech Republic. Barriers hindering cross-border mobility (different medical and social insurance conditions, etc.) should be dealt with in connection with Commission recommendations[102]. Accordingly, a similar document, which will respect the specific situation in the Czech Republic, needs to be prepared and set up in 2006."

- Recommendations:
  - Motivating interest in enrolment in natural science and technical study programmes at universities, in particular by improving material and technical conditions for education and research as well as the relevant financial conditions (scholarships, etc.) – development programmes for universities.
  - Setting up education programmes targeting research and development workers and managers with the aim of improving their knowledge and skills for using and diffusing the results of R&D – development programmes for universities.
  - Setting up programmes supporting international mobility of research workers
  - Drafting a charter for researchers and a code of conduct for the recruitment of research workers Republic.

The *Operational Programme Education for Competitiveness* (OP EC)[103] in analysing the strategy for priority axis 2 – Tertiary Education, Research and Development – includes the following statements:

"It also becomes apparent that the system is not set up in a sufficiently appropriate manner so as to motivate the individual to operate and remain in the area of research and development activities, and get more involved in resulting innovative activities. With regard to intensive internationalisation and globalisation, the tertiary education and R&D system faces the necessity of improving the quality and increasing the attractiveness of the environment for both domestic and foreign employees in order to make use of human resource potential in areas that have a substantial effect on building a knowledge society. Last but not least, the link between tertiary education institutions and research and development institutions on one hand and the manufacturing and service sector on the other hand proves to be insufficient. A more intensive stimulation for partnership and an intensive mutually beneficial cooperation between the above-mentioned entities are missing. As a consequence, transmission of the knowledge and results of research and development from educational and research institutions towards their effective utilisation in practice is limited. For the time being, the tertiary education, research and development, and manufacturing and service sectors form no comprehensive and efficient system that would use various forms to support the formation and transmission of innovative solutions".

"The degree of co-operation between educational institutions and research organisations and private and public sectors is insufficient as well. The number of graduates from doctoral study programmes has so far been very low as well. In research and development, the sufficient capacities and necessary motivating stimuli have not been created for potential applicants to operate in this area, which immediately affects the innovation activities of the Czech Republic."

102 C (2005) 576/1 of 04/03/2005; Commission Recommendation on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers.

103 The final vision of the programme for the programming period 2007-2013 was accepted by the European Commission in October 2007.

The *Operational Programme OP R&D&I* also tackles the issue of human resources. The level of co-operation between research institutions and industry is described as not sufficient with mutual distrust being one of the main causes. The OP R&D&I suggests some ideas for improvement:

"This problem can only be overcome with partial steps and measures with the objective to build trust on both sides gradually and create the conditions motivating the co-operation and create strong incentives for such co-operation. They include an active support of mutual communication of both sectors, increasing mutual sharing of information in the area of R&D and strengthening awareness of domestic enterprises and the whole application sphere of Czech workplaces of R&D, their results and offer. To overcome the lack of communication, it is especially important to support direct involvement of application sphere in the activity of public R&D, in particular through joint projects and formation of joint research agendas. The consequences of insufficient mutual awareness and communication isolate the research sphere and divert it from the applicable directions of research."

The *National R&D&I Policy*[104] in goal 6 "Ensuring human resources for R&D&I" defines three core activities to be realized by the 2015:

- *To create a system of post-doc positions filled through open public competition;*
- *To launch programmes supporting participation of researchers (in particular doctoral students and young research workers) in internships at prestigious European as well as worldwide research institutions;*
- *To promote placement of university graduates in applied research and innovation or hi-tech and knowledge-intensive sectors.*

The realization of these objectives should be positively influenced by the new system of funding of research institutions and teams based on research performance and excellence, which allows the salaries of outstanding researchers to be raised to a level competitive with the EU-15 and which should make research careers more attractive for graduates.

Currently a new "Action plan" for human resources in the research and development sector for the period 2011-2017 is being drafted. Its priorities and recommendations in HR policy focus especially on:

- continuous support to educational programmes oriented on scientific qualification to ensure quality R&D personnel;
- popularisation of science to increase motivation for research career, improve co-operation of tertiary and secondary education to motivate gifted students for research career, promotion of R&D and innovation within the public;
- continuous improvement of conditions for incoming foreign researchers, set clear guidelines for the financial contribution of the Czech participants in these EU projects, set clear competencies and responsibilities of all national institutions concerned; public support to EURAXESS Centres;
- creation of funding schemes facing the brain-drain (i.e. more post-doc positions at the Czech research institutions);
- ensuring stability of jobs in the HEI and R&D, including financing and societal prestige of these positions;
- improvement of conditions for balance of work and family life, especially creating more part-time positions, higher participation of women in R&D management and governing bodies;

104 http://www.vyzkum.cz/FrontClanek.aspx?idsekce=532844

- use financing from the EU Structural Funds to support schemes of qualification improvement and lifelong learning for researchers, inter-sectoral and inter-institutional mobility of researchers and building competitive research infrastructure.

During the interviews and focus groups the strong view was expressed that research-industry co-operation and human resources for R&D&I have already been given sufficient attention in national strategic and analytic documents. Two main conclusions emerge from these documents:

- There is a need for more intensive and efficient co-operation between science and industry.
- Concentration of human resources in R&D&I is highly desirable.

However, these recommendations have often been overlooked and not been given effect to in practice. What is *missing is a long-term agreed upon policy that is consistently and efficiently implemented.*

We conclude that there is awareness within the science and business communities as well as within the state administration that concentration of human resources in R&D&I is very important as is co-operation between science and industry to achieve this concentration. This high level of awareness is an important first step towards the formulation and implementation of a coherent and efficient policy.

6.4.2 Description and perception of the situation in the Czech Republic

This section describes how the *co-operation between research institutions and industry with respect to human resources development* is described in various strategic or analytical documents and how it is perceived by stakeholders.

The issue of co-operation between research institutions and industry with respect to human resources development has not only been paid increasing attention in the Czech policy documents, but there have also been attempts to evaluate the current situation in terms of this co-operation. This can be seen as another positive feature.

- *The <u>Operational Programme Education for Competitiveness</u>* (OP EC) describes the situation in human resources in research and development in the following way: *"The Czech Republic lags behind both in terms of amount of funds and in terms of quantity and quality of research and development poles and their staff. Co-operation among research and development institutions (public, educational, and private) is at an insufficient level – the necessary networking and information transfer are missing"*

  "The generally low share of research employees per 1,000 employees (half the number then compared to the EU) is caused, among other things, by insufficient support of research institutions in the Czech Republic, and insufficient financial remuneration, which results in a "brain-drain" to foreign countries. This unfavourable situation is simultaneously influenced by the demographic trend of the age structure of the population. The high average age of researchers with significant representation in the age category of 50-60 years is a very serious problem."

  "A relatively significant part of research employees (both school leavers and more experienced scientific workers) have reserves in competencies that are absolutely crucial for current research and development, i.e. team work, project management, and business basics. This is reflected in an inadequate demand from commercial entities showing very loose links of R&D institutions with the commercial sector and an insufficiently developed transfer of results of the research and development activity towards its further utilisation."

- The analytical section[105] of the Operational Programme Research and Development for Competiveness (OP R&D&I) confirms the hypothesis of the lack of high quality human resources in the Czech Republic: *"Presumably the most serious barrier to the development of R&D and consequent increasing of the intensity of innovation processes in the Czech Republic has been the lack of well prepared, initiative and motivated people. In international comparison, the Czech Republic has a below-average ratio of R&D workers and research workers per 1000 inhabitants."*

  However, there are also some positive trends identified with respect to co-operation between research and business: "*A positive feature that became evident in the last five years or so is the increasing interest of foreign entities in systematic co-operation with the Czech R&D workplaces, especially with universities and public research institutions (VVI). Since approximately 2000, the Czech Republic has experienced an increasing interest of such foreign subjects in investment into the more advanced types of activities, including the activities of R&D. The amount of expenditure on R&D from foreign sources compared to expenditure of the business R&D sector in the Czech Republic has increased considerably; namely from less than 20 % in 1995 up to nearly 50 % in 2004. This trend clearly illustrates the dynamic role which was played by foreign investments in the Czech business R&D sector. This significant increase of interest from the side of foreign firms in the co-operation with the public R&D sector does not only concern a growth of interest in recruiting university graduates resulting from their shortage in the labour market. In some cases there has been systematic co-operation in the training of graduates, guidance of student works; the foundation of joint shared laboratories and participation in joint R&D projects have occurred. It can be expected that this tendency will continue in the future and the planned interventions should encourage such existing activities."*

From the interviews that have been conducted with various representatives of science and industry it is clear that *research-industry collaboration* (in all aspects) is perceived as relatively weak. Some actors point to historical reasons (the collapse of many research institutes after 1989), while others believe that multi-national companies (mainly interested in advantageous labour costs) are not encouraged enough to co-operate with local research organisations. In general, interviewees have different views on the underlying reasons for low levels of research-industry collaboration - they identify various factors influencing the existing situation and offer various solutions. Many however suggest that a certain level of distrust seems to prevail on both sides.

All above-mentioned statements are in line with the findings described in the Science-Industry Links chapter. Less intensive links between universities and businesses were evident in the low level of mutual R&D financing. In general, regarding innovation co-operation between private firms and public science actors, the Czech Republic belongs to the middle or low-end group of countries.

On the other hand, there are some very good examples of collaboration that are based on long-term commitments, compromises and strong personal links. The level of co-operation depends very much on the specific field. In some areas the co-operation is with foreign partners is smooth and fruitful (not only multinational companies based in the Czech Republic but also with other foreign companies), while in other fields there are very strong links with local small and medium enterprises.

105 Part 1.2.1 Co-operation of research and application spheres

In terms of the *concentration of human resources in R&D&I*, representatives of academia and business share the opinion that *a strategic, long term approach this issue is missing in the Czech Republic*. At the same time, there is a high level of consensus that such an approach/policy is highly desirable – especially in areas in which a certain level of excellence has already been achieved and where good teams have been formed.

The stakeholders argue that there are three main reasons why it is important to concentrate on strategic human resources development in R&D&I:

- A general lack of highly qualified people in particular fields (the energy sector is mentioned as one example)
- Trends in demography (in a three to four year period smaller age cohorts will start entering tertiary education)
- Newly built R&D centres financed from the EU structural funds

It is also felt by the stakeholders that the government does not sufficiently support the desired concentration of human resources in R&D&I. Neither legislation nor specific measures encourage HR concentration or co-operation between science and industry in this area.

There is a shared view that the political situation in the Czech Republic over the last few years has been an important factor influencing the research & development field in general. According to many stakeholders, political instability since 2006 has had a major impact on the overall atmosphere in higher education and research[106].

It seems increasingly difficult to design and implement a long-term strategy which would be sufficiently accepted by various stakeholders including politicians. Unfortunately (according to many stakeholders) research & development has become a highly political topic, and the discussions have often been dominated by particular interests and pressure groups rather than by a strategic vision of what is needed in the Czech Republic in the long term. As a result, the R&D policy field is rather unpredictable on the national level as well as on the institutional level. Such a situation does not contribute to the strategic concentration of human resources in R&D&I.

The consequences of this volatile environment can be summarised in the following way: there are valuable strategic and analytic documents in many areas of R&D, innovation, and higher education. Yet at the level of implementation, those measures and activities that have been put in place have been mainly ad-hoc and have often not been sufficiently integrated with each other given that an overarching direction is missing.

We now look briefly at the three categories of research – industry co-operation in human resources that were identified at the beginning of this chapter: *personal mobility, co-operation in training and education, and research and industry links and networks*.

Traditionally in the Czech Republic it is not typical for researchers to move from industry to science and vice versa. The boundary between these two spheres is still significant. The focus group participants indicated that once people leave science for industry (for whatever reasons) they usually do not return. Personal mobility is low within science and academia in the Czech Republic and even lower between industry and science.

Co-operation in training and education is much more intensive than personal mobility but is still very dependent on a specific field and a specific institution. Many

106 It should be underlined at this point that since 2006 there have been six education ministers. The same is true for the position of the deputy minister for research and higher education.

institutions (higher education institutions) attempt to involve people from industry in various phases of teaching. Partners from industry participate in the process of creating or modifying study programmes or selected people from industry deliver lectures. However, the involvement of external staff in teaching is limited due to accreditation procedures and conditions.

Another instrument for industry involvement in teaching is a student internship. According to focus group participants these are mainly short-term internships as a part of a study programme and are often regarded as a formal requirement. The idea of long-term internships was supported as these would be more beneficial for students and for industry. Once again, accreditation constraints affect this issue.

