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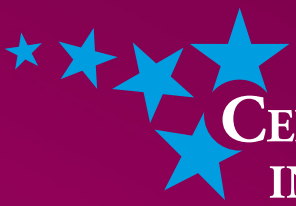

CENTRE OF INTERNATIONAL RELATIONS

CASES OF SCIENCE-INDUSTRY COOPERATION IN SLOVENIAN FOOD AND CHEMICAL INDUSTRIES

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CASES OF SCIENCE-INDUSTRY COOPERATION IN SLOVENIAN FOOD AND CHEMICAL INDUSTRIES

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Ljubljana, 2009

CONTENTS

1. INTRODUCTION

The relationship between industry and science has attracted significant attention in recent years both in the academic circles and among the policy makers. In particular, one should mention the literature related to 'Triple Helix Model' by Etzkowitz and Leydesdorff (1997), pointing to new relationships between business, university and government, or literature on the national innovation system (Dosi *et al.* 1988; Lundvall 1992; Freeman 2002, etc.). Innovation capability as defined by Stern *et al.* (2000) also stresses the importance of close linkages of business to the public research sphere. In terms of policy documents, there is the recent EU Action Paper on Innovation (2006), which sees the promotion of closer cooperation between science and industry as one of the important ways to improve European innovation effectiveness.

In the transition countries such as Slovenia, the issue of cooperation between science and industry is probably even more acute (see Radošević 2004). The importance of research and development (R&D) and innovation as factors of growth and increased competitiveness has only slowly been recognized in the business circles or the government policies. Little attention has been paid to raising awareness of innovation, improving innovation management capacities in enterprises, and ensuring that enterprises have access to competent consultancy services (Reid 2003). This can also be reflected in the low level of business R&D investment (ranging from 0.09 % in Cyprus, 0.29 % in Poland, 0.41 % in Hungary to 0.92 % in the Czech Republic; EU-EIS 2007) or low percentage of business firms involved in innovation activity. The governments have only recently started to pay more attention to the promotion of science-industry links and to formulating R&D and innovation policies with this focus. Slow progress in this area reflects how difficult it is to change the attitudes on both sides: the science community has its own perceptions, values and norms and the business community is driven by much more dynamic logic of the market. One of the positive consequences of the Europeanization of science and technology (S&T) and innovation policies, which resulted in better monitoring of the innovation indicators and policies in New Member States (NMS), is increased attention to the science-industry cooperation.

The objective of this study is to analyse the science-industry cooperation in Slovenia, to show its main characteristics, its general (legal, institutional and policy) framework, the main motivation behind the two sides for cooperation, the problems and obstacles, and, finally, it suggests what should be done on the business and the government levels to intensify the science-industry cooperation

in Slovenia. The analysis is based on the assessment of different policy papers, the study of relevant documents on innovation and R&D policy in Slovenia, as well as on specially prepared eight case studies from food and chemical industry. In the case studies, both partners in cooperation, i.e. the science (public R&D institution or higher education research unit) and a corresponding partner from the industry, have been interviewed.

The study is structured as follows. Introduction is followed by the analysis of policy papers on science-industry cooperation in Slovenia in section two, and by the methodology in section three, where the analysed cases are presented briefly. Section four presents the case study results in more detail; it analyses the main features of science-industry cooperation, conditions for cooperation, guiding principles of cooperation, knowledge concepts used by the partners, measures to improve innovation capacity in the analysed sectors and proposed actions for the intensification of science-industry cooperation. In section five, lessons of the case study interviews are confronted with policy objectives and programmes of the Slovenian government in the field of science-industry cooperation. Section six presents the conclusions.

2. SCIENCE-INDUSTRY COOPERATION IN SLOVENIAN POLICY DOCUMENTS

2.1 Short overview of the evolution of policy debate

In comparison with most transition countries, Slovenia's public sector research seems to be relatively better off. This stems from the fact that during the transition process the public science lobby was strong enough to secure a relatively stable government support for its survival. In contrast, the R&D units in the business sector suffered much more due to the restructuring of a number of large corporations and closing down of their R&D capacities as a consequence of the lack of funds (see Bučar and Stanovnik 1999). This different experience in the first half of the nineties can be identified as one of the main reasons behind the segregation of public research and business sector. The high level of dependence on public resources led to a significant shift of research priorities in the public research units, with basic research gaining importance. With the introduction of the research group financing scheme (see below), the focus on basic research further strengthened and the share of basic research in public financing of research increased (Bučar and Stare 2006).

This problem was perceived quite early, when various assessments of the Slovenian R&D policies called for a closer cooperation with the business community and for refocusing of the research towards priorities of the business sector. In a rather complex assessment carried out by GOPA Consultants back in 1994,[1] both the science community representatives and the people from the business sector were interviewed. One of the main recommendations of the study was to focus more on applied research in the public research institutions and to provide support for the formation of R&D units within the business sector. Then, the strength of the science lobby became evident: not only were these recommendations never taken on board, but a new system of public research financing was introduced in 1998, where the research project system based on periodic calls for research proposals (two to three-year scheme) was replaced by a research group financing under which five-year contracts were awarded to the selected research groups. The selection criteria favoured standard academic 'scientific excellence' indicators, especially bibliometrics, which led to a significant shift towards basic research (Bučar and Stare 2002).

1 The study was conducted under the PHARE Programme as technical support to the Slovenian Government.

Several other policy documents, including the National Research and Development Programme 1995–2000 (Ministry of Science and Technology 1995), addressed the issue of science-industry cooperation and even proposed shifting of resources towards more applied research. They were not successful; at the end of the period, the figures showed that funds available for applied research and especially funds available for research in cooperation between public R&D and business had decreased (Bučar 2002a). These developments were perceived in different external and internal analyses of Slovenian R&D system (Coopers & Lybrant 1997; EIU 2002; Sorcan *et al.* 2002, etc.), where changes in policies and funding were suggested, but never fully taken on board by the government.

TABLE 1: Distribution of R&D expenditures by funders and performers in 2007; in %

R&D PERFORMERS / R&D FUNDERS	Higher education sector	Government research institutes	Business sector	Total	Distribution of R&D exp. by funders	Total R&D exp., in EUR mill.
Government	33.1%	53.5%	13.4%	100.0%	35.6%	178.2
Business	2.8%	5.5%	91.5%	100.0%	58.3%	291.6
Abroad	30.9%	38.5%	30.6%	100.0%	5.8%	28.8
Higher education sector	100.0%	0.0%	0.0%	100.0%	0.4%	1.8
Distribution of R&D exp. by performers	15.6%	24.5%	59.8%	100.0%	100.0%	500.5

Source: Statistical Office of the Republic of Slovenia (26 February 2009).
Note: The share of the private non-profit sector is only 0.1 %.

The problem of insufficient science-industry cooperation in Slovenia is evident from the structure of R&D funding flows by funders and performers of R&D. In recent years, the level of R&D expenditures in Slovenia has been below 1.5 % of GDP, with a slight increase in 2006 to 1.58 %. In 2007 (the last available data), the ratio again decreased to 1.45 %. In nominal terms this means EUR 500.5 million in 2007. The business sector's share of total Slovenia's expenditures for R&D is 58.3 %, followed by the government resources (35.6 %) and resources from abroad (5.8 %). Thus, in 2007, the business sector expenditures on R&D were by 1.64 times higher (EUR 291.6 million) than that of the government (EUR 178.2 million). It was back in 1997, when R&D the expenditures of the business sector surpassed that of the government. Table 1 clearly shows that the government R&D expenditures predominantly finance the public research sector; in 2007, as much as 86.6 % of the government R&D expenditures went to the public sector (higher education and public research institutes), and only the remaining 13.4 % to the business sector R&D units. Business sector, as a rule, finances its R&D activities from its own resources.

In the past decade, Slovenia has established a complex scheme of bridging institutions within the national innovation system to help bridge the gap between public research and industry. The measures and instruments were mostly copied from more developed countries or suggested to the government by various consultancies (TWINNING projects). The bridging institutions include technology parks and centres (from 1994), incubators (2003), clusters (from 2001 to 2004), technology networks (2003 onwards), technology platforms (2005), centres of excellence (2005), different business information units such as the small business development centres, innovation relay centres, Euro-Info-Centres, regional development agencies, the Slovene Enterprise Fund, etc. All of them share the ambition of the policy makers to establish as complete an innovation system as possible. Yet sometimes it seemed that the main emphasis was more on the number of different instruments and institutions than on the quality of their work. Funding has often been insufficient and irregular and several institutions spent much of their energy on survival instead of on carrying out the tasks they were established for (EU 2005). No bridging institution put in place so far has been able to overcome the problem of insufficient cooperation between knowledge-creating institutions (universities and research institutes) and the users of new knowledge and innovation – the business sector (Mali *et al.* 2004). The latter is far less successful in voicing its demands and is less active in the field of R&D and innovation policy. Little attention was paid to a potentially very important barrier to closer science-industry cooperation, i.e. to the absorption capacity of the business sector (Mulej in Mali *et al.* 2004). The problem was identified by this broad research project on science-industry cooperation as especially serious in the small and medium-sized enterprises (SMEs), where innovation awareness is low and the ability to invest in innovation and R&D minimal.

BOX 1: Bridging institutions for science-industry collaboration

Technology centres – the measure to support technology centres has been one of the oldest in the Slovenian innovation policies. Technology centres are jointly set up by interested enterprises in a specific technological area and usually involve research/higher education institution. Government co-finances the running costs of technology centres. A PHARE programme 2002-2004 focused on support to technology centres as well as a special call under European Regional Development Fund under which resources were provided for investment in R&D infrastructure of technology centres.

Technology parks – similar to technology centres, support to setting up or to operating costs of technology parks is also one of early innovation policy measures. The support focused on subsidies for the SMEs working within technology parks.

Clusters – in 2001, the government initiated the programme of support to the formation of clusters. The objective was to stimulate cooperation within the business sector as well as between the business firms and public research organisations. Several clusters were developed, but in 2005 the policy was amended and the establishment of clusters was no longer supported. On the other hand, the European Regional Development Fund was used to provide support to joint research projects proposed by clusters as well as support for R&D infrastructure for the clusters.