There are several platforms and networks within which academic, science and industry representatives can discuss issues concerning the concentration of human resources in R&D&I. Some were created spontaneously; others were created because resources were available for this purpose. An example of the former is the Fórum průmyslu a vysokých škol (the industry and university forum), which was created in 1996, but has struggled to realise its full potential since then[107]. An example of the latter are the "clusters" that were financially supported by the Operational Programmes Industry and Enterprise (OPIE) and Enterprise and Innovation (OPEI) administrated by the Ministry of Industry and Trade (MIT). Financial support for a cluster was dependent on a link with a tertiary education institution.

6.4.3 Specific activities, measures and supportive schemes

In this section we look at whether strategies, strategic intentions and assessments have been transformed into specific measures to further the concentration of human resources in R&D&I. We are not concerned about the measures and activities fostering science-industry links in general – this is discussed in the specific chapter on this theme. In general, however, programmes to foster and support SIL are still rare and more co-ordination across public programmes is needed (see the SIL chapter of this report).

At this point only those activities (within science-industry links) that encourage the concentration of human resources in R&D&I are analysed. However, it must be emphasised that activities, measures or programmes that support mutual co-operation between science and industry (for example mutual R&D projects) have an indirect impact on R&D&I human resources concentration (for example, the programmes financed through the MIT such as TIP).

One example of a noteworthy strategic activity on the national level was the governmental *Council on Human Resources Development* (Rada pro rozvoj lidských zdroju). According to some interviewees this body served as a useful platform for facilitating the discussion on human resources in the Czech Republic in general. Especially during the period between 2004 and 2006 (under the leadership of Martin Jahn, the then deputy prime minister) the Council included representatives of various sectors – ministries, regions, primary, secondary and tertiary education, research as well as business and industry. The Council was dissolved in 200[6] when the new government came into power.

On the regional level the most cited strategic example is the South Moravian region. A key document is the Regional Innovation Strategy (RIS)[108] that is now being implemented for the period 2008 – 2013. An intensive and long-term co-operation is being facilitated between the Region, the city of Brno, higher education institutions and other buffer bodies such as the South Moravian Innovation Centre, Regional Development Agency South Moravia, South Moravian Centre for International

107 http://www.fpvs.cz/

108 http://www.risjmk.cz/cz/

Mobility, etc. As the RIS representative states "it is not about the document itself – the document even cannot be retrieved from the website. It is about meeting people, discussing things and wanting to do something together."

There are many examples at the institutional level of how industry and science/academia co-operate in concentrating human resources. These activities take place on the university level and very often also on the faculty level. They can for example include the establishment of new institutions or the development of new study programmes demanded by local industry as is believed to be partly the case with the College of Polytechnics in Jihlava[109].

Another example of co-operation between industry and academia is the foundation of the science museum in Pilsen (Techmanina Science Museum), which was jointly established by the traditional local industrial company Škoda, and the University of West Bohemia[110].

Finally, there are also some measures and financial incentives recently introduced to foster and facilitate the co-operation between science and industry and the concentration of human resources in R&D&I. The most frequently used instruments are the EU structural funds – mainly the *Operational Programme Prague – Adaptability (OP PA)* for the city of Prague region and the *Operational Programme Education for Competitiveness (OP EC)* for the rest of the Czech Republic.

In the OP PA the priority axis 3 is called Modernization of Initial Education. It supports for *example co-operation with industry or research institutions in the development and implementation of a new study programme and the facilitation of co-operation with industry or research institutions through internships, study assignments (for example the diploma thesis), allowing access to specialised infrastructure and equipment for study purposes or external experts enrolment into teaching*.

The *Operation Programme Education for Competitiveness (OP EC)* supports the following activities in *higher education:*

- Bringing in specialists from both business and abroad during the creation and implementation of innovative study programmes.
- Supporting the creation of quality teams by increasing the professional competencies of academic staff, including improving literacy in ITC, increasing language competencies, and by improving managerial skills in the area of university management.
- Support for co-operation with foreign educational and scientific institutions; preparation for involving individuals in international projects and networks.
- Support of inter-sectoral mobility

Special attention is paid to *human resources in R&D* by creating it as a specific area of intervention. This area includes the following activities:

- Supporting the creation and future progress of quality research and development teams
- Preparing for the involvement of individuals and teams in international networks and projects in the area of research and development.
- Support of inter-sectoral mobility, especially mobility between research institutions and the private and public sectors.

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109 http://www.vspj.cz/

110 http://www.techmania.cz/

- Further education of research and development employees in the area of R&D management, popularisation and communication, disseminating scientific and research results into practice, technology transfer, acquiring the knowledge to protect, remunerate and administer the intellectual property of R&D employees.
- Other specific vocational education of R&D employees.
- Activities aimed at popularising R&D and its benefit to society.

The program also contains an area of intervention especially dedicated to *partnerships and networks*. The supported activities are as follows:

- Preparation of human resources for the formation and functioning of technological platforms, technologically oriented clusters, etc.
- Work placements and internships for students, teachers and scientific workers in the private and public sectors.
- Support for co-operation between tertiary education institutions, research and development centres, business and the public sector, including communication and interactive platforms.
- Support of educational and training activities aimed at increasing mutual co-operation between educational institutions, research and development centres, business and the public sector.
- Setting up and supporting contact points in tertiary education institutions and research and development institutions intended for business and the public sector.

Projects supported by the OP EC are in various phases. Many of them are already in operation, some of them are waiting to be granted support, and a few calls for proposals have still to be announced. For example, in February 2011 a list of beneficiaries of measure 2.4 was published by the Ministry of Education. In total 79 projects were being supported (ranging from 5 to 40 million CZK) to a total amount of 625 million CZK.

It is worth mentioning another project targeted at long-term concentration of human resources, although the involvement of business partners is rather limited. It is one of the projects funded by the Ministry of Education through the EU structural funds on the national level. The project is called "The Support for Technology and Science Fields" and includes marketing support for technology and science fields, motivation activities, science communication and also the targeted support to "regional co-ordinators" who are responsible for various project related activities in all regions of the Czech Republic[111]. Business representatives are involved in the project by being informed about events and taking part in them.

As all of the projects financed through EU structural funds in the 2007-2013 programming period are still in progress, it is very difficult to predict the overall impact of the supported activities. At the same time, the content of the projects are not in the public domain so it is almost impossible to assess which activities are taking place, how they are being implemented, and with what results. Nevertheless, some projects seem to be promising as judged from the information which is available on their websites[112].

111 More information on the website http://www.msmt.cz/strukturalni-fondy/ipn-pro-oblast-terciarniho-vzdelavani-vyzkumu-a-vyvoje/podpora-technickych-a-prirodovednych-oboru

112 For example the project called Bridge4Innovation administered by the University of South Bohemia (www.b4i.cz), the AGENT project administered by the VŠB Technical University in Ostrava (http://pi.cpit.vsb.cz/projekty/188/projekt-agent), etc. There is also a project focused on science communication by the University of West Bohemia (http://www.scicom.zcu.cz/).

A number of remarks regarding the projects financed from the EU structural funds (mainly through the European Social Fund) were made during the interviews and focus groups.

Firstly, the projects have been submitted on various levels – not only on the university and faculty level, but also on the department level. According to some observers it is then very complicated to co-ordinate these activities at the central university level and to find synergies. Secondly, many receivers of project grants complain about the very high level of administrative burden involved. A significant amount of time and resources is dedicated to administration. At the same time the focus of the managing authority is mainly on formal outputs (number of participants, detailed budget items) rather than on the actual impact of the projects. Finally, many institutions perceive the structural funds (especially the OP EC) mainly (if not only) as compensation for decreasing support from the state budget.

6.5 Conclusions and policy recommendations

In this part we first look at the trends regarding co-operation between research institutions and industry in concentrating human resources.

- There is increasing awareness about the importance of concentration of human resources in R&D&I – mainly in strategic and analytic documents
- The weak points regarding human resources in R&D&I in general have been identified and described
- There has been only a limited capacity to transform strategic guidelines and intentions into specific measures and programmes
- Various measures have introduced targeted at either fostering SIL (with an indirect impact on the HR concentration) or on human resource development itself, but an overall co-ordinating and strategic framework is missing
- The main sources of funding are the various EU structural fund programmes, although the existing measures and support schemes seems to be rather fragmented, furthermore there is rather low level of garantee that programmes/measures will continued to be implemented.
- Good examples of co-operation between science/academia and industry leading to concentration of human resources in R&D&I can be found primarily on the local and regional levels

In terms of factors encouraging or discouraging co-operation between research institutions and industry in concentrating human resources there are a number of factors that discourage co-operation.

- The unstable political situation together with frequent changes in top ministerial positions in the past few years made the situation in R&D as well as in higher education very unpredictable. As a consequence an effective strategic approach to concentrating human resources in R&D&I has not been put into place.
- In general there is a limited ability in the Czech environment to implement strategic guidelines and strategic intentions. Many analytical documents have been drafted in areas concerning R&D, human resources, higher education, etc. However, only a fraction of these strategic intentions have been successfully implemented. Many policy issues are highly politicised and there is insufficient overall consensus about them.
- An overarching authority able to strategically guide the development of human resources for R&D&I in the Czech Republic is missing. Many competencies are strictly related to specific ministries, and inter-ministerial co-operation is very often difficult

The need to concentrate human resources in R&D&I for two main reasons has already been stressed at the beginning of this chapter: firstly, the intention of the Czech

Republic to be an economy based on research and development and innovation; and secondly, the urgency of this need has been accelerated by the new R&D infrastructure investment through the Operational Programme Research and Development for Innovation (OP RDI).

The following recommendations are made to enhance the concentration of human resources in R&D&I taking into account co-operation between research institutions and industry. They are presented in the order of importance and priority:

1. The implementation of policies and strategic intentions needs to be tackled systematically. Many critical issues have addressed in analytic and strategic documents drafted by various bodies (ministries, advisory bodies, etc.) but implementation has lagged behind.
2. Co-operation between the various key actors needs to be strengthened – especially the Ministry of Education, Youth and Sports; Ministry of Industry and Trade; the Council for R&D&I; and other relevant players. All measures and programmes need integration into a comprehensive set of complementary tools targeted at various levels of the education and R&D&I systems.
3. Increased attention should be paid to measures and programmes supporting science-industry links in general. These projects can have a significant impact on human resource development.
4. Detailed monitoring and evaluation is essential in the area of the new R&D infrastructure funded by the OP R&D&I. The newly built capacities will require high quality human resources. At the same time, the Prague region (still a leading locality in terms of the quality and quantity of R&D) is entitled only to a small fraction of the EU structural funds in the 2007-2013 programming period. Developments in Prague in terms of human resources in R&D&I in comparison to the rest of the Czech Republic should be carefully analysed.
5. Developing and concentrating human resources in R&D&I is a very complex issue. A crucial role is played by the education system – not only at the tertiary level. Primary and secondary levels are equally important to motivate young people for potential future careers in R&D&I. Measures taken at advanced stages of education can only be complementary. Therefore, the contribution of the education system at all levels to developing human resources for R&D&I should be carefully analysed. A significant step has already been made at the tertiary level – the recommendations of the OECD Thematic Review of Tertiary Education in the Czech Republic need to be acted upon[113].
6. Co-operation between research institutions and industry, especially in human resource related categories such as personnel mobility, co-operation in training and education and informal links, can significantly contribute to the concentration of human resources in R&D&I. However, the most important role needs to played by the education system and supporting measures directed at researchers (at the national or regional level).

6.6 European good practices

The concentration of human resources in R&D&I systems in Europe is often facilitated through enhanced cross-sector exchanges and training (for an extended list of examples see Appendix A). These include student traineeships, common doctoral projects and programmes, temporary secondments for academics in firms and vice-versa, joint research laboratories and joint training programmes. Here initiatives may come from government funding schemes, universities, from industrial firms, or individual professors. The Collaborative Awards in Science and Engineering (CASE) in

113 File, J. et al, OECD Country Note Czech Republic, Paris: OECD, 2006

the UK is a good example of a government programme which promotes joint PhD supervision as well as traineeships of PhD students in companies. For the past thirty years the Research Councils in the UK have awarded CASE studentships to supervisors or firms to provide PhD studentships and train students. This programme involves close interaction between a company, a doctoral candidate, and a university. A distinctive characteristic of this programme is that industry experts officially take part in the supervisory committee. Concrete application requirements may vary among the different research councils. In the case of the BBSRC Research Council, for example, the industrial CASE awards can be applied for by both parties: academic supervisors or firms[114].

The proposals submitted by firms (citing academic partners) have to indicate the value of the research project to the company. The student project has to be in clear collaboration between the company and the academic research group and has to contribute to the development of key research skills needed by the UK bio-industry. If the proposal is led by the academic supervisor (citing an industrial partner), the project has to establish high quality collaborative training, ensure that students experience different research environments and support knowledge exchange with a commercial collaborator.

A good example of a training scheme stemming from a company can be found in Switzerland Zurich research laboratory IBM[115]. Zurich Research Laboratory offers the opportunity for PhDs in close cooperation between the Lab and a university. PhD students are employed by IBM and enrol as external PhD candidates at a university that is jointly selected by the student, the IBM mentor and the university professor. A PhD contract usually lasts for an initial three years, with an optional fourth year. During this period, students are expected to work on site at the Lab, but also have regular interactions with their professors.

Zurich research laboratory also offers student internships. They employ a number of student interns every year for periods of at least three to six months. Talented, students have a chance to put their ideas into action on high-level research projects. In cases where universities allow or even require it, undergraduate students are hosted for the duration of their Master's (*Diplom*) thesis, typically for a period of six months. These students work full-time on a project that fits with company‘s research objectives and is acceptable to the university as a suitable undergraduate thesis topic.

The case of Technical University of Denmark[116] is an example of a collaborative training programme initiated by a university. The university collaborates with a range of businesses in the training of their PhD students. They offer a PhD programme co-financed by the industry or an industrial PhD.

Co-financing a PhD student – Businesses who would like an investigation of a specific problem have the option of partially financing a PhD student at the Technical University of Denmark. Students enrolled in a research school typically receive funding from a business for one year. The funding covers salary, tuition fees and an overhead to the university.

Industrial PhD – This arrangement is administered by the Ministry of Science, Technology and Innovation. The purpose of the arrangement is to further development and innovation in the Danish business community. The Ministry provides financial support to businesses that wish to take on industrial PhD students.

114 BBSRC website at: http://www.bbsrc.ac.uk/business/training/industrial-case.aspx

115 Available at: http://www.zurich.ibm.com/employment/students.html

116 Available at http://www.dtu.dk/English/Industrial_Collaboration/PhD_programme_firm.aspx

7. European good practice

The objectives of this component are to consider the analysis of human resources for R&D&I in the Czech Republic in comparison with other European countries. The focus is on a selection of examples of good practice from different countries that have successfully implemented policies on issues of a similar nature. The examples chosen are subsumed under the five thematic area in the Human Resources work package, but many of them encompass a broader area.

7.1 Career structure

7.1.1 The Concordat to Support the Career Development of Researchers (United Kingdom)

In the UK there has been a longer need for more effective career management of research staff. This led to a 'Research Careers Concordat' between HE institutions and research funding bodies, designed to provide a career management framework especially for contract researchers. This resulted in its turn to Government funding for the development of broader professional and personal skills for doctoral students and postdoctoral researchers being funded by the UK research councils. More recently, the national Concordat to Support the Career Development of Researchers (launched in June, 2008) formulated key principles which set out the expectations and responsibilities of researchers, their managers, employers and funders. These are:

- Open and transparent recruitment and selection processes
- Recognition and value
- Support and career development opportunities
- Researchers' responsibilities
- Diversity and equality
- Implementation and review

These principles would increase the attractiveness and sustainability of research and improve the quality, quantity and impact of research in the UK. Institutions are seeking to embed these principles into their practices. At the national level there have been a series of seminars and practice sharing events which are conducive to a gradual implementation of the Concordat. These have been invaluable in enabling staff from institutions to engage with the Concordat at an institutional level to learn from the policies and practices of other institutions.

In the terms of reference the Strategy Group is committed "to report annually to the UK Research Base Funders Forum on the implementation to date". The Executive Group recommended that HE institutions be requested to report biennially on progress implementing the Concordat. Every four years the Strategy Group will produce a major progress report. This will align with the reporting cycles for the European Charter and Code, as expressed in the European Partnership for Researchers and reinforced by the Institutional Human resources Strategy Group.

The experiences with the Concordat show many initiatives to support improvement in Human Resources practices in England, including for those in research careers. Overall the messages from the evaluations the Careers in Research Online Survey (CROS) conducted by HE institutions in 2009 show positive results. Most researchers feel valued, are satisfied with their work-life balance and believe their institutions appear to recognise the importance of supporting career development. There is clear improvement in the uptake of induction, appraisal, and training and development opportunities by research staff compared to previous survey results.

7.1.2 Diversity of research careers in the European Research Area (Finland)

Finland has attempted to estimate the volumes of the different career paths after a doctoral degree based on official statistics and different surveys. Finnish universities annually award approximately 1500 doctoral degrees in total. As the number of professors appointed annually is about 150, roughly 10% of the newly appointed PhD can expect to attain a professorship. Although the distribution of doctoral-level researchers in the different career paths is likely to vary between countries, it seems clear that the majority of doctoral level researchers end in non-academic research careers. Choosing a non-academic career should be marketed as a valid first choice rather than a failure to get an academic position.

7.1.3 Gender policies

The Konstanz Networking Project on promoting dual career couples (Germany)

This is a networking project between seven universities, three research universities and four universities of applied sciences, in Germany and Switzerland. It aims to provide:

- Career choice advice and network of contacts;
- Opportunities for gaining further qualifications, job exchange and employment assistance;
- Family-friendly frameworks and questions regarding the compatibility of carer and family, childcare services and schools for accompanying children;
- Funding for temporary research positions (one year) for partners who want to relocate and pursue their research career in Konstanz

Women careers (Switzerland)

Support programme for women researchers who have had an interruption or education in their scientific career due to childcare obligations. The subsidies provide a chance to re-enter the science and continue a career in research in Switzerland. The MHV Programme is opened for all disciplines and for doctoral as well as post-doctoral candidates. The two-step selection is based on peer review followed by an interview. The basic funding is available for two years, covering salary and social contributions. Evaluations show that 85 per cent of the funded women stay employed in science and research after the termination f the awarded subsidy.

Rosalind Franklin Fellowship (University of Groningen, the Netherlands)

The Faculty of Science of the University of Groningen introduced the Rosalind Franklin Fellowship. This programme aims to provide an opportunity for female scientists and to increase the number of female scientists in the permanent staff. RF fellowships are five-year tenure-track appointments reserved for women with that guarantee that after proven stability promotion to ‘adjunct-professors’ with permanent employment status is lying ahead. When attaining this position the next evaluation takes place five years thereafter and if a positive assessment the fellow will be promoted to a full professorship.

Because of the success of the programme the Board of Governors of the university decided to extend the programme and implement it in all faculties. The funding has been shared between the central administration and the faculty during the fellowship period (5 years). After positive evaluation the fellow becomes a permanent member of the faculty that bears all the costs.

Part of the success of the programme is the open and international recruitment and widely announced advertisements in scientific media. Fellows have been attracted from a group of international scientists and from Dutch fellows who did a substantive part of their career abroad. The long-term perspective appeared to be a crucial role for candidates to accept such a fellowship.

7.2 Research Mobility

7.2.1 Rubicon programme (The Netherlands)

In Europe, the promotion of researcher mobility has been facilitated both at the policy as well as institutional levels. National governments either through ministries or research councils have been promoting mobility through a variety of grant schemes. This includes short-term and long term visits abroad, for example. Schemes facilitating postdoctoral stays abroad can be seen as a good example. In the Dutch context, the Netherlands Science Foundation (NWO) administers a programme as part of its researcher mobility programmes called Rubicon[117]. It funds recent PhD graduates from the Netherlands to go to a top research university or institute for the period from 12 to 24 months to expand the area of expertise and to increase the networks. The grantees are obliged to return and work in the Netherlands upon the completion of the grant. The amount of the grant corresponds to a monthly salary of a researcher in the Netherlands.

7.2.2 Network of European Neuroscience Institutes ENI-NET (Europe-wide)

This network, established in 2004, comprises a large number of young research groups in research institutes located in several countries across Europe and is supported by funding from the European Commission. The ENI-Network recognized that European neuroscience research depends critically on the creative contributions of young researchers. The participating institutes supply laboratory space, infrastructure, a nurturing environment and other support, which enables young researchers to build small research teams and to perform independent work. The activities of the network involve regular meetings , workshops, and exchange of students and know-how. The young researchers supported by the network are typically researchers in the age group 30-40 years and who are at the peak of their productivity (typically the stage II of the four-stage career structure – see above). They usually have experience of 3 to 5 years as a post-doc researcher – very often abroad – but are too young to be considered eligible for a tenured professorship in most EU member states.

7.3 Doctoral education

7.3.1 Research institute in physics (FOM – the Netherlands)

The research institute FOM (fundamental research in physics) from the Dutch Royal Academy of Science is well known because of its personnel policy. FOM sees those in doctoral training as its most important 'product'. PhD candidates receive a contract for four years as junior researchers in order to write a dissertation. During that period FOM aims to equip them with necessary knowledge and skills. The education and supervising plan that every PhD candidate draws up jointly with the supervisor does not only contain the research work, but also the development of knowledge and skills and the supervision needed. Every FOM PhD candidate takes training sessions that are partly mandatory. These trainings are focused to develop personal skills (e.g. presentation skills) that are needed to become a good researcher, the career after graduation (labour market orientation and soliciting), but also to become acquainted with management skills. FOM-graduates are well prepared for the labour market. From a survey among graduates it turned out that about 75% of the graduates found a job before their graduation or closely thereafter. About half of the graduates has been employed in the public sector and the other half in the private sector. FOM-graduates have broad skills, a fact indicating that they are well prepared for a diversity of career paths.

117 NWO Rubicon programme: http://www.nwo.nl/nwohome.nsf/pages/NWOP_6H2G7R

7.3.2 Doctoral Research School (Bochum, Germany)

The Ruhr-University Research School was selected for funding in the context of the competitive call of the Excellence Initiative by the German Government to set up overarching graduate schools. The close proximity of Life Sciences, Natural Sciences, Humanities, Social Sciences and Engineering on one single campus offer a particular chance to bridge the gap between different research cultures. The current challenges in doctoral education, including the employability of graduates in the wider labour market, are addressed within the Research School: inter- and trans-disciplinary perspectives, the development of transferable skills and the acquisition of competences form an integral part both of the individual research training and the common activities. This includes individual budgeting responsibilities, organisation of scientific events, doctoral representation in decision-making bodies as well participation in the so-called Science College and a number of high-end transferable skill courses.

Within their individual project, doctoral students have the opportunity to carry out cutting-edge research in an internationally competitive environment, in close contact to and guided by their supervisors, and largely in teams together with other candidates. Curricular components comprise research-related training, training in generic skills (writing research reports, articles, designing posters, presentation) and familiarity with trans-disciplinary perspectives.

Courses can be selected by each candidate in agreement with the supervisor to fit their individual training needs. Progress is documented in an individual training and supervision plan. To foster mobility, funds are made available for doctoral candidates to participate in international conferences or to carry out research as partners institutions.

7.4 New opportunities

7.4.1 Collaboration between science and industry (Germany)

The German Research Council (DFG) has signed a cooperation agreement with software manufacturer SAP AG. Within the scope of this agreement, universities can conduct DFG-funded research projects together with SAP. The collaboration is primarily intended to support talented researchers in science and industry and to facilitate promising research activities on both sides through the mutual use of resources. The agreements will also serve as a model for further collaborations between business from other branches of industry and universities.

Framework contracts have been signed between the funding council, SAP and three technical universities (Dresden, Darmstadt and Karlsruhe). In the joint project, doctoral researchers for the respective universities and employees from SAP will work on jointly agreed research topics in the area of computer science and related areas, and in doing so will earn their doctorate. The projects will also be carried out within departments of SAP.

The university projects will be funded by the DFG, whereby the participating universities submit a funding proposal in accordance with the DFG's standard funding guidelines. The results obtained through the work performed by the universities as part of the cooperation project will be passed on to SAP. In exchange, the university will generally receive from SAP a compensation totalling up to 50 per cent of the funding provided by the DFG.

7.4.2 Education for Competitiveness (Masaryk University Brno, Czech Republic)

The operational programme 'Education for Competitiveness' is part of the European Structural Funds focused on improving the quality of university education. This has two aspects. First, it has a connection with industry and applied sectors in general with the aim to encourage research groups to find actors from the applied sphere and bring them in the educational domain. The second aim is the development of soft skills.