Technology platforms – following the European Research Area (ERA) trend of forming technology platforms at the EU level, the Chamber of Industry and Commerce of Slovenia launched the idea of technology platforms at the national level. In 2006, the Ministry of Higher Education, Science and Technology announced a public call, supporting joint development/investment projects submitted by firms involved in technology platforms.

Centres of excellence – establishment of joint research projects and research infrastructure of centres of excellence are a subject of a special measure supported by the European Regional Development Fund. In line with the research priorities, eight centres of excellence have been established, bringing together higher education institutions, public R&D institutions and business enterprises in a particular scientific area (for example, ICT centre of excellence; centre of excellence in nanotechnology ...).

The discussion on science-industry links gained a new momentum with the preparation of several strategic documents in the more recent years (more specifically from 2004 on). There are several reasons behind it, but maybe the analysis of the factors of growth of Slovenian economy within the Slovenian Development Strategy 2006–2013 (IMAD 2005) was one of the most important ones. The analysis revealed that new growth dynamic can only be expected from restructuring of the business sector towards higher value added activities. This, however, cannot be achieved without increased R&D and innovation activity of the business sector. Embracing also the Lisbon Strategy targets, the new policy documents pay increasing attention to R&D and innovation in general and to the cooperation between science and industry more specifically. The next section provides an analysis of the main policy documents (white papers), currently backing the government macroeconomic and R&D and innovation policies.

2.2 Current policy documents

Different strategic documents in the area of R&D and innovation, which were adopted by the Slovenian government during 2005–2007, reflect the general

trends in the policymaking. The most important policy documents which will be discussed in more detail are the Slovenian Development Strategy 2006–2013 (SDS); the Resolution on the National Research and Development Programme (NRDP); the 2006 Framework for social and economic reforms for increasing the welfare in Slovenia, and the National Reform Programme for Achieving the Lisbon Strategy Goals (NRP). Also, both National Development Programmes (NDP 2004–2006; 2007–2013), which are the basis for the allocation of structural funds, need to be presented, since several measures focusing on promotion of cooperation between science and industry have been financed through the European Regional Development Fund (ERDF).

These documents are novel in a sense that for the first time both R&D results and increased innovation efforts by the business sector are seen as the key inputs into increased competitiveness and therefore more dynamic economic growth. This clear linkage of R&D and economic policy has not been so explicitly pronounced in the past. Also important is the stress on socio-economic relevance of research and expectations that increased public investment in R&D should be aimed at increasing the innovation activity of the business sector. Gradually, this rhetoric has been finding its way in the research programmes, where the socio-economic relevance of research, not just scientific excellence, has become more pronounced as the financing selection criteria.

One can observe a significant level of coherence in the documents, in part because the SDS and NRDP were prepared simultaneously and with reference to one another. The NRP and Framework built on the objectives and priorities of SDS and NRDP and expanded into the level of specific measures.

2.2.1 Slovenian Development Strategy 2006–2013 (SDS)

The preparation of SDS started in 2003 by the Institute of Macroeconomic Analysis and Development. A draft document was prepared by a wide group of experts, organized in ten thematic areas. Workshops were organized by these thematic groups in spring 2004. The draft Strategy was adopted by the Government in June 2004 and opened for public discussion, which took place in the second half of 2004. In the first months of 2005, respective ministries prepared their Action Plans to complement the Strategy, which was then submitted to the government for final approval in June 2005. The Strategy is a long-term economic development programme of the government and serves as a framework for more specific actions of different ministries and departments. It sets an overall vision of the future economic and social development. The objectives specified are annually assessed in the 'Development Report' thus assuring the monitoring of the Strategy's implementation.

The strategy follows the belief that Slovenia has a potential to increase its rate of economic growth by creating a more favourable environment for entrepreneurship.

This would imply more investment in R&D and innovation and improved flow of knowledge and cooperation between public research sector and business sector. The main objectives of the SDS (IMAD 2005) are the following:

- to exceed the average level of the EU's economic development (as measured by GDP per capita in PPP) and increase employment in line with the Lisbon Strategy goals in the next ten years;
- to improve the quality of living and the welfare of each individual, measured by the indicators of human development, health, social risks and social cohesion;
- to enforce the sustainability principle as the fundamental quality criterion in all areas of development, including the goal of sustained population growth;
- to develop into a globally recognisable and renowned country through a characteristic development pattern, cultural identity and active engagement in the international community.

In order for Slovenia to achieve the SDS objectives (as well as the Lisbon objectives), it must carry out structural reforms that will strengthen the competitiveness of its economy and raise its employment levels. SDS defines five development priorities:

- a competitive economy and faster economic growth;
- effective generation, two-way flow and application of the knowledge needed for economic development and quality jobs;
- an efficient and less costly state;
- a modern social state and higher employment;
- integration of measures to achieve sustainable development.

Measures to achieve the set objectives are specified for each development priority. In relation to R&D policy, the SDS stresses the need for research to be more integrated with the needs and capabilities of the business sector. The Strategy calls for an increase of R&D expenditures to 3 % of GDP following the Lisbon target and to achieve this, special measures to promote business R&D investment should be designed. Attention should be paid to raising the absorption capacity for R&D results in the business sector, particularly of SMEs. Organisational structure of public R&D system should be restructured as well and more effective placement of public R&D resources assured. The mobility of researchers from public to private sector should be stimulated. With all the planned measures, the SDS aims at making R&D and innovation one of the key drivers of growth.

A need to stimulate higher investment of business sector in R&D led to the proposals of tax incentives for R&D investment as well as other measures enabling cooperation between public and business R&D sector (mobility schemes). What was particularly welcomed was the new tax incentive introduced in 2006, under which investment in R&D is tax deductible in the amount of 20 %. The enterprises can reduce their taxable income for corporate tax by 20 % of their investment in R&D in general and by additional 10 % if the investment was made in the regions up to

15 % under the average development level and by 20 % for the R&D investments in regions where the development gap is more than 15 %. Eligible costs comprise both the purchase of equipment and new technology for the purposes of R&D, the cost of labour in R&D activities, and the purchase of licences. In all, the enterprises have claimed EUR 72.2 m in 2007 on account of R&D tax relief (IMAD 2008).

2.2.2 National Research and Development Programme (NRDP)

The basic document specifying the R&D policy (and implicitly also the science-industry cooperation) in Slovenia is the National Research and Development Programme, which is prepared by the government and adopted by the parliament every five years. The current NRDP was adopted by the government in September 2005 and by the parliament in December 2005. The document calls for the coordination of innovation policy with education policy, with economic/industrial policy and fiscal policy. The document realizes that a full contribution of R&D and innovation to the growth and development of Slovenian economy and society is unattainable without a well-coordinated policy. NRDP calls for prior assessment of the impact of different policies on R&D and innovation, which in case of implementation would be a substantial policy improvement. Most of the targets and priorities are coordinated with the Slovenian Development Strategy. Key objectives of the NRDP include:

- increasing of public R&D investment to 1% of GDP by 2010;
- shifting public research funds from basic non-targeted research more in favour of targeted (and applied) research;
- introduction of support measures to stimulate growth of investment of business sector in R&D to help achieve a 2 % of GDP target;
- growth of number of researchers with Ph.D.s in the business sector;
- higher rate of establishment of new high-tech firms, including promotion of spin-offs from universities;
- continuous participation in the international research, especially in ERA;
- support to the growth of patents, as an indicator of business relevance of research;
- growth of high-tech exports and growth of value-added in Slovenian economy.

A relatively wide array of research priorities set in NRDP followed the priorities of the EU Sixth Framework Programme (Information and communication technologies, advanced /new/ synthetic metal and non-metal materials and nano-technologies, complex systems and innovative technologies, technologies for sustainable development and health and life-sciences) and added research of specific importance for the Slovenian culture and history.

At the programme level, the NRDP includes:

1. More selectivity in R&D financing: All new allocations of public research money should follow the set priorities or at least positively discriminate in favour of research in the priority areas.[2]
2. Restructuring of public research funding from programme to project funding: shifting the structure of public funds from research programme funding[3] (basic research) more in favour of project funding (targeted basic research, applied and developmental research projects). NRDP calls for the redistribution of public research funds between science and technology to achieve a ratio of 55:45 by 2010; this would suggest gradual diminishing of the funds for research groups' programmes, which favour basic science, and increasing the funds for applicative and developmental research projects.[4] Programme groups funding should receive only half of the resources it receives now.[5]
3. Proposal for stricter promotion criteria at academic and research institutions, meaning that both the scientific excellence as well as socio-economic relevance of research (i.e. innovation relevance!) would be taken into account. A new resolution on higher education was to be submitted to the Parliament in 2007 and a new law on both research and higher education was announced by the government with a key objective of changing the institutional set-up of higher education and public research institutions; but the minister resigned. The discussion has been restored by the new government (since November 2008) but with no legal texts yet in procedure.
4. Developments in R&D evaluation system: a lack of interest among public researchers for co-operation with business sector has often been explained by the current R&D evaluation system for researchers, research programmes and/or projects and public research organisations, which awards scientific excellence on the basis of the number of publications. Research policy debates suggested a change of this system, attributing credits also for socio-economic relevance of research, demonstrated by the ability to draw additional funding from non-government resources. The NRDP calls for the changes in the evaluation system

2 In practice, some of the public calls (applied projects, mobility scheme) stress the priorities, while others remain open to all fields on equal footing.

3 Commonly known as research groups' programme.

4 A target of 80:20 in favour of project financing was suggested, yet in the final text this ratio is to apply only for the new (additional) money available for public R&D.

5 This is difficult to achieve, since the current research group contracts are binding till 2008 and unless serious breaching of the contract terms is proven to the recipient of the financing, no redirection can be executed till the end. In spite of expectations of change with the new round of programme group financing, the scheme has continued in the same manner with only exception being the length of financing: some programmes only received 3 years grant while the best ones were given a 6-year contract. Still, the assignment of priorities was not practiced and research topics were produced bottom-up: the groups proposed their own priorities.

to be implemented by the Slovenian Research System in the direction of attributing higher score to business relevance of R&D.

5. Policy of increasing budget allocation for R&D: ever since Slovenia's government endorsed the Barcelona target of 3 % of GDP as investment in R&D, this goal has been included in all the research policy documents. NRDP reiterates 3 % target, with setting a 1 % target for the government and 2 % target for the business sector R&D.[6]

The NRDP puts forward centres of excellence and the promotion of mobility from public research institutions to business R&D units as specific measures to increase science–industry cooperation.