The research institute RECETOX at the Faculty of Science has obtained a project and utilises the funds as follows. The project is for four years to improve all the fields in which the institute has teaching obligations. This includes management skills such as how to write scholarly papers, how to prepare proposals, how to manage research projects. Lectures are in English. About six external partners from industry are involved who participate in workshops, are supervising or reviewing the doctoral work, and are developing new subjects. This changes the spirit of the educational process completely.

In addition this operational programme provides an opportunity to link junior academics to older teachers who are close to retirement. They work together, learning from each other and to develop the course further so that the juniors can take it over. Workshops are organised with all the external partners where each single course is under review: what should be in it, what should be changed or renewed, what new courses or practical training are needed. Expectations are that such an exercise will lead to important curricular innovations on a continuous basis. New courses will basically be taught by juniors, thereby creating a future career for them.

7.4.3 Research and teaching collaboration (University of Utrecht, The Netherlands)

Academic and research staff at the Faculty of Science works regularly with colleagues from other teaching and research institutes as well as with companies[118]. The three major teaching collaborations and the five largest ongoing research collaborations are presented.

Teaching collaborations:

- ECENT: Expertise Centre for Teacher Training in Science and Technology Education. This centre draws together eight teacher training programmes and research institutes. The project aims to make the successful teaching techniques and innovative projects from the fields of science and technology more widely available, both for teacher-trainees and experienced teachers who wish to update their knowledge.
- ELWIeR: National Expertise Centre for Teacher Training in Mathematics. This programme involves eight partners from teacher-training institutions. It aims to provide expert training for teachers in mathematics and to increase the quality of training programmes. It is also expected that the project will encourage more students to apply for teacher training in the sciences.
- JCU: Junior College Utrecht. This college involves 26 schools in the Utrecht area. The project gives ambitious sixth-formers the chance to participate in a unique two-year science programme. In addition, it aims to be a laboratory for educational renewal in which new, attractive forms of science teaching are developed.

Research collaborations:

- CatchBio: CAtalysis for sustainable CHemicals from BIOmass. This group draws together 22 partners from science and industry (including small and medium-sized enterprises). The programme aims to develop cleaner processes of converting biomass into usable, sustainable end products.
- GATE: Game research for training and Entertainment. GATE is an alliance of eight partners involved in science and industry. It aims both to promote scientific

118 http://www.uu.nl/faculty/science/EN/organisation/samenwerking/Pages/default.aspx

research into game technology and to stimulate the innovative use of games in applications for training and leisure.

- MediTrans: Targeted Delivery of Nano-medicine. MediTrans is a collaborative project involving some 30 European partners from science and industry. The research group intends to develop new nano-medications that can be used for treatment of cancer, rheumatic arthritis, Crohn' s disease and multiple sclerosis.
- NPC: Netherlands Proteomics Centre. The NPC is a strategic collaboration of 21 partners from science and industry who are currently conducting research into the large-scale analysis of proteins and their biological functions. By analysing proteins, it is hoped that the team will get a better understanding of the causes of various illnesses.
- TI Pharma. This so-called top-institute involves 61 partners from science and industry. TI Pharma has been established as a leading concept-oriented research centre for drugs and provides supplementary training for researchers in the Netherlands. The group is researching ways of developing new medicines faster and cheaper than is currently possible.

7.4.4 Competence Centre initiatives (various countries)

Competence centres are collaborative entities to build bridges between science and industry by creating excellent academic research environments in which industrial companies participate actively and persistently in order to derive long-term benefits. They are resourced by highly qualified researchers associated with research institutions who are empowered to undertake market focused strategic R&D&I for the benefit of industry.

Competence centres create strong and innovative academic research environments with researchers from different disciplines collaborating with a network of companies. The researchers focused on problems that offer new and exciting challenges for the scientists and are of strategic importance for the companies. The industrial involvement in the centres means that new ideas and knowledge are implemented and used by companies.

Competence centres can be found in various countries. Experiences and results are very positive. This is mainly due to the combination of a sustainable governmental funding and the active involvement by companies in he research collaboration. In most countries competence centres are financially supported by governmental funding in the context of their national innovation strategy (e.g. Sweden, Ireland, and Germany). The next section gives a more detailed description of the Finnish case.

7.5 Co-operation and concentration

7.5.1 Centres of Excellence policy (Finland)

The Centres of Excellence policy of Finland is a good example of a way to create long-term concentration of excellence in ways that do not disadvantage existing excellence. The message for the Czech Republic is that the OP 2007-2013 developments should be regarded as the first step in a process of developing world-class research in the Czech Republic rather than single investments that create an entirely new research landscape. The Centre of Excellence policy in Finland emerged in the mid-1990s; it is important to stress that although Finland became a poster-boy for innovation and R&D policy in the early 2000s, this position of strength was built from the economic weakness of the mid-1990s. The problem for Finland was a deep depression in 1994, arising from the economic implosion of the USSR, one of its biggest trade partners, and a recession in which GDP fell by 40% and unemployment rose by 20%. The trauma of this crisis impressed upon the Finnish government the need to deliver an economic transition towards a high-technology economy strongly integrated into (western) Europe.

The first step in this process was a decision by the Finnish government to set an explicit target for Gross Investments in R&D (GERD), and the broad success of this is seen in the fact that Finland's GERD rose around 2.1% in the first half of the 1990s, to around 3.5% in the second half of the 2000s, which must be regarded as a structural shift. The decision was made that this GERD would come about through government spending which fed through to boost the economy as a whole, and also thereby stimulating business R&D activities. There were two key prongs to this increased government spending in the period 1997-99, namely raising funding for technology programmes through TEKES (FIM 1.8bn, €300m), and a centres of excellence programme for the Academy of Finland (FIM 630m, €100m).

The concept of the Centres of Excellence was set out in the national Centres of Excellence strategy; in 1995, the Academy of Finland persuaded the Ministry of Education to designate 12 centres of excellence, although this was an unfunded mandate until 1997, when the national strategy was articulated, and a total of 17 centres were funded under this €100m programme. The vision of the strategy was to create new environments from which innovative scientific excellence could emerge, so the centres were anticipated as being innovative, temporary, scientifically excellent and helping to strengthen competitiveness. From 2000, there was a shift from a single national strategy to a rolling programme of Centres of Excellence; to date there have been three programme rounds, and a fourth is currently under preparation

The programme evolved in a way that has seen fewer resources being provided to the programme as it has evolved and certain centres have acquired financial stability. There has been a degree of movement within the programme, so for example in the 2008-13 programme, eight were new and ten were existing centres that had previously been funded but had returned with a new research programme. Funds were allocated through the Academy via their peer review system, and on the basis of excellent applications. Each round in the revised programme (after 2000) involved an open call for proposals from Centres, with a short-list drawn up, and invited to submit full proposals of which around one half were eventually funded (although the proportions have varied from year to year.

Evaluations have found that the core funding was only a small percentage (c. 20%) of the total operating budgets of the research centres and that the programme has been highly successful in building capacity in the scientific sector. There have been a number of centres that have evolved through the programme, and the programme itself has emerged from capacity building to sustaining advantage in the sector. It forms an important element of a balanced programme of government investment in R&D that is one of the highest in proportional terms globally. The key reasons for this have been that it has been taken seriously by participants, provided enough resources to develop capacity, it has been driven by peer review and not by administrative requirements, and has been support by the Finnish Academy of one of its primary funding and most prestigious funding methods.

7.5.2 Long-term cluster policy (Sweden)

One of the important elements of a science and technology policy is consistency, necessary to create scientific assets as well as build up new behaviours and approaches that sustain the long-term competitive advantage. One very successful science and technology programme is the VINNVÄXT programme in Sweden, run by VINNOVA. In 2001, Sweden introduced a comprehensive approach to regional policy, which in line with the guidance of the European Commission, emphasised the development of regional innovation capacity. Regional growth agreements were introduced in 2000, and in 2001, VINNOVA was created as an agency to stimulate innovation in systems, the stable relationships that build up between knowledge producers and knowledge users, and which contribute to knowledge-based economic growth.

One of the flagship research programmes of VINNOVA has been its Regional Innovation System programme (VINNVÄXT), which was launched in 2002 and has run in three separate funding rounds. The central concept of VINNVÄXT is that of strengthening a limited number of high potential regional innovation systems, supporting innovative, high-growth clusters across Sweden, and helping to support Sweden's long-term competitive advantage. The basis for VINNVÄXT is existing partnerships, with good track-records of collaborative working between firms, research laboratories, innovation agencies, local/ regional authorities and universities. These partnerships come together to submit proposals for VINNVÄXT status on the basis that the VINNOVA funding is matched against regional funding to undertake projects which specifically strengthen the regional innovation system of that particular region. One of the key criteria for assessment was that each of the three key elements of regional innovation systems, universities, firms and government had to be present and the strategy had to identify existing and desired linkages between them.

The total funding for the project was 1.2bn SEK (€130m) for a ten year period, with each successful project awarded a total of 10m SEK (€1.08m) annually for the ten year period. The funds were provided in tranches of three years, with each successful centre being awarded funds in principle for the full period, but subject to period review to ensure that the managing agency was allocating funds to projects ensuring the growth and development, rather than the maintenance, of each regional innovation system. A key element of the programme was its focus on an extremely limited number of centres, and adherence to that principle over a decade in which the Swedish government changed course fundamentally, particularly in terms of its commitment to regional development policy.

The programme started with a pilot phase, in which 5 pilots were selected and then provided with process support and training on regional innovation system management. This preceding the launch of the full competition in 2003. The final round in 2005 sought to target innovation systems in an early stage of development and with high future growth potential, so there was a two-step process, in which 86 proposals were received, 10 of those received a planning grant. These ten submitted bids for development grants, which funded the preparation of the full grant over a two year period; five development grants were funded and in the end four winners were designated in 2008.

The evaluations of the programme are very positive. This is mainly due to the combination of sustainable governmental funding and the active involvement by companies in the research collaboration. The relatively long-term perspective during which support may be given to each of the chosen projects (10 years) as well as the consistent, fair and thorough use of competition as a project selection mechanism were success factors. The essential role that VINNOVA has taken as a dialogue partner rather than emphasising the role of controller or auditor contributed to the success[119].

This highlights the key dimension of the VINNVÄXT partnerships, in that they provided a reason for the long-term accrual of strong regional innovation systems by providing partners with a task to work on, and a tangible product to build connections with other strategies such as the regional growth programmes. They also highlighted the problem that because these were bottom-up programmes proposed by regional partnerships, the level of strategic steer that national Agency (VINNOVA) was able to provide was highly restricted. Nevertheless, the VINNVÄXT programme is a highly successful model for how to use strategic science/ innovation investments to strengthen regional partnerships and at the same time improve the commercial and application focus of universities.

119 Sources http://www.proinno-europe.eu/sites/default/files/3861SE19_T1_Appraisal_Report.pdf and www.vinnova.se/vinnvaxt

8. Conclusions and Recommendations

8.1 Main Findings

The report on Human Resources in Czech Republic R&D&I has presented and analyzed the policies, trends, strenghts and weaknesses of development of human resources in R&D&I in this country. Here the key findings are presented following the structure of the report: careers structures, researcher mobility, doctoral training, future challenges and cooperation and concentration of human resources in R&D&I. This is followed by a set of recommendations which are organized according to their priority as perceived by the authors of this report and based on European good practices presented in the previous chapter 8.

8.1.1 Career structures

This report has identified some unsatisfactory characteristics of the current career structure in the Czech Republic, such as the skewed age composition and high age of academics in the highest ranks, low representation of women, low mobility and in-breeding of staff, and the relatively low remuneration of young academics compared to the average national salary levels. These aspects make it less attractive for young people to start an academic career. The causes of these issues have traditional as well as personal and structural dimensions. The very demanding and complicated nature of an academic career is an example of the latter.

Among Czech academics there is a high level of dissatisfaction with the working conditions and the salary system compared to other employment sectors in the Czech Republic as well as to equivalent jobs abroad. A comparison of salaries between scientists and engineers working in the public and the private sector and international comparisons shows:

- Salaries in the private sector are substantively higher for scientists in physics
- For scientists in biological and medical fields the difference is negligible. Biotech companies may pay slightly higher than in academic institutions but it is not believed that this difference would motivate researchers to work there.
- The yearly salary average of researchers in the Czech Republic is far under the EU 25 average. However, when corrected in PPS the Czech average approximates the EU 25 average and above the associated countries average. Not only East European countries is lower (except Slovenia), but also Finland, Italy, and Portugal.