2.2.3 The National Reform Programme to Achieve the Lisbon Strategy Goals (NRP)

The National Reform Programme to Achieve the Lisbon Strategy Goals is based on SDS. The NRP was prepared in October 2005 and presented to the European Commission and the National Parliament in November 2005. Just like in SDS, the measures aimed at achieving the Lisbon strategy goals are divided into five development priorities. They cover all Integrated Guidelines for growth and employment and also respond to the EU recommendations given to Slovenia so far. The extensive programme of measures was assessed by the Commission to be in accordance with the Directives and is responding to the main challenges and structural weaknesses. The NRP also stresses the fact that these problems have been identified by the strategic papers prepared by Slovenian government. So in fact, NRP can simply apply the objectives of SDS and the measures, which are more or less identical to the measures for achieving the Lisbon strategy goals. This is the way NRP is structured: it presents each of the objectives/priorities of SDS and assigns respective priority measures.

The sections of NRP relevant for innovation policy are: III.A.3.2. Promoting entrepreneurial development and innovation, III.A.3.3. Education for entrepreneurship, III.A.3.4. Small and medium-sized enterprises' access to financial resources, as well as the entire second development priority. Within the chapter on the second development priority (Effective generation, two-way flow and application of

6 Recent revision of the R&D statistics revealed a less favourable situation in R&D financing. Instead of previously estimated 1.61 % of BDP for R&D in 2004, the actual figure was 1.44 %, with slight increase in 2005 to 1.49 %. (Statistical Office of the RS, December 2006). In 2006, the ratio increased to 1.58 %, but in 2007 again decreased to 1.45 %) (Statistical Office of the RS, 19 February 2008 and 26 February 2009). This makes the implementation of changes in the public research funding mentioned above more difficult, since they were primarily related to new money.

knowledge needed for economic development and quality jobs), the NRP discusses the issues relevant for research. It reiterates the importance of the NRDP as the key policy document in the research policy area. Specific attention in the measures to be designed should be given to the two-way flow of knowledge from public research institutions and higher education to business sector. The priorities of the NRP are consistent with the priorities of the NRDP and SDS.

The NRP reiterates the same as other documents, i.e. that the innovation intensity, especially among SMEs is low and declining, the transfer of knowledge from public research institutes to business sector is deficient, bureaucratic procedures are complicated and lengthy, bank system is not adjusted to the needs of SMEs, venture capital is scarce, payment discipline is low, availability of suitable real estate for entrepreneurial activity is insufficient. Also identified is the lack of appropriate human resources.

The objectives and measures of the NRP are consistent with the SDS and incorporate the reform proposals of the Framework of Economic and Social Reforms for Increasing the Welfare in Slovenia (see below in this section). The targets set in the area of innovation, which support also the closer science-industry cooperation (III.A.3.2. and III.B.1.1.), focus primarily on:

- improvement of the awareness among SMEs of the government policies and instruments of support to innovation;
- better knowledge on innovation and entrepreneurship among young people, by introducing special workshops in schools;
- increase the share of income from business sector in public research institutes;
- achieving higher growth of sales revenue from exports in relation to support incentive for internationalisation;
- establishment of minimum 50 new high-tech SMEs;
- establishment of minimum three new business zones and at least two new technology parks;
- redirection of public research funds to priority areas of research and technological development, identified on the basis of cross-matching of research and business potentials;
- improve flexibility of labour market in R&D area to attract more researchers in business sector;
- introduce economic relevance as one of the criteria in new evaluation system in R&D;
- support spin-off enterprises;
- introduction of R&D favourable tax incentives.

The implementation report of the NRP in 2006 (IMAD 2006a) announces a new act on risk capital companies, which is in the process of drafting and aims at providing the missing legal basis for risk capital funds and public-private partnerships in this sphere. Also announced is the redrafting of the Protection of Intellectual Property Rights Act, which is expected to deal more specifically with research

results and innovations achieved in public research institutions or in co-operation between public research institutions and the business sector. In terms of the priority measures (Guidelines Nos. 7–8) the key findings of the implementation report are the following:

1. *Increase public expenditure on R&D by approximately 0.1 % of GDP a year.* Due to the revision of data on GDP for the period 2003–2005 as well as the difference between statistical estimates and final data, the figures on R&D expenditures in relation to GDP have changed significantly.
   The implementation report states that the planned share of public expenditure on R&D in GDP (both from the national budget and EU funds) by 2008 will be gradually increasing (2005: 0.66 %, 2008: 0.77 %). The shares from 2006 on include about 0.1 % of EU funds. The report also stipulates that in order to reach the set objective of 1 % of public expenditure on R&D in GDP by 2010, more funds will have to be allocated for this purpose in the future national budget.[7]
2. Gradually *change the structure of public investment in R&D* in such a way that additional public funds for R&D will be distributed between the technology sphere and the science sphere at the ratio of 80:20, while within the existing public funds, the share for specific applied and developmental research will be gradually increased in the sense of promoting technological development and innovation. The main problem here, as already mentioned above, is the contractual commitments of the Slovenian Research Agency. Until they are completed, only minor changes of the structure of public investment in R&D are possible. The implementation report states that several such initiatives have been started by the Agency, even though currently still with limited funding (thematic projects' funding).
3. *Change the tax policy* and industrial policy and the system of financing research activity in a way to encourage co-operation between the research sphere and the business sector, the establishment of spin-off enterprises and the employment of researchers in the business sector.

7 In fact, the most recent report on the implementation of the Lisbon Strategy officially moves the date for 3 % to 2013. Yet the postponement of the 3 % investment in R&D to 2013 is just as unrealistic as the first target. As already mentioned, the most recent statistical data reveal that Slovenia has only achieved 1.45 % of GDP investment in R&D in 2007, and the trend of growth was in 2007 considerably lower for the business sector as well. This is a serious warning that more needs to be done to support R&D investment in the business sector, since obviously the tax subsidies only stimulated the growth in 2006. Current government's response to allocate more resources in the 2009 budget to business R&D and technology development could be the right move to persuade the firms not to withdraw from investing in R&D and innovation during the times of crisis. The question remains what other bottlenecks limit the business sector R&D investment, especially among those firms which invest little or nothing in R&D and innovation.

The implementation report cites the amendments to the Corporate Income Tax Act as the most important achievement in this area, as they provide for an additional tax allowance for investments in R&D. The taxable persons have the possibility to claim a reduction of the taxable base in the amount of 20 % of the total sum intended for investment in R&D in a particular tax period. Investments qualified for allowance include investments in the internal R&D activities of taxable persons and in the purchase of R&D services provided by other people, including affiliated entities, or other public or private research institutions. In the case of R&D investment in less developed regions, the law allows for 40 % tax allowance.

4. Establish a *legislative and financial environment* supportive of the establishment and growth of high-tech and other innovative enterprises, particularly SMEs (strengthening the Slovenian Enterprise Fund, co-founding and supporting the operation of risk capital funds and other forms of support for enterprises through rebates). Most of the measures to promote co-operation between R&D and the business sector are included in the Programme of Measures to Promote Entrepreneurship and Competitiveness 2007–2013 (Ministry of the Economy 2006), which was adopted by the government in July 2006. They include: (i) establishing a Slovenian centre for competitiveness and innovativeness; (ii) encouraging the establishment and operation of innovative groups of enterprises; (iii) supporting SMEs and potential entrepreneurs in the use of consultation and support services for innovations; (iv) encouraging SMEs to acquire intellectual property rights (in 2006, this is part of the tenders, but will represent a separate measure starting from 2007).

2.2.4 The Framework of Economic and Social Reforms for Increasing the Welfare in Slovenia

To improve the competitiveness of Slovenian economy and thus achieve the ambitious goals of SDS, a set of reforms was proposed by the government. The Framework of Economic and Social Reforms for Increasing the Welfare in Slovenia (referred to as the Framework) was adopted by the government on 2 November 2005. The Framework intends to influence the following most important mechanisms for an enhanced development climate (Government Office for Growth 2006):

- motivation for activity (restructuring of social transfers, remuneration of work);
- possibilities for activity (tax reform, promotion of entrepreneurship, and a more flexible labour market);
- incentives for productivity, productive use of knowledge and employment (taxes and technological subsidies);
- free economic initiative (privatisation, entrepreneurship and liberalisation);

- an efficient and less expensive state (restructuring of public finance + limitation of public spending + better regulation + public private partnership + drawing EU funds + national projects + elimination of court backlogs);
- an efficient welfare state (social transfers + health care + pension system).

The Framework proposes policy measures in four development priorities: first, competitiveness and economic growth; second, efficient creativity, two-way flow and use of knowledge for economic development and quality of the workplace; third, an efficient and cheaper state; and fourth, a modern welfare state and higher employment.

The measures within the second priority are intended to achieve Slovenia's better use of domestic and foreign knowledge for its economic development. The basic change to undertake is strengthening cooperation between research, or better, the academic sphere, and the business sector. The aim is the creation of an efficient and open 'innovative system' in which all key participants will interactively cooperate (companies, universities, public and private research institutions, state administration and para-state support institutions, such as agencies, technological parks, finance organisations, etc.). The Framework proposes the creation of an environment encouraging a gradual transformation of existing universities, their links with institutes and founding of new private higher education institutions. In the area of R&D, the Framework proposes above all a reallocation of funds to technological development and cooperation with the business sector, facilitating procedures for obtaining funds and centralisation of technological policies within a single body.

Within the second priority, the Framework, *inter alia*, proposes the following measures of importance for the strengthening of science-industry link:

Measure 28: Reform of education. A number of measures are proposed to reform the system of education and training towards higher quality and increased competitiveness, to the user's – including business sector's – benefit.

Measure 29: Improving the efficiency of the use of knowledge and innovativeness. The purpose is to redirect the activity of highly-qualified people and experts into activities that indirectly and directly contribute to a rise in the productivity and business success of the national economy. The proposed changes include: (i) to simplify the system of obtaining and using of domestic public funds, (ii) to simplify the system of drawing EU funds and to up-grade public administration for assistance to companies and institutions in obtaining EU funds, (iii) to increase investments in R&D in line with the aims of NRDP, (iv) to ensure economic motivation for greater demand of the business sector for science and innovation, with a reduction of the labour costs of top experts and with favourable tax treatment of R&D expenditures; (v) to change the system of remunerating researchers in such a way that they will have greater authority and autonomy in managing projects, including the use of funds; (vi) consistently to implement the changes in financing public research institutes foreseen in NRDP.