8.1.2 Researcher mobility

The study of researcher mobility has indicated the following current strengths in the system when it comes to promotion of mobility:

- Researcher mobility is on the R&D policy agenda
- Strong family relationships – a strong reason to come back to CR
- Some good examples of human resources cooperation between universities, research institutes and industrial enterprises (e.g. Material Sciences, Aeronautics, Chemistry)
- It is common for researchers from institutes to work at universities and vice versa – there are possibilities to build on existing networks in both types of institutions and profit from them for mobility purposes

However, due to historical path-dependencies as well as socio-economic developments, different in cultures between science and industry as well as demographic realities, there are a number of weaknesses that can be identified:

- Bureaucratic procedures for immigration coupled with low professionalization of HR staff at institutions
- Relatively low salaries and salary ceilings
- No explicit strategies and systematic measures for promotion of researcher mobility in the institutions, especially no promotion of cross-sector mobility
- No coordination between ministries regarding promoting international and cross-sector researcher mobility
- No tradition of cooperation between academia and industry in human resources; different perceptions of work styles
- Limited transparency in hiring procedures and limited inter-institutional mobility
- Language barriers for incoming international researchers

8.1.3 Doctoral Training

Strong points are the quality of the study programmes, the clearly defined regulations regarding the set requirements throughout the whole PhD process, and the possibility to participate in concrete research projects and being 'organically connected' with a larger research team. The latter most often applies to research institutes.

The following weaknesses were identified:

- Dependence largely on the availability of good tutors. Supervisors tend to have limited time available or are too occupied with their own research interests.
- The low financial support students receive which is hardly sufficient for living. Students are often forced to accept other jobs that negatively affect their study progress. The drop-out rate is quite high.
- Concern about attracting enough students who meet the quality standards.
- Controversies between universities and ASCR regarding the training of and responsibilities for doctoral students continue to exist. ASCR institutes feel they are not in an equal position and the view was expressed that there should be a return to the position prior to 1990 when they had an independent role in providing doctoral studies.
- Little cooperation with industry and generally insufficient financial support from the private sector. Companies are very reluctant to provide additional funds for scientific research as they consider this as an important task for the public sector. For them topics of doctoral research seldom lead to relevant research outcomes. However, examples were found where doctoral research is taking place in the context of an industrial project, with a second supervisor from industry.

8.1.4 The HR challenges of potential new fields for R&D%I and current investmetns in R&D&I infrastrcture

The strengths in this area were the following:

- Substantial, long-term funding for knowledge exchange activities
- Good network of public universities outside Prague as bases for CEs/ RCs
- Existing Regional Innovation Strategies identified how RCs could add value to regional innovation
- Regional A few regional development agencies with understanding of regional needs

The following weaknesses were identified:

- No regional political oversight of national Operational Programme

- Poorly developed career structures in Czech science for newly appointed staff undermine progressive scientific labour market.
- Lack of apparent belief in economic potential of regions outside Prague.
- Short-termism and lack of co-ordination in territorial economic development policy
- Barriers preventing knowledge in science base being exploited in Czech Republic markets.

8.1.5 Cooperation and Concentration of HR in R&D&I

The key trends strengths in cooperation and concentration of human resources have been identified, such as:

- There is increasing awareness about the importance of concentration of human resources in R&D&I – mainly in strategic and analytic documents
- The weak points regarding human resources in R&D&I in general have been identified and described
- Good examples of co-operation between science/academia and industry leading to concentration of human resources in R&D&I can be found primarily on the local and regional levels

The identified weaknesses include:

- There has been only a limited capacity to transform strategic guidelines and intentions into specific measures and programmes
- Various measures have introduced targeted at either fostering SIL (with an indirect impact on the HR concentration) or on human resource development itself, but an overall co-ordinating and strategic framework is missing
- The main sources of funding are the various EU Structural Funds programmes, however the existing measures and support schemes seem to be rather fragmented
- In terms of factors encouraging or discouraging co-operation between research institutions and industry in concentrating human resources there are a number of factors that discourage co-operation.
- The unstable political situation together with frequent changes in top ministerial positions in the past few years made the situation in R&D as well as in higher education very unpredictable. As a consequence an effective strategic approach to concentrating human resources in R&D&I has not been put into place.
- In general there is a limited ability in the Czech environment to implement strategic guidelines and strategic intentions. Many analytical documents have been drafted in areas concerning R&D, human resources, higher education. However, only a fraction of these strategic intentions have been successfully implemented. Many policy issues are highly politicised and there is insufficient overall consensus about them.
- An overarching authority able to strategically guide the development of human resources for R&D&I in the Czech Republic is missing. Many competencies are strictly related to specific ministries, and inter-ministerial co-operation is very often difficult

8.2 Recommendations for the Human Resources in R&D&I

The top priority recommendations emanating from the above findings are:

1. The implementation of policies and strategic intentions needs to be tackled systematically. Many critical issues have addressed in analytic and strategic documents drafted by various bodies (ministries, advisory bodies, etc.) but implementation has lagged behind.
2. Early and effective budget planning is necessary to ensure that the Czech innovation system benefits from the full €2bn community resources made available through OP R&D&I.
3. Strengthen the role of HRM on the central institutional level. Counteract the loose federative structure with decision-making powers at the lowest level by active HR policies regarding recruitment and careers and correcting current age and gender imbalances and in-breeding at all levels. Adherence to principles of open competition for positions and transparency of appointments and promotion procedures should be given particular attention.
4. Improve the remuneration of doctoral students. A combination of different resources is seen as most effective, such as targeting specific priority areas, stimulating collaborative forms of doctoral education, the quality of the programme or the balance between supply and demand of PhD graduates on the labour market.
5. Create an explicit inter-ministerial strategy and action plan on how to coordinate immigration (visas and permits), pension schemes and mobility promotion activities both at universities and ASCR research institutes.

Recommendations critical to future success of the Czech R&D&I system are:

1. Manage the academic career in a flexible manner. Develop career plans that enable academics to develop their own strengths, create flexible career paths, joint appointments, junior positions that break through the current long hierarchical career ladders. These plans should be oriented to make the academic career more attractive to young researchers.
2. Apply more diverse criteria to assess and reward the performance of academics. Performance assessment should not predominate, but should constitute part of a broader set of criteria, including the perspectives of individual staff and combined with staff development plans and training possibilities.
3. Co-operation between the various key actors needs to be strengthened – especially the Ministry of Education, Youth and Sports; Ministry of Industry and Trade; the Council for R&D&I; and other relevant players. All measures and programmes need integration into a comprehensive set of complementary tools targeted at various levels of the education and R&D&I systems.
4. Detailed monitoring and evaluation is essential in the area of the new R&D infrastructure funded by the OP R&D&I. The newly built capacities will require high quality human resources. At the same time, the Prague region (still a leading locality in terms of the quality and quantity of R&D) is entitled only to a small fraction of the EU structural funds in the 2007-2013 programming period. Developments in Prague in terms of human resources in R&D&I in comparison to the rest of the Czech Republic should be carefully analysed.
5. Human resources policies for those centres funded under OP R&D&I should ensure that employees funded through this route receive due recognition and are

managed to deliver a national leadership/ 'hub' function in their field, to strengthen these fields across the Czech Republic as a whole.

6. Swift progress need be made in identifying Centres of Excellence and in developing scientific programmes and institutions that transcend the existing problems in R&D&I in Czech universities.
7. The Centres of Excellence must be implemented in such a way as to strengthen rather than disrupt disciplinary activities elsewhere in the Czech Republic.
8. There is a need to retain a central (national/ regional) oversight of technology transfer activities under OP R&D&I, to ensure that there is not 'project sprawl' and that activities are contributing to strengthening the Czech, and regional, innovation system.
9. Strengthen the internal and external quality assessments of doctoral education. Despite the general high level of doctoral education, the quality varies in the system as a whole. Although some structures are in place, the quality assessment of doctoral programmes should be more integrated into institutional policies and HR strategies.
10. Strengthen the relationship between universities and ASCR research institutes. There is currently much cooperation although also controversies have been noticed. Rather than taking legislative steps to have PhD degrees awarded by the ASCR as well, it is recommended to strengthen the model of cooperation between universities and AS institutes utilizing their respective strengths. Other European countries provide examples to find creative solutions for practical problems.
11. Stress the human resources dimension in university-industry collaboration schemes besides infrastructure development and the creation of technology transfer offices
12. Increase the transparency of hiring in the R&D system via requirements to advertise the new positions nationally and internationally in media and on the Euraxess and other international jobs portals.

The recommendations **desirable for an efficiency/effective R&D&I system** are:

1. Develop critical mass in doctoral education. This can be achieved by creating larger settings where students are confronted with a broader range of knowledge than in the prevailing master-apprenticeship model. Structured forms of graduate training that are emerging in Europe such as graduate schools and research schools are means to achieve such critical mass.
2. Encourage research collaboration and interaction with external organisations. Work outside the traditional academic framework, for example through staff exchange or adjunct appointment systems, should be recognized more in academic appointments and careers, and become part of performance appraisals and rewards. There should be no legislative barriers to prevent institutions from encouraging this.
3. Encourage the international orientation of doctoral education. The current initiatives and co-supervisor arrangements with universities abroad should be expanded where possible. This is an important instrument for recruiting international students and increases the compatibility among doctoral programmes internationally. These initiatives should be supported by policy, for example by providing adequate funds or research grants.
4. Increased attention should be paid to measures and programmes supporting science-industry links in general. These projects can have a significant impact on human resource development.

5. The contribution of the education system at all levels to developing human resources for R&D&I should be carefully analysed. A significant step has already been made at the tertiary level –the recommendations of the OECD Thematic Review of Tertiary Education in the Czech Republic need to be acted upon.
6. The Programme need be executed to ensure that both national and regional stakeholders can participate in decision-making and integrate OP activities in other education, research and innovation activities
7. The Regional Centres theme need be executed to ensure that both national and regional stakeholders participate in decision-making and integrate OP activities in other education, research and innovation activities
8. The Regional Centres should ensure that there is a suitable provision of high-technology venturing and innovation support services available, and help to proactively diffuse access to those services beyond the Centre locality into the wider regional hinterland.
9. In rationalising regional technology transfer activities, care must be taken to ensure sufficient diversity of support activities and to ensure multiple pathways ensuring innovative businesses are guided towards the services that best improve their innovation pathways.
10. The Programme should form part of ongoing developments in the field of employment conditions for researchers in the Czech science system, and in particular fill particular barriers in current career trajectories.
11. Use a comprehensive approach to attract foreign top researchers as well as expats back to the Czech Republic by combining financial and 'soft' mechanisms – support to families, housing, institutionalised help with visas, residence permits (e.g. translation services at the institutions within the international offices)
12. Create subsidies for Czech academic staff to go abroad for longer periods (post-docs) with the requirement to return to the home country upon completion of the programme.
13. Professionalise international relations office staff to facilitate advising researchers on mobility opportunities and facilitating transition for incoming researchers.

The recommendations for **fine-tuning and optimizing the R&D&I system** are:

1. Create greater stability for human resource policy. Multi-annual research budget allocations rather than annual allocation of the budget would create greater stability and certainty in the policy environment for HE institutions.
2. Programme Managers and other policy makers should make intelligent use of international advisers with experience of previous European innovation policy rounds to 'learn cheaply from their expensive mistakes' and maximise the policy added value of OP R&D&I.
3. There must be no incentives for managers in centres to maximise the number of staff they employ at the potential cost of career development, researcher involvement in teaching, and continuity of employment within successful research groups.
4. Resources should be made available for researchers not based in the funded centres to access knowledge based there through internships, exchanges and fellowship schemes, to diffuse the benefits of the concentrated research activity through the Czech science system as a whole.
5. The Programme should have the ambition to use its investments to transform the student experience in the Czech Republic using reflective, conceptual methods to learn through applying knowledge in real contexts.

6. Increase labour market consideration and monitoring of PHD graduates. The growing relevance of PhD graduates on the labour market implies that it is important to know what doctoral students are being prepared for and how well this is being done. This includes exploration of the skills and competences that PhD graduates require informing doctoral programmes as well as their rates of return.
7. Market Czech Republic R&D system's strengths and institutions internationally; pro-actively recruit people in the domains that are crucial for the future.
8. Support further and expand the Euraxess Centre in the Czech Republic.
9. Provide Czech language courses to foreign researchers working at universities and ASCR institutes as part of the integration portfolio.