Measure 30: Technological Agency of Slovenia (TIA). Change of the legal status of TIA in a way to put it within the 'Ministry of Development', and in such a way to enable TIA to carry out the activity independently of the 'scientific lobby', which will bring the activities of the Agency nearer to the needs of the business.

Measure 31: Technological and innovative programmes for economic growth. The basic purpose of these programmes is to increase the competitiveness of Slovenian companies in such a way that the development and the use of global technologies and applicative knowledge are promoted. The aim of co-financing development technological programmes for the business sector is the support of development in specific areas of industry and the creation of higher value added in the business sector. Within the framework of technological programmes for economic growth, co-financing will be available for technology projects of companies in the area of investment in high technology, improving technological processes, services or products, innovativeness, cooperation with knowledge institutions, SMEs, increased value added and rate of innovation, new jobs, ecological acceptability, use of science and international cooperation. The proposed policy actions in this measure include: (i) creation of a new, efficient, transparent and simple mechanism of awarding funds to companies, (ii) plan and design of the programmes in cooperation with companies and knowledge institutions, (iii) half of the projects to be co-funded within the framework of research programmes, the participation of companies is needed for the other half, etc.

Measure 32: Programmes for the transfer and rising of knowledge in the business sector '1000 young experts'. The intention is to rise the existing education structure in companies and the inflow of foreign experts by procuring the funds for three years employment of postgraduate and post-doctoral students in the business sector. The government will finance 75 % of salaries of these experts for a fixed term of three years.

Measure 33: Programmes for promoting the transfer of global technologies to Slovenia. Co-financing the exchange of Slovenian business-persons in foreign companies within the framework of joint projects.

Measure 34: Programmes for linking the business sector with universities. Co-financing of applicative and development projects or of research institutions that stimulate the applicability of academic research. The measure will promote the transfer of knowledge from universities and institutes to companies through projects directly connected with the interests of companies. Projects have to relate to the interests of the business sector.

Up to now, no official assessment of the implementation of the Reform programme has been undertaken.[8] Looking at different measures proposed by the

8 The assessments have been done by the IMAD in its annual development report on the implementation of the Slovenian Development Strategy and annual assessment of the implementation of the National Reform Programme for the Implementation of the Lisbon Strategy Goal. So, the

Framework of Reforms and comparing them to the actual policy measures introduced in the period 2006–2008, one can notice only sporadic implementation of certain ideas, which were not novel to the Framework, but can be found in other policy documents as well.

While support to business R&D is high on the government's priority list in its strategic documents, the actual allocation of public R&D funds shows that only approximately 10 % of these funds go to the business sector (see Table 1). The measures designed to stimulate private R&D investment include corporate income tax subsidy, different ways of co-financing of R&D projects, subsidised loans for R&D investment, support to technology centres and technology platforms, co-financing of the services offered to business sector by technology parks, business/university incubators as well as mobility schemes. Most of the government's support measures have been included in the Operational Programme for Strengthening Regional Development Potentials in the National Strategic Reference Framework, under the development priority 'Competitiveness and research excellence'. For this priority as much as 23.5 % of total resources of this Operational Programme (or EUR 402 million) have been earmarked (primarily from European Regional Development Fund). This means that from 2008 on, the financial resources available will increase significantly, but so will the administrative procedures – the experience of the previous round of projects/calls supported with EU funds reveals that the system in Slovenia is highly complex and has discouraged many potential applicants (Bučar *et al.* 2007).

A new measure to support mobility of researchers from public sector to business R&D units was introduced by the Ministry of the Economy in 2006. It provides for the co-financing of the salaries of the researchers who have been working in public R&D units and are to move to the business sector. Due to rather complex criteria and relatively limited financial stimulation, the measure was met with mild enthusiasm in the research community. In 2008, the measure was moved to JAPTI (*Javna Agencija za podjetništvo in tuje investicije* – Public Agency for Entrepreneurship and Foreign Investment) and modified so as to encourage transfer of highly-skilled personnel from large enterprises to the small ones. The specific criteria is that the researchers eligible are those with engineering or natural science background and that they should continue working in the same area of research. The goal is to achieve annually at least 30 transfers from public R&D to the business sector and another 30 from large corporations to small and micro firms.

goals which are similar in all the three documents have been assessed, as seen in the other parts of this chapter.

2.2.5 National Development Programme and Single Programming Document 2004–2006 (SPD)

For the Research, Technological Development and Innovation (RTDI) area, the first priority of the SPD, called 'Promotion of productive sector and competitiveness', is the most relevant. The activities were to be focused on the development of innovation environment, removal of administrative barriers and improved access to information, knowledge and finance for entrepreneurship. Also, development of suitable locations for further expansion of enterprises was to help improve the investment conditions. According to the official documents of the Government's Office for Local Self-Government and Regional Policy, the resources of ERDF, located to the Priority 1, were to be used for the following measures: 1.1. Promotion of innovation environment (20 % of resources); 1.2. Promotion of development of tourist destinations (20 % of resources); 1.3. Improvement of the support environment for entrepreneurship (15 % of resources); 1.4. Economic infrastructure and public services (45 % of resources).

From the viewpoint of RTDI, the second priority should be mentioned as well, since the activities in the area of human resources which were planned there have a potential impact on innovation policy as well. Most of the specific measures concentrated on the promotion of lifelong learning, active labour policies (education and training of the registered unemployed) and promotion of entrepreneurship as a means of self-employment.

Objective 1 'Better environment for innovation activities' of SPD supports the creation of *centres of excellence* and *technology networks* (initiated by private institutes) and organisations, supporting industrial R&D activities. The initiative is partly modelled after Sixth Framework Programme's 'networks of excellence'. It combines research facilities at different public research units (both institutes and universities are involved) in research, which is focused on the needs of the business sector members of the centres of excellence. Financial resources go to research units, but co-financing must be coming from the business sector for each individual project. Eight centres of excellence have been established so far. According to the interviews with project managers, the centres have generated new research activity in the areas directly relevant for the business sector. Cooperation with the business sector is gradually increasing and business partners in the centres are getting more and more involved in directing the research towards the questions relevant for them.

2.2.6 The National Development Programme 2007–2013 (NDP)

The National Development Programme was prepared during 2006 and was approved by the European Commission in the second half of 2007. The topic of science-industry cooperation is included in the second development-investment

priority 'Effective creation, two-way flow and use of knowledge for economic development and quality employment'. The following activities are listed in support of science-industry linkages:

- promotion of cooperation between the academic community and the business sector by supporting mobility of researchers with scholarships for undergraduate and graduate studies, strengthening participation of employees in business in postgraduate studies, promoting employment of postgraduates and doctoral students in the business sector, promoting of mobility from public research institutions to the business sector, as well as mobility schemes from large to small enterprises; promoting formation of interdisciplinary and cross-sector R&D teams, as well as promotion and popularisation of science, especially technical and natural science fields;
- science for development, where higher investment in R&D in accordance with the Barcelona goal is to be assured, along with higher effectiveness, more attention to priority research areas, increased share of specific applied and development research and increased share of project financing, design of measures to link research and teaching, awarding cooperation with business sector, internationally comparable expert evaluation system in R&D, organisational restructuring of public R&D system to increase responsiveness to business initiatives, integration in national and regional centres of knowledge, etc.
- quality, competitiveness and responsiveness of higher education with the formation of new universities and higher education institutions, more integrated with the business sector.

These activities are to be funded through the projects within the first priority of the Operational Programme of European Regional Development Fund 'Competitiveness of enterprises and research excellence'. The support should go to joint R&D projects as well as to the investment in modernisation, construction and equipment of intermediary organisations and other institutions in R&D and business support environment as well as in business enterprises.

The increased transfer of knowledge between institutions in public sector and business as well as within the business sector should be achieved especially by:

- linking the public sector R&D and education institutions with the business sector and cooperation of top professionals of the two sectors;
- integration of business entities in joint projects;
- inter-disciplinarity of development and research projects;
- development of centres of excellence.

2.2.7 Increasing the Competitiveness of the Slovenian Economy: White Book of the Proposals of the Chamber of Commerce and Industry of Slovenia (CCIS) for Higher Competitiveness of the Slovenian Economy 2007

Above, various strategic and policy documents of the Slovenian Government have been analysed, relevant for the science-industry linkages. The subsection below, however, presents the position of the Slovenian business community as formulated by the Chamber of Commerce and Industry of Slovenia (CCIS), which is the main business sector association in the country.

The CCIS (2007) groups its proposals for the improvement of the competitiveness of the Slovenian economy into eight areas, one of them being 'Technological Breakthrough of the Slovenian Economy'. Within this area, the CCIS puts forward the following proposals for the authorities to improve the science-industry link:

- to establish national innovation system – to link the education and R&D sphere with the business sector for joint innovation. The proportions and methods of the allocation of public resources for R&D should be changed in a way to support more the development orientation and needs of the business sector. This calls for the changes in the main legal policy documents, such as the Research and Development Act, NRDP, NDP. The role of the CCIS here is: (i) to act as the point of meeting and networking of enterprises with universities and institutes, (ii) to support the technology platforms and to assist in the planning of joint investments in knowledge and technology development, (iii) to offer support in the integration in international development partnerships and organization of innovation networks.
- to better define and link the priorities of R&D investments at the state level with the innovation potential of the enterprises. The CCIS will assist enterprises in their dialogue with the state on the selection of the national technology priorities.
- to define an incentive pattern in the education system so as to stimulate students to enrol in the programmes of high relevance for the innovation growth of the Slovenian enterprises. These incentives relate to public and private scholarship funds, tax incentives, etc. The CCIS will stimulate discussion on this topic between the enterprises and the state.
- to speed up the transfer of R&D results to the business sector, in order to stimulate more dynamic restructuring of the Slovenian corporate sector towards higher value added activities. The CCIS proposes the change in financing of R&D activity whereby public R&D financing would depend on the participation and cooperation of the business sector in R&D projects/activity.

Several of the suggestions of the business community are similar to the objectives and targets contained in the government's white papers, yet it seems that the business community is dissatisfied with the dynamics of implementation of various strategies, programmes and reforms.