Appendixes

Appendix A : Examples of European university-industry collaborative training

A.1 Switzerland

Graduate students in the „Business integration technologies“ group - Zurich Research Laboratory IBM

http://www.zurich.ibm.com/csc/bit/students.html

After PhD DefenseThe Zurich Research Laboratory offers the opportunity to do a PhD in close cooperation between the Lab and a university. PhD students are employed by IBM and enroll as external PhD candidates at a university that is jointly selected by the student, the IBM mentor and and the university professor. A PhD contract usually lasts for an initial three years, with an optional fourth year. During this period, students are expected to work on site at our Lab, but also have regular interactions with their professors.

http://www.zurich.ibm.com/employment/students.html

Student internships

We also employ a number of student interns every year for periods of at least three to six months. Talented, highly motivated students will have a chance to put their fresh ideas and energetic drive into action on high-level research projects. If you want to work on innovative technology with industry-leading researchers and have the opportunity to collaborate with other students from around the globe, then we may have a place for you.

In cases where universities allow or even require it, we also host undergraduate students for the duration of their Master's (*Diplom*) thesis, typically for a period of six months. These students work full-time on a project that fits in with our research objectives. We ensure that this work is acceptable to the university as a suitable undergraduate thesis topic.

A.2 United Kingdom

University of Exeter : Graduate Business Partnership

http://services.exeter.ac.uk/businessprojects/gbp/index.php

The Graduate Business Partnership is a project-based placement scheme organised by the University of Exeter. The scheme places recent graduates with local organisations for a minimum of 20 weeks. During the placement the graduate receives training from the University and on completion provides a case study and makes a presentation. Devon companies have been benefiting from this scheme for many years - the effect of having a dedicated person working on a company project can be quite spectacular.

University of Exeter - Career mentor scheme

http://www.exeter.ac.uk/employability/employers/careermentorscheme/

The University of Exeter Career Mentor Scheme brings bright, enthusiastic and entrepreneurial students together with successful businesses in mutually beneficial mentoring partnerships.

University of Exeter - Work placement

http://www.exeter.ac.uk/employability/employers/placements/

Offering a work placement has a range of benefits to employers:

- Fill a skills gap or vacancy at low-cost without long term commitment
- Complete specific one-off specialist projects
- Inject fresh ideas from enthusiastic and motivated students
- Develop mentoring or supervisory skills of current staff
- Test-run talented individuals before offering a permanent position
- Create international networks through students from overseas

Scottish Funding Council - university and business collaboration for economic growth

http://www.interface-online.org.uk/view_item.aspx?item_id=3830&list_id=list1-3679&list_index=1

Scotland launched in 2011 a £8.1 million programme that involves universities and businesses working together in a series of innovative knowledge exchange projects aimed at key sectors of the Scottish economy.

The programme has been developed and funded by the Scottish Further and Higher Education Funding Council (SFC). The investment is to be divided among ten projects, each involving different university collaborations. They will share their knowledge and expertise with businesses to help address a number of crucial areas such as problem solving, efficiency improvements, capacity for research and development, and skills needs.

The cash, from SFC's Horizon Fund, will support a variety of projects across five key economic industry sectors:

- Life sciences - BioSKAPE led by the University of Aberdeen for the Scottish Universities Life Sciences Alliance (SULSA) research pool (£1.26 million), INSPIRE led by the University of Dundee for the Scottish Universities Physics Alliance (SUPA) research pool (£1 million), Translational imaging led by the University of Edinburgh for the Scottish Imaging Network, A Platform for Scientific Excellence (SINAPSE) research pool (£1.12 million);
- Creative industries - Moving targets: new models for new media audiences in the creative media industries, led by the University of Abertay (£1.1 million);
- Energy - Crystallisation science excellence for manufacturing technologies, led by the University of Glasgow (£709,900), Mathematical methods to support the integration of renewables into the electricity network, led by Heriot-Watt University (£64,671), Low Carbon Housing led by Edinburgh Napier University (£465,513), the Scottish Energy Research Academy led by the University of Strathclyde on behalf of the Energy Technology Partnership (ETP) (£1.2 million);
- Financial and business services - the Scottish Financial Risk Academy led by Heriot-Watt University (£335,255); and
- Food and drink - programme led by the Scottish Agricultural College (£808,250).

A.3 Denmark

Department of Mechanical and Manufacturing Engineering, Aalborg University-Company Collaboration with Department of Mechanical and Manufacturing Engineering

http://www.m-tech.aau.dk/Company+Collaboration/

New knowledge is essential for the development of all companies and organisations. New knowledge is not an off-the-shelf-item, but is something that has to be created - and this costs time and money. For many companies and organisations a shortcut exists through collaboration with the researchers and students of Department for Mechanical and Manufacturing Engineering

Department of Mechanical and Manufacturing Engineering offers many opportunities for collaboration and address both SME's and larger companies and organisations. The amount of resources a company invests in the collaboration can of course vary and therefore the department offers different opportunities:

Joint Research Project

Joint research projects with Department of Mechanical and Manufacturing Engineering is one of the most used types of collaboration. The projects are outlined by both researchers and the company in question to ensure that all needs are met. A joint research project can take many forms and involve from one to many researchers. Therefore, the budget of a project can range from almost nothing to several millions.

A joint research project gives the company the opportunity to put a scientific focal point on production, systems and much more.

Industrial PhD's

An industrial PhD is a researcher with one foot in the company and the other in research. In other words, the company has an expert attached for a period of three years. An Industrial PhD is first of all a researcher, however the area the researcher is engaged in is related to the strategy of the company.

Department of Mechanical and Manufacturing Engineering operates within the PhD programme Mechanical Engineering.

Student Projects

Department of Mechanical and Manufacturing Engineering emphasise close contact between its students and the surrounding world.

Collaboration with one or more of our students brings many opportunities for your company. The collaboration can be:

- Project collaboration
- Internship
- Student job

Regional Industry Joint PhD Programme - Aalborg University, Center for TeleInFrastruktur

http://www.ctif.aau.dk/CTiF+PhD+Programme/Regional+Industry+Joint+PhD+Programme/

Center for TeleInFrastruktur (CTIF), a world-wide research center with headquarters at Aalborg University (AAU), Denmark It offers companies in North Jutland a PhD student on very actractive terms. The programme is co-funded by Vækstforum/Regionalfonden

How is the PhD financed?

- CTIF can initiate PhD projects under the following conditions:
- PhD salary is paid by CTIF/AAU. (Student employed by University)
- Involved company co-fund the project with hours corresponding to one full time employee, working on the same project (Total 36 Man Month).
- No cash money required from the company
- Individual cooperation agreements will be made for each PhD project detailing the set-up, including IPR issues.

Who are the possible candidates?

- A current or former employee from the company
- A student from CTIF network
- Formal application from advertisement (internet)

A public call for the positions has to be conducted for all 3 alternatives.

General conditions:

- The PhD student will be enrolled at the PhD school at Aalborg University under normal conditions
- The Supervisor is from AAU (Chosen by CTIF and company in collaboration). A co-supervisor can be identified from the company
- The PhD student will primarily work at AAU, but it is strongly encouraged that the company also set up an office.

Industrial Collaboration - Aalborg University, Center for Communication, Media and Information Technologies

http://www.cmi.aau.dk/Industrial+Collaboration/

CMI has a strong backing from industry evidenced in, e.g., participation by leading Danish and international persons in the Advisory Board and construction of common research projects.

Industrial advisors include Nokia, Motorola and Terma. They participate in the development of the research and teaching strategy of CMI.

The project related activities include co-financing of ongoing projects as CAMMP, a prestigious mobile media platform funded by the Danish Advanced Technology Foundation (Højteknologifonden), supply of equipment and teaching/ tutoring of students. Collaborating companies include BSD, DR, Litepoint, Motorola, Nokia, Protelevision, Rohde&Schwartz, Sonofon, Telia, Terma and Wirtek.

An essential function of the industrial partners is to participate in creating the unique research cluster around CMI and to contribute to the development of the teaching curriculum. The partners will contribute to the activities at CMI and will initiate Ph.D. projects as an ongoing activity financed within the industry/university scheme. This activity will create good long term recruiting opportunities for both industry and university.

CMI will also promote collaboration on student projects, master theses and PhD theses, where CMI researchers, students and companies can find matching partners.

Danish Agency for Science, Technology and Innovation (Ministry of Science, Technology and Innovation) - Industrial PhD Programme

http://en.fi.dk/research/industrial-phd-programme

An Industrial PhD project is a three-year industrial ly focused PhD project where the student is hired by a company and enrolled at a university at the same time.

The company receives a monthly wage subsidy of DKK 14,500 while the university has its expenses for supervising etc. covered. The PhD student works full time on the project and divides his or her time equally between the company and the university.

Technical University of Denmark - Industrial Collaboration

Student training service and projects

http://www.dtu.dk/English/Industrial_Collaboration/Student%20training%20service%20and%20projects.aspx

DTU's students are very often able to contribute to the high-tech development of businesses. In this connection, private and public sector businesses have the opportunity of establishing a collaboration with DTU concerning student training service and business projects.

In our experience, businesses as well as students benefit greatly from this kind of collaboration as both parties often gain more from the relationship than expected.

DTU works together with a large number of businesses in the education of PhD students. The following models of collaboration are available:

Businesses and the PhD Programme at DTU

http://www.dtu.dk/English/Industrial_Collaboration/PhD_programme_firm.aspx

Co-financing a PhD student – Businesses who would like an investigation of a specific problem have the option of partially financing a PhD student at DTU. Students enrolled in a research school typically receive funding from a business for one year. The funding covers salary, tuition fees and overhead to the university.

Industrial PhD – This arrangement is administered by the Ministry of Science, Technology and Innovation. The purpose of the arrangement is to further development and innovation in the Danish business community. The Ministry provides financial support to businesses that wish to take on industrial PhD students. For more information about this collaboration model, please follow the link on the right side of this page to the Ministry's own web pages.

A.4 Finland

University of Vaasa - Important Corporate and Public Sector Partners - specific forms of cooperation

http://www.uwasa.fi/tuotanto/english/partners/

ABB
Nature of collaboration: ABB Operations Development Group: ASDN project, joint seminar lectures/occasions, students employed, source of research funding. ABB Motors: M.Sc. theses, production/product development, source of empirical data (e.g. Make-to-Order/Make-to-Stock case data) PhD-projects: Katja Rajaniemi (2005), Natalia Kitaygorodskaya (2008), Petri Kärki, Satu Koivisto and Eero Halmelinna.

Wärtsilä
Nature of collaboration: ShipPower/Powerplant/Service: joint research projects (Modulemetrics, together with Wärtsilä's Commonality Team), source of research funding, M.Sc. theses. PhD-projects: Ahm Shamsuzzoha (2010), Helena Haapio.

Vacon
Nature of collaboration: common projects (ASDN calculation module "how to compute logistical costs before product development"), source of research funding, M.Sc. theses

Kone
Nature of collaboration: common research in Technology management (Ph.D. Kari Hakkarainen), Technology Roadmap -development projects, source of research funding, M.Sc. theses. PhD-projects: Katri Rekola (2006).

Wapice Ltd

Nature of collaboration: Research and development of Summium Sales configurator (www.summium.com), a system used by industrial manufacturing companies for mass customisation. Joint co-operation in research programmes CATER and NetChallenge.

Merinova
Nature of collaboration: joint projects, joint funding (e.g. Better Products in Time (BIT) – project), one professor previously a member of Merinova's board.

A.5 Germany

Joint Research Projects Support Emerging Talent - Deutsche Forschungsgemeinschaft (German Research Foundation)

http://www.dfg.de/en/service/press/press_releases/2010/pressemitteilung_nr_48/index.html

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is taking new approaches for collaboration between science and industry. Germany's central funding organisation in the area of basic research has signed a cooperation agreement with software manufacturer SAP AG. Within the scope of this agreement, universities can conduct DFG-funded research projects together with SAP. The collaborations are primarily intended to support emerging talent in science and industry and facilitate promising research activities on both sides through the mutual use of resources. The agreements just signed will also serve as a model for further collaborations between businesses from other branches of industry and universities.

The first joint research projects to employ the new cooperation model are being undertaken by the Technical University of Dresden, the Technical University of Darmstadt and the Karlsruhe Institute of Technology (KIT), each together with SAP. The respective framework agreements between the DFG, SAP and the three universities have just been signed. In the joint projects, doctoral researchers from the respective university and employees from SAP will work on mutually agreed-upon research topics in the area of computer science and related areas, and in doing so will earn their doctorate. The projects will also be performed in part in the development departments of SAP.

The university projects will be funded by the DFG, whereby the participating universities submit a funding proposal in accordance with the DFG's standard funding guidelines. The results obtained through the work performed by the universities as part of the cooperation project will be passed on to SAP. In exchange, the universities – as per the cooperation agreement – will generally receive from SAP compensation totalling 50 percent of the funding provided by the DFG, though in some instances it may even exceed this amount.