2.3 Concluding remarks on science-industry cooperation in Slovenia's policy documents

The common denominator of all the analysed strategic and policy documents is that intensification of R&D and innovation efforts by the business sector is the key factor of increased competitiveness and therefore more dynamic economic growth. This clear linkage between R&D, innovation, competitiveness and growth has not been so explicitly recognised by the economic policy documents in the past. Based on this recognition, there are several objectives and policy priorities which address the field of knowledge creation, R&D and innovation. The priority measures proposed can all be recognised as appropriate. They are focusing, on one hand, on the overall environment for entrepreneurship and SME activities and, on the other, on research and development. Some of the intended measures require a sufficient rise in (public) funding to be fully implemented (higher support to applied business related projects), others require a serious commitment on the part of all the institutions involved.

Here, a certain level of criticism goes to the university sector, where the willingness for change and reorientation towards the needs of the business sector, be it in the area of education or research, has been particularly weak. The academic sector employs a large share of the Slovenian science community, which is even more detached from daily business challenges than the R&D institutes. In spite of several suggestions of business, foreign and domestic evaluators of national innovation system (NIS) to the academic sector about adjusting its promotion criteria and putting more emphasis on the practical experience of university professors, no change has been introduced (Bučar 2002b). The business community considers the universities as too slow in responding to the changed economic environment and therefore does not consider them as well equipped with practical knowledge or able to respond within the timeframe required by firms (EU 2006b).

Yet, several successful companies have established links with public research either at universities or research institutes and formed permanent teams of researchers from both sides. According to their statements, it took some time to find a common language and to develop fruitful cooperation, but at the end, the result is beneficial to both sides. The same can be said of some of the bridging institutions; those that were able to 'weather it out' have found their place and work in spite of occasional financial or technical difficulties.[9]

As for the implementation of the strategies and reform programmes, it may be too early to pass an objective evaluation. However, only meagre increase in resources available for R&D and innovation support measures in 2006–2008 allows

9 A positive example is Ljubljana's Technology Park, where companies have successfully developed from the start-up stage into regular SMEs in spite of the unsuitably small size of the premises and the irregular nature of financial support from the state.

us to question the achievement of the 3 % target as well as several other objectives set forth in the policy papers. In fact, the 2008 Report on the Implementation of the National Reform Programme already postpones the achievement of 3 % to 2013. Even this date is much too optimistic. Slow progress in the area of R&D and innovation objectives was noticed in the Development Report prepared by IMAD (2008). This gap in the implementation was also highlighted in the European Commission's 2007 report on implementation of the Lisbon Strategy, urging Slovenia to develop a research and innovation strategy and to strengthen its efficient implementation.[10] To promote this process, the Competitiveness Council of the Government of the Republic of Slovenia was set up at the beginning of 2008 (Official Gazette of the Republic of Slovenia No. 14/08) aimed at improving cooperation between the business sector, research institutions and government in the area of formulating and implementing policies to promote technological development. The main objectives of the Council are:

- to improve the cooperation between the government, knowledge institutions and business sector in the area of design and implementation of the policies to promote technology development;
- to stimulate technology development in Slovenia by selection of research and technology areas within the priorities defined in strategic government documents, so as to enable the concentration of resources and search for synergies among the selected fields;
- through concentration of public and private resources to priority areas to increase the share of resources for research and technology development (RTD) as a share of GDP as well as to increase their efficiency.

The objectives have been translated also in measurable targets:

- achievement of the 3 % R&D investment in GDP by 2013–2015;
- increase the number of innovation active SMEs from 27 % to minimum 40 % (2002– 2004)[11];
- increase the number of patents at EPO to at least 110 patent applications per million population;
- increase the share of high-tech exports to 16 % (EU 27 average).

The Competitiveness Council consists of ten *development groups,* each with 16 members, representatives of the research-higher education and business sector.

10 Recommendation of the Council of Europe on the 2008 update of the Broad Economic Policy Guidelines of the Member States and the Community and on the implementation of the employment policies of the Member States, March 2008.

11 Since the time of setting these objectives, the Statistical Office has already published the results on innovation activity during 2004–2006, according to which 35.1 % of enterprises are innovation active. (SURS, April 2008)

Seven groups follow the sectors (life and health, ICT, materials and nanotechnologies, environment and construction, energy and renewable energy sources, communications, transport and vehicles, process technologies), while three are meant to be horizontal (creative industries, business-finance and public research and higher education governance). By the fall of 2008, the groups presented their deliberations as to the priority research areas/themes both for basic and applied research, identified some of the business interest and research capabilities, as well as assessed absorption capacity of Slovenia's business and market potential at the global markets. Yet no specific plan was prepared on how these proposals are to be integrated in the research policy and especially different funding schemes. So, priority setting remains one of the deficiencies of Slovenia's research system.

To conclude, the overview of strategic and policy papers shows that the issue of science-industry cooperation is high on the policy agenda in Slovenia, with several targets set forth as well as numerous measures proposed and planned. What seems also conclusive is that the follow-up is less apparent: who is to implement which measure and how the overall policy should be coordinated remains an open issue. This, of course, significantly contributes to the overall (non)relevance of the policy documents.

3. METHODOLOGY – INTRODUCTORY PRESENTATION OF CASES

Eight cases have been selected for the analysis of science-industry cooperation in Slovenia, four in the food industry and four in the chemical industry. Cases have been selected in a way that each case in the science sector has a corresponding case in the industry sector, i.e.:

- *Food industry:* Case of the Chair for Agricultural Economics, Policy and Law of the Biotechnical Faculty, University of Ljubljana *(Case 1)* has a corresponding case of its collaboration partner in the industry Food Industries Association of Slovenia within the Chamber of Commerce and Industry of Slovenia *(Case 2)*;
- *Food industry:* Case of the Animal Science Department of the Faculty of Agriculture, University of Zagreb, Croatia *(Case 3)* has a corresponding case of its collaboration partner in the industry Emona RCP – Nutrition Research and Development Department, Ljubljana *(Case 4)*;
- *Chemical industry:* Case of the Chair of the Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology, University of Ljubljana *(Case 5)* has a corresponding case of its collaboration partner in the industry R&D Department of Melamin, Kočevje *(Case 6)*;
- *Chemical industry:* Case of the Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry Slovenia, Ljubljana *(Case 7)* has a corresponding case of its collaboration partner in the industry Krka, Novo Mesto *(Case 8)*.

Each case tackles the following issues:

- the main features of the collaboration project;
- the conditions for science industry cooperation;
- the guiding principles in science-industry cooperation;
- the importance of knowledge;
- measures to improve the innovation capacities in the sector;
- what science and industry should change/do in order to improve their cooperation.

Below there is a short description of science departments and companies analysed in the cases.

Case 1: Chair for Agricultural Economics, Policy and Law of the Biotechnical Faculty, University of Ljubljana (http://kaepp.insist.si/). The Chair for Agricultural

Economics, Policy and Law is a part of the Department of Animal Science of the Biotechnical Faculty of the University of Ljubljana. It employs nine people involved in teaching, research and consultancy to government, other agencies and companies. Its main current domestic/international research and consulting projects include issues, such as policy of multifunctional agriculture in Slovenia, market possibilities for agricultural and food industry products of special quality, information system for decision-making support of farms, a policy model of multifunctional agriculture.

In this case we concentrate on the project of 'Competitiveness of the Slovenian food industry: economic-analytical support', which is a joint project of the Chair and the Food Industries Association of the Chamber of Commerce and Industry of Slovenia. The project is a kind of umbrella project for assisting the companies from the food processing industry in increasing their competitiveness.

Collaboration of the Chair with food processing industry is concentrated on economics and marketing issues. Apart from that, the Biotechnical Faculty is also engaged in more 'technical' aspects of the science-industry cooperation. Currently, it is engaged in the following projects for the business sector: quality control of honey for the Apiculture Association of Slovenia, testing adequacy control of food items for retail stores, sowing experiments, testing of tractor sprinklers and increasing of Omega 3 fats in eggs.

Case 2: Food Industries Association of Slovenia within the Chamber of Commerce and Industry of Slovenia (http://www.sloveniapartner.com/article.asp?ID=145&IDpm=144). Food Industries Association of Slovenia is one of the branch associations within the Chamber of Commerce and Industry of Slovenia. Its members are companies and independent entrepreneurs primarily engaged in the production of goods and services within agriculture, hunting, forestry, fishing and manufacture of food, beverages and tobacco products. All the main Slovenian food processing firms are members of the Association. It has five employees. Its main tasks are, *inter alia*: (i) monitoring and analysing of economic trends and creation of conditions for strengthening the competitiveness of food processing firms; formulation of common standpoints of food processing firms with regards to important economic policy and legislative issues; affirmation of the interests of food processing firms in formulation of economic policy and legislative measures; (ii) implementation of joint projects in the field of R&D activity, technological development, organizational issues, promotion issues, etc.; organising of joint representation of Slovenian food processing firms at specialised fairs abroad.

In this case we analyse two aspects of the science-industry collaboration of the Association. First, we specifically concentrate on the project of 'Competitiveness of the Slovenian food industry: economic-analytical support', which is a joint project of the Association and the Chair for Agricultural Economics, Policy and Law of the Biotechnical Faculty of the University of Ljubljana (see above). Second, we analyse the science-industry collaboration of the Slovenian food processing industries in general, as reflected in the activities of the Association.

Case 3: Animal Science Department of the Faculty of Agriculture, University of Zagreb, Croatia (http://www.agr.hr/cro/ustrojstvo/zavodi/24/index.htm).[12] The Animal Science Department of the Faculty of Agriculture in Zagreb is involved in various research and development projects in the area of genetics, physiology, breeding, selection and nutrition of animal and meat science. The Department employs thirteen people involved in different research areas for their faculty as well as for other entities in the business sector. Its main current domestic/international R&D project is the EUREKA project titled 'Influence of Animal Diet on Fatty Acid Composition of Beef'. This project presents a follow up of the project 'Influence of Animal Diet on Fatty Acid Composition of Pork', undertaken in the period 2003–2006. Since the current project is in the initial phase, the case study is based on the completed project, the 'Influence of Animal Diet on Fatty Acid Composition of Pork' (see below).

Case 4: Emona RCP – Nutrition Research and Development Department, Ljubljana (http://www.e-rcp.si/o_podjetju_angla.html). Emona RCP – Nutrition Research and Development Department, Ljubljana is a R&D unit of the enterprise Jata Emona and is involved in various R&D projects in the area of human and animal nutrition. It employs eight people involved in research, testing and development of different solutions for their own company as well as other companies. Its main current domestic/international R&D projects include EUREKA project 'Influence of Animal Diet on Fatty Acid Composition of Pork', PHARE project on production of functional foods, R&D project on bioavailability of Ca and P from the new products as well as a series of projects on the traceability of different meats (pork, beef, poultry) and eggs.

The case study focuses on the EUREKA R&D project on the influence of animal diet on fatty acid composition of pork, which is a joint project of the Department and the Faculty of Agriculture of the University of Zagreb, Croatia. As an EUREKA project, it had been co-financed by both the Slovenian and Croatian government and co-sponsored by the business sector participants (pork meat producers) from both countries. The project is the result of several years of research work in the area of animal nutrition where in previous phases different other public (including Biotechnical Faculty of the University of Ljubljana) and private partners have been involved.

Case 5: Chair of the Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology, University of Ljubljana (http://www.fkkt.uni-lj.si/en/?505). The Chair of the Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology is involved in various R&D projects in cooperation with industry. The case study focuses on the overall experience in different projects in collaboration with the partners from chemical industry. More specific attention is

12 This case was prepared by Zoran Aralica from The Institute of Economics, Zagreb.

devoted to the cooperation established with company Melamin, but comments on good practices or weaknesses in cooperation were given on the basis of experience in other collaborations as well.

Case 6: R&D Department of Melamin, Kocevje (www.melamin.si). Company Melamin is located in Kočevje in South-Eastern Slovenia. It is basically a chemical factory, but apart from Chemical Industry Division, it also has Wood Industry Division and Foot Industry Division. Melamin's products are used by paper industry, wood processing and furniture industries, civil engineering, paint and lacquer industry, rubber industry and in footwear manufacturing. R&D Department is situated within the Chemical Industry Division. The Department is registered as a research organization with the Ministry of Education, Science and Sport. R&D Department employs 20 people which is almost 10 % of all the Melamin's employees (209). Melamin products are to a considerable degree a result of their own development efforts and intensive investments in new technologies. The work of R&D Department is based on: (i) development of new products, (ii) modification of existing products because of the demands of the market, legislation or other demands, (iii) co-operation with buyers, (iv) co-operation with production management and the inspection of quality.

The work of R&D Department is necessary in the following areas: (i) development and modification of products intended for buyers of rubber industry, (ii) modification of classic lacquers according to the buyer's needs, (iii) development work in the field of highly etherized lacquers, (iv) implementation of new technologies in the production of highly etherized lacquers, (v) co-operation with buyers on closing of circuit of their technological waters, (vi) modification of products in the sense of improving their technological, toxic and environmental acceptability, (vii) development work in adhesive and impregnation resins which enables longer stability of products and easier usage of resins as well as lesser consumption of energy, (viii) development work in new fields, and (ix) testing of some products according to their eco-toxic character and the make of new security papers. Orientation of the work of the R&D department in the near future will be concentrated on: (i) final implementation of synthesis on new machines, (ii) modification of technological procedures in connection with new machines, (iii) introduction of new types of resins for buyers of rubber industry, (iv) further development, in laboratorial and industrial sense, of new types of resins for lacquers, (v) further development in the field of adhesives and impregnation resins, (vi) further development with insulation materials and development of new products, (vii) further development of new types of super plastic coating material for concrete, (viii) development in the field of coating adhesives: optimization of syntheses of AKD coating adhesives, lab synthesis of other types of coating adhesives in connection with closing of water circuit in paper mills, (ix) introduction of new products, which have been developed in the last years, in the field of paper resins, (x) work in the field of epichlorohydrinic resins for the reduction of toxic waste products, (xi) further work with exterior application projects together with other research institutions.

The topic of this case is science-industry collaboration between Melamin and the Faculty of Chemistry and Chemical Technology (FCCT) of the University of Ljubljana in the field of melamine-based chemicals, especially ultra-light melamine-based foams, which is an incombustible material for sound and heat insulation, characterised by high elasticity at low temperatures.

Case 7: Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry Slovenia, Ljubljana (http://www.ki.si/en/research-departments/l-09/). The Laboratory for Inorganic Chemistry and Technology is a part of the National Institute of Chemistry Slovenia. It employs five researchers and three young researchers, employed on the basis of the Young Researchers Programme of the Slovenian Research Agency. Research activities of the laboratory are focused on the investigations of porous materials (zeolitic materials, mesoporous materials and cement research) and on materials structural analysis (x-ray diffraction, nuclear magnetic resonance spectroscopy and X-ray absorption spectroscopy). The science-industry cooperation of the laboratory is concentrated on three Slovenian companies, i.e. a pharmaceutical producer Krka from Novo mesto, a cement producer Salonit from Anhovo and a chemicals producing company Silkem from Kidričevo. In this case we tackle the collaboration with all three companies.

Case 8: *Krka, Novo mesto* (http://www.krka.si): Krka is one of the top generic pharmaceutical companies in Europe and one of the two largest Slovenian pharmaceutical companies, known for its intensive and significant investment in R&D. Founded on 23 April, 1954 in Novo mesto, Krka grew to become an international company employing over 7.362 workers and supplying its products to the markets in more than 70 countries worldwide – manufacturing its products in its own facilities in Slovenia, Poland, Russian Federation, Croatia and in Germany. In the first half of 2008, Krka Group recorded sales worth EUR 469.3 million in product and services sales. The central element of Krka's strategic orientation is the manufacture of generic medicines. Krka's generic medicines are based on their own innovative synthesis processes or processes for the isolation of active substances and on their own innovative pharmaceutical formulations. Today Krka has over 280 patent-protected innovations for which a number of patents have been issued in several European and Asian countries and in the USA. The quality of their active substances is controlled by a number of laboratory tests using highly sensitive and reliable validated analytical methods and instruments. The wide spectrum of their activities in R&D, from basic research to numerous analyses and control monitoring requires not only large in-house R&D department, but wide network of collaborating partners in R&D area. The case study relates to the cooperation of Krka with the Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry.

4. MAIN FINDINGS OF THE CASE STUDIES

4.1 Case 1: Chair for Agricultural Economics, Policy and Law of the Biotechnical Faculty, University of Ljubljana

4.1.1 The main features of the collaboration project

Research/consultancy activities of the Chair for Agricultural Economics, Policy and Law for the Slovenian food processing industry take place at four different levels:

1. The first level is specific contract-based cooperation between the Chair and the Food Industries Association of the Chamber of Commerce and Industry of Slovenia. The activities under cooperation are concentrated on the analysis of current developments in the Slovenian and international food processing industries, and regular annual analysis of the food processing industry in Slovenia. The involvement of the Chair in this project results in a number of research/consulting links with individual food processing firms (see below).
2. The second level is quite frequent everyday informal support of the Chair to the firms in the food processing industry, directly in contact with the firms or indirectly via the Food Industries Association. This is mostly free of charge consultancy to firms. The advantage of this kind of science-industry cooperation on the side of the firms is that they get immediate and free advice. The advantage for the Chair is the acquisition of knowledge on what goes on in firms and where the key problems are.
3. The third level usually develops from the second level. Every day contacts with firms often develop into more comprehensive science-industry cooperation between the Chair and the firms. The cooperation develops mainly with the largest Slovenian firms in the food processing industry; smaller ones do not yet feel a need for such a cooperation. The cooperation is formalised in a contractual form either with the Faculty/Chair as a partner or individual Chair members as contractors (individual consulting). The most frequent types of services offered to firms are: (i) background studies on various economics and marketing related issues, and (ii) appearance as speakers at various occasions in firms.
4. The fourth level of the Chair – firms cooperation is in the form of applicative B.A. and M.A. thesis of students on particular topics, which are of interest of particular firms. In this case, it is usually a firm who specifies the problem, which could be elaborated in a thesis. A student then works under the mentorship of

the faculty member in the firm itself. In such a case, all the actors involved gain: (i) a firm gains a solution for its current open problem, (ii) a student learns something in practice, completes the studies and often gets a job, (iii) the Chair gets a better insight into the developments at a firm level, satisfied students and firms. In this way the Chair also assures permanent future cooperation with its former students and firms in which they are employed.

Biotechnical Faculty in general and the Chair for Agricultural Economics, Policy and Law only establish cooperation with the largest firms in Slovenia. Only these firms are willing and able to cooperate, since they have sufficient human and financial resources for such cooperation. Small firms often have significant problems in adequately formulating their needs, lack the human capital and are too much involved in day-to-day business to consider R&D as relevant for their operations.

4.1.2 The conditions for science-industry cooperation

External and internal factors influencing the science-industry collaboration. From the *external factors* point of view, the main problem of the Slovenian food processing industries is that they are treated as a primary producer of food (the same as agriculture) and not as a typical manufacturing activity. As such, food processing industries are in principle eligible to those economic policy instruments which are intended for the primary sector – agriculture. This kind of instruments is not what food processing industries really need. On the other hand, food processing industries are often not eligible for the standard support instruments which focus on the promotion of science-industry cooperation and which are offered by the Slovenian R&D and industrial policy. A typical example is Slovenian Technology Agency, which for certain calls does not include food processing industries as eligible. The result is that food processing industries are often not eligible for support through the programmes which they would need most, i.e. investments in 'soft' factors of competitiveness such as process optimisation, information technology support, etc. For instance, a joint project of a firm from food processing industry, Biotechnical Faculty and a consultancy firm, specialised in production processes optimizing, is not eligible for the support through a particular R&D policy instrument since the main contracting partner (providing the required co-financing) is from non-eligible food processing industry firm. The same type of the project as regards the contents would be eligible if the main contracting party was from any other manufacturing industry.

The reality of the Slovenian food processing industry is that its competitiveness is in a sharp decline. The main *internal* inhibiting *factor* which co-determines the science-industry collaboration in the Slovenian food processing industries is low level of R&D activity in the food processing firms, accompanied by their low level of awareness about the necessity of R&D activity and collaboration with science. Slovenian food processing industries are characterised by a large number of small

firms and a handful of firms which may be relatively large by Slovenian standards but in fact they are small to medium-sized firms by international standards. This largely defines R&D ambitions and activities of Slovenian food processing firms. Smaller firms do not really understand the need for and do not have capacities for any R&D. They are even not capable of formulating their R&D/innovation needs because they actually do not have them. Larger, in fact medium-sized firms are also not big enough to have own R&D departments or activities.