A.6 Slovakia

Faculty of Informatics and Information Technologies - Cooperation with industry

http://www.fiit.stuba.sk/generate_page.php?page_id=2113

Training and Consultation Activities

FIIT STU has been very successful in training and consultations in cooperation with the companies Cisco System Slovakia Ltd., Microsoft Slovakia Ltd. and GTEC Ltd. In cooperation with Cisco Systems the Faculty has been integrated into the worldwide academy programme oriented to training in network technologies. Nowadays FIIT STU Regional Networking Academy offers a full 4-semester programmes CCNA (Cisco Certified Networking Associate) and CCNP (Cisco Certified Networking Professional). Two instructors of our RCNA were trained in Birmingham thanks to remarkable support of the company Tronet Ltd. and DITEC Ltd. Except above-mentioned programmes FIIT STU offers programmes for IP Telephony, WiFi Communication, Network Security and other special courses.

In co-operation with GTEC Common Training and Consultation Centre (CTCC) was established. The main purpose of this centre is to offer technical training for the non-academy sphere. There are two special Networks technology Laboratories in this CTCC.

Educational Cooperation

In the field of education and other activities the Faculty has been cooperating with important Slovak companies for many years. Academy training programmes were developed thanks to the support of cooperation with Tronet Ltd., BGS Ltd., DITEC Ltd., DATALAN Ltd., ASSET Ltd., HP Slovakia Ltd.

Other remarkable support the Faculty has obtained in cooperation with IBM Slovakia, Microsoft Slovakia, SUN Microsystems, SIEMENS and ORACLE. Cooperation with the above-mentioned companies is based on special agreements.

A.7 Transnational university networks

UNIDO Global University Network on Industrial Innovation Systems

http://www.unido.org/fileadmin/user_media/Services/Investment_and_Technology_Promotion/University_Chair/network_concept.pdf

By 2013, a UNIDO Global University Network on Industrial Innovation Systems between at least 300 Universities world-wide, will be recognised by UNIDO Member States as an essential example of practicing effective Industry – University cooperation in Science and Technology. The Network will have created a non-marginal national capacity, both in academia and industry, for raising the next generation of Industrial Innovators.

General Objectives of the network:

- To increase the success rate of innovations through improvement of Industry – University cooperation to apply Science and Technology.
- To bridge the gap between the technological and human resource requirements of industry in the field of innovation on the one hand, and the academic capacities to supply these on the other.
- The ability to regularly review and update the national policies of UNIDO Member States in the field of innovation.
- To facilitate the knowledge and coordination of experiences and research in the field of Innovation Systems in developing countries and economies in transition.
- To increase the perception of Innovation and Applied Science and Technology as an instrument for supporting the sustainable growth and the alleviation of poverty

UNIDO is the single UN Agency advocating the necessity to develop Industry. The network activities will deliver:

- Tangible University – Industry projects on Innovation, leading to new products for Industry
- Global Forum platform for channelling discussions on appropriate Innovation Policies for developing countries and economies in transition, and production of related publications

- Structural improvements in human resource development for innovation in industry as a pre-condition for sustaining industrial development
- Direct Publicity, Goodwill, and Networking
- Creation of South-South, East-South, and North South cooperation opportunities.

A.8 International network

Government-University-Industry Research Roundtable (GUIRR) - UIDP Fellows Program

http://sites.nationalacademies.org/PGA/uidp/PGA_050962

Convened by the National Academies, the University Industry Demonstration Partnership (www.uidp.org) seeks to advance university-industry collaborations through the development of bold and innovative projects and implementation of valuable demonstrations.

Proposed by UIDP members for adoption by the Partnership, these projects and demonstrations (projects that provide the means to introduce and experience innovative ideas and approaches and prepare the way for replication and up-scaling) are further developed by volunteers from the membership (and occasionally by outside parties with specific expertise) who develop the project scope, planned course of action, an aggressive timeline, and project deliverables. Project deliverables can include a report, a tool for use in university-industry collaborations, and the generation of new knowledge and approaches for strengthening these collaborations. Each project Working Group is led by co-chairs – one from industry and one from academia.

A.9 EU initiatives

Seventh Framework Programme (FP7) - Industry Academia

http://cordis.europa.eu/fp7/people/industry-academia_en.html

Funding scheme

Marie Curie Industry-Academia Partnerships and Pathways (IAPP)

Objective

This action seeks to open and foster dynamic pathways between public research organisations and private commercial enterprises, in particular SMEs, including traditional manufacturing industries, based on longer term co-operation programmes with a high potential for increasing knowledge-sharing and mutual understanding of the different cultural settings and skill requirements of both sectors.

The action will be implemented through targeted and flexible support for human resources interactions within co-operation programmes between at least two organisations, one from each sector and from at least two different Member States or Associated countries.

What will be funded

Support is provided for the creation, development, reinforcement and execution of strategic partnerships based on a longer-term cooperation programme between the participants, aimed at knowledge sharing and inter-sector mobility, based on targeted human resources interaction. Such strategic research partnership projects can be co-ordinated either by an industrial or an academic participant. The longer-term cooperation programme shall exploit complementary competences of the participants in the strategic partnership, as well as other synergies. The implementation of the co-operation programme will be realised by:

- Exchange of know-how and experience through inter-sector two-way secondments of research staff of the participants, with in-built return mechanisms, and also by enabling these staff to attend events in a trans-national setting. All projects are expected to have staff exchange, normally in both directions.
- Recruitment by the participants of experienced researchers from outside the partnership for involvement in transfer of knowledge and/or in the training of researchers.
- Networking activities, organisation of workshops and conferences to facilitate sharing of knowledge and culture between the participants also in a wider setting, involving the participants' own research staff and external researchers. Where these events are open to researchers from outside the partnership, additional reimbursements are foreseen.

Participants

Participants under this action are on the one hand, one or more universities/research centres and on the other, one or more enterprises, in particular SMEs, that propose a project based on a joint cooperation programme. Within this scheme, the industrial partners must be organisations operating on a commercial basis, i.e. companies gaining the majority of their revenue through competitive means with exposure to commercial markets, and will include incubators, start-ups and spin-offs, venture capital companies, etc. The different participants should be from at least two different Member or Associated countries, of which at least one must be from a Member State. The participants recruit and/or host eligible researchers and contribute directly to the implementation of longer-term cooperation programmes established between them in line with the objectives of this action.

http://cordis.europa.eu/fp7/mariecurieactions/iapp_en.html

Industry-Academia Partnerships and Pathways (IAPP)

Research and business have to work hand in hand. Marie Curie Industry-Academia Partnerships and Pathways help commercial and non-commercial research organisations work together. Partners include universities and companies of all shapes and sizes. Focussing on joint research projects, IAPPs aim to boost skills exchange between the commercial and non-commercial sectors.

Who can apply?

To qualify for an IAPP, your proposal must include one or more universities/ research centres and one or more enterprises. The industrial partners must be operating on a commercial basis. An IAPP project proposal must come from partners in at least two different EU Member States or Associate Countries. Partners from Third Countries can also join in, but only if enough EU members or associates are represented in the partnership too.

What does the funding cover?

Exchange of know-how and experience through two-way or one-way secondments of research staff between the commercial and non-commercial partners

Recruitment of experienced researchers from outside the partnership, for involvement in the transfer of knowledge and/or the training of researchers

Networking, workshops and conferences involving external researchers as well as the partners' own research staff.

How does the partnership operate?

Your project should promote a strategic research partnership, which can be co-ordinated by either a commercial or a non-commercial participant. It should also highlight longer-term cooperation. And it should make full use of all the skills and synergies available in the partnership.

Which topics can be funded?

Proposals from all scientific and technological research fields of interest to the EU are welcomed by the IAPP team with the exception of research areas covered by the EURATOM Treaty.

Who decides?

IAPP proposals are selected in an open competition. Selection is through transparent, independent peer review, based on excellence using a series of predetermined criteria.

Appendix B : European Best Practice in New Opportunities: learning from STRIDE & RIS

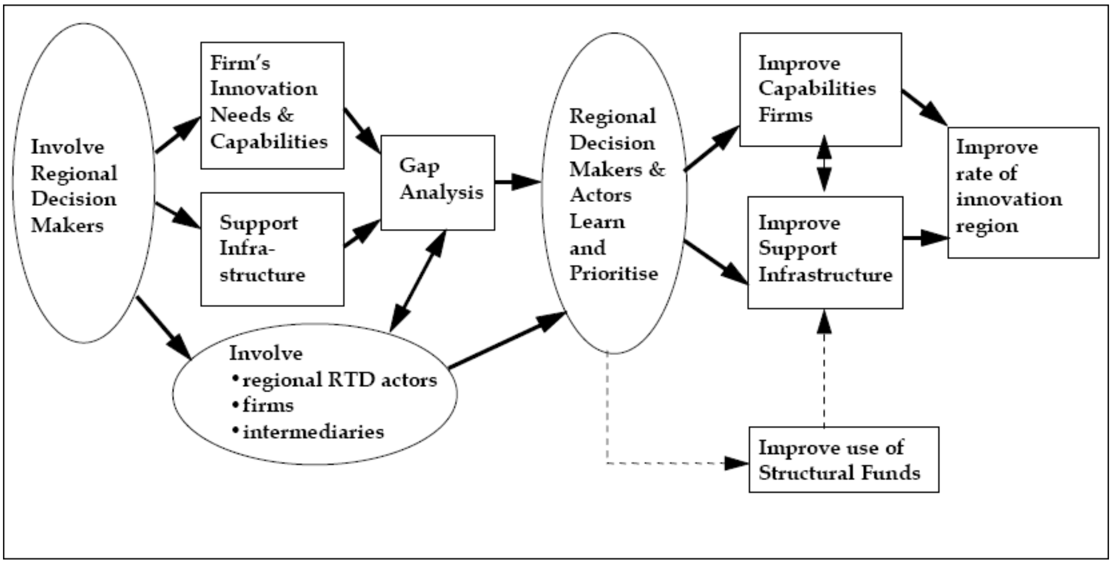
In understanding how to absorb the OP R&D&I resources, it is perhaps instructive to reflect on how this programme emerged and what lessons this genesis has for its improved management. Since The Lisbon declaration, the promotion of innovation has been a key task of both the European Union in general as well as the Structural Funds in particular. But this position did not emerge in a vacuum; rather a series of policy experiments had been undertaken whose results demonstrated the added-value of regional innovation approaches. All these policy experiments have been evaluated, and for member states faced with suddenly having to develop a mature regional innovation policy, it can be helpful to at least understand the regional learning processes which brought the policy situation to the current point.

The beginning of the current situation was marked by the 1989 reform of the Structural Funds, which marked their evolution from an implicit subsidy for industrial countries (matching the agricultural subsidies) to a mechanism for making the approaching Single European market work better. The funds were taken away from Member States who had previously been allocated funding according to a national quota and were free to spend it on economic development projects of national interest in their weakest regions (independent of those regions' overall wealth). As part of this national system, there was also a non-quota element allocated by the Commission, in which the Commission began experimenting with using the non-quota element for *inter alia* funding thematic programmes (the Integrated Mediterranean Programme) as well as innovation support.

In 1989, the funds were comprehensively overhauled along four principles; they were all to be allocated by the Commission to the most needy regions (concentration) judged against transparent criteria (Objective areas) on the basis of regional multi-annual plans (programming) which regions would co-finance (matched funding). The Commission also introduced a range of regional initiatives ("Community Initiative) to target specific types of region (e.g. KONVER for former shipbuilding regions) and retailed a 1% experimental fund (the so-called Article 10) to continue developing innovative regional policy ideas. Two activities are here salient: the STRIDE Community Initiative invested a total of €400m (400m ECU) in strengthening the science base of Europe's poorest regions to better participate in European science activities (including Framework Programmes). The Regional Technology Plan (an Article 10 intervention) approach provided around fourteen pilot regions with funding to develop co-ordinated plans to maximise interactions between regional knowledge producers and users, to improve regional competitiveness (*Cf.* Potts, 2002[120]).

From the 1994-99 programming period, promoting innovation became an increasingly important activity for the Structural Funds, and the responsible Directorate-General also funded a programme to maximise the use of these Structural Funds, building on the lessons of STRIDE and RTP. The Regional Innovation Strategies (programme) was launched and provided participating regions with funds to develop comprehensive regional innovation strategies to inform the development of their Single Programming Documents. The idea with RISs was they followed a set process (shown below) in which a regional partnership came together, mapped technological assets, identified gaps and potential opportunities, developed a plan to fill those gaps, priorities activities within the plan, agreed on a set of pilot projects and delivered the pilot projects. The other half of RIS activity was on the learning within the partnership throughout the activity, and resources were provided to fund external (to the region) advisers and regional consultants to ensure that the whole process developed effective knowledge. The net result was to improve the expenditure of public funds which improved firm innovation performance, and which ultimately improved the rate of innovation in the region.