Official data report of a rather low R&D expenditures and activity in the Slovenian food processing firms. What most of the firms have is a kind of analytical support, responsible for various routine procedures such as testing. This has nothing to do with real R&D, but the management wrongly believes that the people performing simple analytical and testing operations are also capable of real R&D activity. There are only few exceptions to this general trend such as Agroemona Domžale in the farming of cattle and dairy farming, Perutnina Ptuj in the poultry meat production and processing, or Medex in the field of bee products and herbal extracts. For instance, Perutnina Ptuj has its own product development centre. Medex develops away from its traditional bee products and increasingly enters into herbal extracts and various food additives; it has its own R&D unit and the so called Young Researcher financed by the Slovenian Research Agency (see Box 3).

An important determinant of a low level of R&D performance of the Slovenian food processing industry is the lack of investment in physical equipment for R&D activities. These investments are very costly and Slovenian food processing firms, predominantly being of small or at best medium size, are not able to provide the necessary funds for them. This is one of the obvious issues which economic policy will have to tackle if to increase the R&D intensity of the Slovenian food processing firms. Another problem which inhibits R&D activity in the food processing firms is the inadequate ownership structure of these firms, characterised by the domination of agricultural cooperatives in combination with various para-state funds. This has two unfavourable consequences, domination of the primary agricultural logic in a secondary activity and bad management.

Strengths and weaknesses/difficulties in science-industry collaboration. At the beginning of its science-industry collaboration, the Chair was very much faced with the competition of various consulting firms, whose services to the firms and government administration were rather expensive. Since the Chair has entered into the field of collaboration with industry, the competitors more or less disappeared. The reasons are two-fold. The first is that the Chair has a number of advantages over potential competitors in science-industry collaboration:

- The Chair is much cheaper as compared to private institutes or consulting firms. This is because it is a part of the University and, thus, of a public sector and its main 'infrastructure' is available free of charge.
- The Chair has also created a large data basis of Slovenian food processing industries, which is a big asset for any study in the field and actually prevents others to enter the field.

- Combination of education and consulting seems to be the winning one.
- The same is true for the combination of technical knowledge on food processing and the economics/business aspect. Both aspects could not be really offered by any other potential competitor.

The second reason is that Slovenian food processing industry is a kind of too 'exotic' for other science institutions or consulting firms to be really eager to enter. In the field of 'economic/business' type of science-industry collaboration, a potential candidate would be the Faculty of Economics of the University of Ljubljana, but is seems that entry costs are too high and potential returns too low.

Still, the Chair is not happy about its role/position in the science-industry collaboration. The first problem is that the government and its agencies consider the Chair more or less as a 'public good' whose services are free of charge. The problem is that there is no clear demarcation line between the role of the Chair as a public entity and the services which it should provide in this role, and the role of the Chair as a provider of specific analytical and R&D services to firms and government. Possible solution is a creation of university spin-offs or joint ventures with consulting firms. The problem in itself is also the University of Ljubljana framework, which does not offer a proper support for science-industry collaboration.

4.1.3 The guiding principles in science-industry cooperation

In the food processing industries, science-industry cooperation is the most important for medium-sized firms. Large multinational food-processing firms have their own research departments which are stronger than any university research capacities. If they need relevant cooperation with the science sector they have several ways and means to secure this either through offering much better working and salary conditions to scientists or contracting out the R&D work to relevant university departments. As far as small firms are concerned, they often lack the human and financial resources and even more the long-term vision, which is needed for investing in and undertaking R&D and innovation activities.

The problem of low R&D/innovation activity of Slovenian food processing firms is directly linked to the above 'firm size' issue. As mentioned, Slovenia does not have large food processing firms; it has a lot of small firms, with the main food processing firms actually being relatively small meduim-sized firms. In this situation, it is the government who should take the action. The action should go in several directions:

1. The first is that policy makers should change their perspective, in the sense that it is not the primary production of food in the agricultural sector, which is a problem, but the food processing sector, which is the main supplier of food. The Ministry of the Economy does not do its job here. It is not capable to set the priorities.
2. The second, which is very much linked to the first one, is to allow for some consolidation/concentration of the food processing industry in order to increase the

size of a typical food processing firm. For instance, Slovenian meat producers want to consolidate and increase their size to be able to compete, because they face a competition of a mid-size Austrian meat producer just across the border, which is larger than all the Slovenian producers together. However, the consolidation of Slovenian meat processing firms may be problematic from the competition policy point of view, if one defines the 'relevant market' narrowly. The situation calls for some policy measures on the side of the Ministry of the Economy to allow consolidation in the food processing industries.

3. The third is that EU has no policy schemes for mid-size firms, it concentrates on small firms, while large multinational food processing firms are able to take care of themselves. EU has no policy scheme for companies like those being the main food suppliers in Slovenia. This is where Slovenian policy-makers should intervene and create some policy measures for this kind of firms.
4. The fourth direction of the government intervention is to set clear priorities and to stimulate creation of networks of existing food processing firms for R&D/innovation activity purposes. The precondition for successful science-industry collaboration is a joint formulation of the main issues, clear commonly agreed priorities on what is the most important and what is to be researched.

4.1.4 The importance of knowledge

What Slovenian food processing industry needs most are not big fixed investments but investments in 'soft' factors of competitiveness, informatisation, etc. An increasingly important knowledge in the contemporary food processing industry is the understanding of consumer behaviour, i.e. the knowledge of food consumers: to know and understand what are the real needs, wishes, perceptions, etc. of food consumers. Slovenian food processing companies do not know that. In the case of Slovenia, new food products do not result from the interface with consumers but more from new equipment and ingredients imported by food processing firms. The firms buy new machinery and ingredients and these actually force/stimulate them to introduce new products. Suppliers of machinery and ingredients usually offer assistance in this regard.

In Slovenia, it would be extremely important to increase the general level of knowledge on food consumers. This is not a firm-specific knowledge and, therefore, it is convenient for being supported by the state, i.e. by economic policy. A proper solution here would be to establish a 'food research centre', even more for Slovenia with a prevalence of small medium-sized firms which could not do that on their own. The concept of Dutch 'Food Valley' seems interesting in this context.

BOX 2: 'Food Valley' in Wageningen, The Netherlands

Food Valley is a region in the Netherlands where international food companies, research institutes and Wageningen University and Research Centre are concentrated. Within Food Valley about 15,000 professionals are active in food related sciences and technological development. Far more are involved in the manufacturing of food products. The Food Valley organization creates conditions so that food manufacturers and knowledge institutes can work together in developing new and innovative food concepts. The mission of the Food Valley organization is to position the Netherlands as the global centre of innovation in the food industry. This is done by matching demand and needs of companies with the excellent knowledge base, available in the Netherlands and by, pro-actively, acting as an innovation broker between individual companies, knowledge providers and government authorities. To accomplish this, the Food Valley organization is constantly:

- facilitating interaction between food companies and research centers, with the objective to develop innovations that form the basis for the food products of tomorrow;
- supporting food companies in setting up their facilities in Food Valley;
- stimulating the development of new food companies;
- attracting investors;
- assisting in the preparation of project proposals (http:/www.foodvalley.nl/).

4.1.5 Measures to improve the innovation capacities in the sector

The main barriers for more R&D/innovation in food processing firms are: (i) small size of firms (structural problem), (ii) lack of awareness about the need for R&D, (iii) lack of awareness of specific developments in the food processing sector, i.e. of the need for developments in the field of food consumer interface, (iv) inadequate financial instruments for R&D, especially the lack of short-term financing and research centres. Lack of proper marketing, food consumer interface, food consumer behaviour in the laboratories is where the Slovenian food processing firms seem to be particularly weak. The issue now is consumer-oriented food technological development, with a lot of analysis of consumer psychology, consumer relations. These issues are basically ignored in the Slovenian food processing. These aspects are rather specific for the food processing industry, but weak consumer interface is a general problem not only of Slovenian food processing industry but in general. Slovenian firms – food and non-food – are much better when they are producers of intermediate products for firms and not of final products for final consumers. This has to do with the lack of brand names, lack of funds

for advertising, but also with the lack of consumer interface. The Slovenian food processing firms are really strong in the food safety perspective and this is where they may begin their interface with consumers.

What Slovenian food processing firms would need is a kind of common research platforms which would assist them in defining and performing of R&D. Slovenian policy does not offer such an instrument. One of the recommendations of the ongoing Technology Platform 'Food for Life' is to establish a Centre of Excellence for food processing industries. In a number of other industries Centres of Excellence have been established, but not one for food processing industries. The main reason for that is not the lack of money but the lack of firms' awareness of a need for such a Centre. An interesting example of such a common platform is the Dutch 'Food Valley'.

4.1.6 What must science and industry change/do in order to improve their cooperation?

One of the basic problems to intensify the science-industry cooperation is to change perceptions on both sides. At present, the view of the science is too much that firms are mostly preoccupied with some 'trivial'/everyday problems, while the firms mostly believe that science is too much engaged in some 'high science' topics with a lack of practical, business relevance. The second main thing is to stop treating food processing industries as a part of the primary sector and to make them eligible for all the standard instruments of the R&D, technological, etc. policies. This is one of the main problems of Slovenian R&D policy as far as food processing sector is concerned; the R&D policy simply does not recognize the specifics of the food processing industry as the secondary sector; the consequence is that the funds which are supposed to be channelled into R&D, in fact do not go to R&D.

The precondition for successful science-industry collaboration is a joint formulation of the main issues, clear commonly agreed priorities on what is the most important and what is to be researched. Stable model of science-industry collaboration would include: (i) more flexible institutional solutions in support of short-term needs of science-industry collaboration, (ii) education and training of mid-level management in firms, (iii) training of all those directly and indirectly involved in the collaboration, (iv) more intensive use of the Young Researchers scheme, and (v) a kind of a 'Food Centre'. Let's look at some of them.

Firms need more flexible institutional solutions in support of short-term needs of science-industry collaboration. They need short-term supporting mechanisms of three months or so duration to solve a particular problem. From the point of view of the science sector the best thing to do would be to stimulate establishment of spin-offs. Present organisation of the science sector is too rigid to react to such short-term needs of firms. Present instruments for the promotion of

science-industry cooperation lack flexibility. Partly this can be overcome by the engagement of students.