Figure 18 The stylised model of the Regional Innovation Strategy process



Source: Boekholt et al. (1998).

The cost of a RIS process was relatively low, providing a secretariat to oversee the process and produce the reports, to fund meetings, study tours and external advice (of the order of hundreds of thousands of ECU). A later project, the RIS+ innovative action provided more substantive funding (MECUs) for pilot programmes, to give a sense of reality to the process of prioritising pilot projects. Once those pilot activities had been decided, then the intention was there would be a 'mainstreaming' phase in which the regional Operational Programme would fund more of these projects (€M 10s-100s). However, this process of upscaling occurred over subsequent programming rounds; clearly, the RISs became a way of reconciling the Structural Funds and the Lisbon Agenda, and in the negotiations over the 2007-13 programming round, the decision was taken that innovation promotion should stand central.

The problem for the Czech Republic is that Western European countries had a relatively long time to develop their plans and programs. Although not every EU15

120 http://pdfserve.informaworld.com/367231_751305627_713666323.pdf

region developed a regional innovation strategy before 2000, they were widespread, and that meant as Structural Fund expenditure became increasingly focused on promoting innovative activities, regions had an awareness of what were their assets and gaps, their strengths and weaknesses, and what kinds of projects could reasonably be funded to ensure that the increasing resources were not wasted, and coherence and co-ordination was retained. Technical and administrative expertise was built up in identifying suitable projects and delivering them in a suitable way, and exchanged within European networks. The Czech Republic has a relatively limited time period to move from a situation of a fragmented and under-resourced regional innovation policy to a set of integrated and well-functioning regional innovation systems.

The lesson for the Czech republic is in not underestimating the importance of the regional learning process. There is a need to couple regional actors to one another to achieve collective goals, without shackling them and undercutting their initiative. In the original process set out in the diagram above, that came through a process in which learning took place and more resources were released as actors could demonstrate learning: RIS+ financing for pilot projects was contingent on having a completed strategy with identified priorities and being able to demonstrate that those priorities were being taken forward by partners. Part of the learning process is driven by this need to achieve collective goals in order to unlock additional funding. There are examples of regions which did not necessarily follow the RIS process, but merely allocated project funding to partners, who ended up with a convoluted and messy innovation landscape that lacked the networked and systemic qualities that would warrant it being described as a regional innovation system. In Piemonte, Italy, for example, in the 2000-06 period, the focus was on spending resources, with as a result that there was a proliferation of support institutions without a parallel proliferation of support; emphasis shifted in the 2007-13 period to bringing this system back under regional control, and mobilising a coalition of innovators who collectively agreed on priorities and actions for funding.

Nevertheless, the Czech Republic does face a considerable absorption problem, even bearing in mind the n+2 rule which allows funds to be expended up to two years after the programming period concludes (but penalises expenditure which is not timely within the programming period). There is therefore a need to balance sufficient expenditure to meet with Commission demands, with not showering regional partners with funds that prevent them understanding their situation, analysing their collective needs, developing a strategic action plan, prioritising early interventions and mainstreaming activity. It may be worth segmenting along two dimensions, projects of primary national significance against those strengthening regional innovation systems, and those consortia already ready to be implemented as against those which require further learning.

- Some activities, particularly those around national priority areas, will be non-negotiable and benefit from early implementation, especially where they will be large, complex and expensive projects.
- Some strategic projects of national importance will benefit from a phased approach where later funding is made contingent on earlier planning and prioritisation.
- At a regional level, there are already some regional innovation strategies in place in the Czech Republic, and where there is evidence that partners have set genuine priorities, then resources can be allocated relatively quickly to those activities, particularly for the Regional Centres if they are to fulfil a more strategic, steering role.
- Other regions and regional partnerships will benefit from a carrot-and-stick approach, where later substantial funding is made contingent on regional partners collectively developing a strategy and set of priorities for promoting regional innovation.

Appendix C : The regional geography of the Czech Republic

This section involves detailed regional analysis of the Czech Republic involving two geographical scales. This Appendix sets out the regional geographies of the Czech Republic which are used in this report. There are two kinds of regions in the Czech Republic: there are 14 statutory-administrative regions (technically 13 and a capital city) and eight regions used for the administration of EU Structural Funds (NUTS 2 Regions).

The current regional boundaries were established by Czech Law 129/2000, the Law on Regions, which established thirteen regions and a capital city, Prague, which had comparable regional status. The location of these fourteen political regions is shown in the map below.

Figure 19 Map of the Czech Regions, 2011

Source: Czechinvest, 2011[121]

All the 14 regions have populations between 500,000 and 1.2m, with the most populous regions being Prague, South Moravia and Central Moravia. However, the urban structure is strongly primate – Prague is the largest and richest of the Czech cities, with a population of 1.2m, followed by Brno (400,000) and Ostrava (310,000). The remainder of the Czech Republic's cities have about or slightly less than 100,000 population. Prague is also the economic and financial centre of the Czech Republic. Its GDP per capita is around twice the level of the national average. Some basic data about the Czech regions is provided in the table below.

121 http://www.czechinvest.org/en/regions

Table 33 Base regional data for the 14 Czech regions

Region	Population	Capital City	City Population	GDP pc (CZK)
Prague	1,170,571	-	-	547,096
South Moravian Region	1,123,201	Brno	405,312	254,684
Central Bohemian Region	1,144,071	Prague		253,912
South Bohemian Region	625,712	České Budějovice	100,065	251,106
Hradec Králové Region	547,296	Hradec Králové	94,493	244,549
Vysočina Region	517,153	Jihlava	51,222	234,53
Pardubice Region	505,285	Pardubice	90,778	230,88
Liberec Region	427,563	Liberec	105,050	229,146
Ústí nad Labem Region	822,133	Ústí nad Labem	120,477	229,146
Zlín	590,706	Zlín	79,714	222,885
Moravian-Silesian Region	1,257,554	Ostrava	311,077	222,638
Karlovy Vary Region	304,588	Karlovy Vary	54,221	216,639
Plzeň Region	549,618	Plzeň	171,111	216,639
Olomouc Region	635,126	Olomouc	102,979	211,467
Czech Republic	10,220,577	Prague		271,100

Source: Wikipedia[122]

In European terms, these regions are NUTS-3 level entities (which means for example that only limited R&D data is available for them[123]); whilst there are regional councils for each of these regions, EU funds are allocated according to Operational Programmes which cover NUTS2 areas, which means that in eleven cases there is no single authority responsible for the programmes and they have to be negotiated between regional partners. The other regional division in the Czech Republic is into these Operational programme areas, which have no political bodies underpinning them, with the effect that the regional Operational Programmes are negotiated between regional authorities and the national Ministry. The NUTS2 regions of the Czech republic are shown in the map below.

122 http://en.wikipedia.org/wiki/Regions_of_the_Czech_Republic

123 Three NUTS 2 regions are the same as NUTS 3 regions, Prague, Central Bohemia and Moravia-Silesia ; South West includes Southern Bohemia and and Plzen, North West includes Karlovy Vary and Usti, North East includes Hradec Kralove, Pardubice and Liberec, South East include Vysocina and South Moravia., and Central Moravia includes Olomous and Zlin.

Figure 20 Map of the Czech EU Operational Programme Regions, 2011

NUTS2 Code	Name	Includes Regions
CZ01	Prague	Prague
CZ02	Central Bohemia	Central Bohemia
CZ03	South West	Plzen, South Bohemia
CZ04	North West	Karlovy Vary; Usti nad Labem
CZ05	North East	Libirec, Hradec Kralove, Pardubice
CZ06	South East	Vysocina, South Moravia
CZ07	Central Moravia	Olomouc, Zlin
CZ08	Moravia Silesia	Moravia Silesia

Appendix D : Centres of Excellence & Regional Centres

D.1 Centres of Excellence

BIOCEV: Biotechnology And Biomedicine Centre in Vestec	The ASCR and the Charles University
BIOEKO	Biology Centre of the Academy of Sciences of the Czech Republic, České Budějovice
CEITEC: Central European Institute of Technology	Masaryk University, Brno
Centre of Excellence IT4Innovations	Technical University of Ostrava
Telč Centre of Excellence	Institute of Theoretical and Applied Mechanics of the ASCR, Telč, Vysočina Region
CzechGlobe - Studies Centre for Global Impact Climate Change	Institute of System Biology and Ecology of the Academy of Sciences and Mendel University of Agriculture and Forestry, Brno
ELI: Extreme Light Infrastructure	Institute of Physics ASCR, (FZU), Prague
International Clinical Research Centre – ICRC	St. Anne's University Hospital, Brno
NTIS: New technologies for information society	University of West Bohemia, Pilsen

D.2 Regional Centres

AdMaS Center - Advanced Materials, structures & technologies	Brno University of Technology
Agriculture and Environmental Research Centre (AERC)	Research Institute for Fodder Crops Troubsko
Biomedical Research Centre (BMRC)	Charles University in Prague, Faculty of Medicine in Pilsen
Centre for Security and Advanced IT (CSAIT)	Tomas Bata University, Zlin
Centre for Bioactive Materials (CBaM)	Tomas Bata University, Zlin
New Technologies Research Centre (NTRC)	The University of West Bohemia, Pilsen
Centre for Polymer Systems (CPS)	Tomas Bata University, Zlin
Engineering Development Research Centre (EDRC)	VUTS (Liberec)
Algatech – Centre for Algae Biology in Trebon	Institute of Microbiology, ASCR
Centre for Sensors & ICTS (CSICTS)	Brno University of Technology
Research Centre for non-ferrous metals	Science and Technology Park - VÚK a.s.,

(CEVYNEK) in Panenské Břežany	Central Bohemia
Research Centre for Underground waste disposal and energy conversion (CEVPU)	Masaryk University, Brno
Centre for ICT Education, Research & Innovation (CERIT)	Masaryk University, Brno
Horticultural Research Centre	Mendel University of Agriculture and Forestry, Brno
DEVelopment of InfraStructure for Smart Engineering Materials Research (DEVISER) in Řež	Nuclear Physics Institute ASCR
Transport Research Centre (TRC)	Transport Research Centre, Brno
Power Units for Non-conventional energy courses (ENET)	Technical University of Ostrava
EXAM: Experimental Animal models	Institute for Animal Physiology and Genetics, Libechov, Central Bohemia
Institute for Mining and Technology (IMT)	Technical University of Ostrava
Institution of Environmental Technology (IET)	Technical University of Ostrava
Membrane Innovation Centre (MIC)	Membrain, Liberec
National Institute of Mental Health of the Czech Republic (NIMHCR)	Psychology Centre, Klecany, Central Bohemia
Pomology Research Institute (PRI)	Research and Breeding Institute HOLOVOUSY Fruit LtdHořice, Hrdac Kralové
Centre for Sustainable Vehicle Mobility (CSVM)	Josef Bozek Centre for Automotive Research Czech Technical University, Prague
Institute for Advanced Building Materials and Technologies (IABMT)	Technical University of Ostrava
RECAMO: Regional Centre for Applied Molecular Oncology	Masaryk University, Brno
Regional Centre for Advanced Technology and Materials (RCTAM)	Palacky University, Olomouc
Regional Centre for Opto-electronics (RCOO)	Institute of Plasma Physics, Turnov,
Regional Innovation Centre of Electrical Engineering (RICE)	The University of West Bohemia, Pilsen
Regional Institute of Technology (RIT)	The University of West Bohemia, Pilsen
Regional R & D centre for low-cost nanotechnology en plasma-surface technology (LNCPST)	Masaryk University, Brno
Sustainable Energy Research (SER)	Research Centre Rez, Central Bohemia
Unipetrol Centre for Research and Education (CRE Unipetrol)	Research Institute of Inorganic Chemistry

(UCEEB) University Centre for Energy Efficient Buildings	Czech Technical University, Prague
Metal Treatment & Coating Technologies Research Centre (ZMMC)	COMTES, Dobrany, Pilsen
Scientific Center for Applied Biomedical Research (SCABmR)	Charles University - Faculty of Medicine in Hradec Kralove

Source: http://www.msmt.cz/strukturalni-fondy/seznam-prijemcu-v-ramci-op-vavpi

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