Another opportunity to increase science-industry cooperation is to use more the Young Researchers scheme (see Box 3). This scheme, operated by the Slovenian Research Agency, finances postgraduate study and research training for young researchers and enables people from firms to go into the science sector for a certain period of time for M. A. or Ph. D. education. In the programme for Young Researchers from industry, the young researchers need to work on a particular research project within their firm, but receive mentorship support at the public R&D unit (university or institute). At present there is no application to this scheme from the food processing industry.

BOX 3: Young Researchers' Programme

The Young Researchers Programme is one of the most successful activities in the area of education and training for R&D and innovation in Slovenia (Monitoring, updating and disseminating developments in innovation and technology diffusion in Central and Eastern Europe – The TREND CHART: Slovenia, May 2000). Within the programme, potential young researchers receive financial support for the period of their graduate studies (doctoral level) and can participate in the research projects of the university/institute which are prepared to host them. The Programme was set up back in 1985 and has over the years worked successfully in bringing young people into research. The impact was so significant that it actually lowered the average age of researchers in the public research sector in Slovenia. Both internal and external evaluations found the programme to be very positive and administrative problems or unclear definitions were continuously resolved by the responsible office (problems relating to the actual allocation of the funds to the young researcher and not just to the institution where the researcher got his/her placement, amounts allocated to the researcher and/or the mentor, etc.). The only critical remark of the past analyses of the Programme was that only a very small number of young researchers left the public research/academic world for a job in the business sector after completing the Programme.

This was one of the key reasons for the extension of the Programme at the end of 2002 with a special call aimed at young researchers from the business sector only. A special sub-programme opened only to young people from the business sphere who continued to be employed in business sector and have constant links with the sector during their training period, was designed to respond to the criticisms that the Young Researchers Programme was focused too much on the public research sector. A recipient of funds under the new sub-programme is a legal entity in the business sector, technology centre or regional development agency which

has an independent R&D group or has established a cooperation with a research institution where the young researcher will complete his/her doctoral education. The objective of the programme is to raise the level of education of researchers in the business sector and to indirectly contribute to strengthening the cooperation between public research/universities and the business sector.

The first call for Young Researchers announced jointly by the two Ministries (at the time Ministry of Education, Science and Sports and Ministry of the Economy) was launched for the academic year 2001/2002. 122 applications were received and 33 scholarships granted. For the next call in 2002, 51 applications were received and 30 scholarships were awarded. The third call for 2003/2004 was completed by September 2003. Out of 42 applicants, 26 were approved. In 2007, the Ministry of Higher Education, Science and Technology was funding all together approximately 150 young researchers from industry at a cost of EUR 4.2 million annually. Since 2008, the financing has been supplemented by the European Social Fund (ESF). This makes it possible to annually add more than 100 new young researchers. The call for 2008 was announced by TIA at end July 2008: the funding provided for the selected 2008 generation of young researchers was more than EUR 20 million, with 85 % coming from ESF. However, 90 applications were received and 71 new young researchers approved. The allocated resources for the 2008 generation were therefore 11.5 million EUR.

The Young Researcher's Programme is now run by both agencies; the Slovenian Research Agency announces annual calls for young researchers at pubic R&D units and the Technological Agency of Slovenia runs the calls for young researchers from the business sector. Since 2005, the methodology for the selection of young researchers at the public R&D institutions has changed. The Research Agency decided to put more emphasis on the selection criteria for the mentors this time, so that in the first selection phase, the mentors (i.e. professors and senior researchers) who are suitable to provide the necessary supervision will be selected. Only at the second stage are the applications of potential young researchers considered. Also, a more favourable treatment is to be given to the applications from technical sciences and engineering (in line with the Research Agency's intention to better reply to the needs of the industry).[13]

More information of the Young Researchers' Programme can be found on ERAWATCH research inventory: http://cordis.europa.eu/erawatch/index.cfm?fuseaction=search.resultList

13 This programme decision was taken on the basis of no prior evaluation or assessment, simply taking on board a popular notion that in order to promote the technological restructuring of the Slovenian industry, there is a need to for more researchers in the areas of technical science and engineering.

What Slovenian food processing industries need in order to increase the science-industry cooperation is a kind of development centre or centre of excellence, which at the beginning should be very specialized and only gradually increase the span of its activities. One of the problems of the existing centre of excellence scheme is that it does not cover the managerial costs to the needed extent: the labour costs need to be strictly in line with the research project, while overhead is minimal. Food processing business would need someone to develop the research agenda and promote it within the industry; to this end the previous measure of cluster support would be more efficient.[14] A more ambitious solution would be an establishment of a kind of a 'food centre' as the focal point of everything related to the food processing industry. This would be the main contribution to the improvement of science-industry link in the sector, especially due to the dominance of small and meduim-sized firms and the lack of consumer interface. As already mentioned, the case of the Dutch 'Food Valley' is an interesting example in this regard. On a much smaller scale and scope, Slovenia could look at this concept, by concentrating on wine, milk, meat and bakery.

4.2 Case 2: Food Industries Association of Slovenia within the Chamber of Commerce and Industry of Slovenia

4.2.1 The main features of the collaboration project

There has been a constant collaboration between the Association and the Chair for Agricultural Economics, Policy and Law of the Biotechnical Faculty since 2000. The collaboration takes place at two levels. The first level comprises regular annual analysis of current developments in the Slovenian and international food processing industries, and regular annual analysis of the food processing industries in Slovenia prepared by the Chair. The second level contains *ad hoc* analyses prepared by the Chair upon the request of the Association. The two recent analysis of this kind relate to the consequences of the introduction of a single tax rate for food processing firms, and to the level of labour costs in the value added of food processing firms.

In the 2000–2004 period, the collaboration between the Association and the Chair was based on a kind of a framework contract. Since the recent institutional reorganisation of the Chamber of Commerce and Industry,[15] such a contract no longer exists. This, however, does not bring any problems to the Association-Chair collaboration as there is mutual trust between the partners arising from a long-lasting collaboration. Now, specific contracts are concluded for each task

14 Formation of clusters was promoted in the innovation policy from 2001 to 2005, afterwards the support was stopped.

15 The basic change was conversion from compulsory to voluntary membership of firms in the Chamber. This brought about a lot of changes in the organisation of the Chamber.

undertaken by the Chair for the Association. Members of the Chair also participate in the work of the Association's Management Board.

In the view of the Association, the collaboration with the Chair has met the expectations and the purpose for which it was initiated. In the future, the Association would like to strengthen its collaboration with the Chair. One way to do this is that one of Association's employees would work within the Chair under the so called Young Researchers' scheme.

The view of the Association on the science-industry collaboration in Slovenian food processing industries is less satisfactory. The need for the collaboration definitely exists, but the existing science-industry link is very weak. The blame for this situation is on both sides. More specifically, the problems are the following:

- Slovenian food technology science is concentrated in the Biotechnical Faculty of the University of Ljubljana. The people there are overloaded with teaching and publishing, while there is no motivation to do more practical/consulting work for the industry. To improve that, two steps should be undertaken at the Faculty: (i) to establish an institute and/or spin-off firm(s) which would tackle the industry needs to a higher extent; (ii) to introduce other 'non-technical' knowledge in the teaching/researching/consulting processes, in particular economic, business and legal aspects of food processing.
- One of serious shortcomings of the Slovenian scientific as well as business sector is the non-existence of the people dealing with 'food-related' legal issues. The problem is very serious, knowing that 40 % of the *acquis communautaire* relates to food, that no registration of new food products/ingredients is possible without serious legal expertise and back-up. In this regard, the situation in food processing industries has become similar to the situation in the pharmaceutical industry with introducing and registering new drugs.
- Most of the Slovenian food processing firms are not able to articulate their needs as far as the science-industry collaboration is concerned. In the past, especially within the EU integration process, firms invested a lot of funds in fixed investments; a lot related to the fulfilment of the stipulations of the *acquis communautaire* (for instance, related to food safety, etc.). Before that a number of Slovenian food processing firms had their own R&D or at least development departments. However, a need for large fixed investments, a loss of the former Yugoslav market, increased pressures to reduce costs have led to a situation when there is no more money for people in R&D departments. As a rule, R&D departments have been transformed in a way to handle everyday tasks. If policy instruments would assist food processing firms in covering R&D related labour costs, a number of firms may reconsider re-engaging in some kind of R&D.
- In the food processing industries this situation has been accompanied by a wrong decision of the government to 'classify' food processing industries in the primary sector (agriculture). Because of that food processing firms have not been eligible for any industry/R&D policy instruments otherwise available to the manufacturing industry.

4.2.2 The conditions for science-industry cooperation

In the case of Association's collaboration with the Chair, the main selection criterion for choosing Chair as the partner has been the references of the Chair and people there. This is also the case with any other science-industry collaboration in the Slovenian food processing industries. The fact, however, is that Slovenia is a small country with a small number of people involved in science. In principle, there are not many people dealing with specific issues, especially not in the food processing related science. Basically, they are more or less all located in the Biotechnical Faculty of the University of Ljubljana. Therefore, there is not much to choose and not possible to apply any kind of criteria when searching for proper partners in science. In principle, it is generally known whom one should engage for a certain problem. The only alternative to avoid the narrow domestic scientific space would be to search for science collaboration abroad. Food processing firms do not do that, but there are firms in other industries, which do look for science collaboration abroad.

Science-industry collaboration in the Slovenian food processing industries is affected by the fact that R&D activity in the Slovenian food processing firms is weak. As regards development, they are mostly interested in the development which would help them reduce the cost; these are mostly rather routine improvements in processes. Recently, the representatives of DG Research and DG Enterprise visited the Association to present the instruments in support for R&D and science-industry collaboration in the food sector. The firms which attended the presentation were almost uninterested in these instruments because the activities which European Commission supports are beyond the level and field of interest of the Slovenian food processing firms.

The Association attempts to be more integrated in the EU projects and to disseminate results of these projects to Slovenian firms. At the moment, the Association is involved in two FP6 projects as a kind of 'dissemination' partner. The leading partners in these projects developed an apparatus which could be used by the firms. The Association organised the presentation of this apparatus, where mostly the representatives of larger Slovenian food processing firms attended.

Yet another inhibiting factor for more science-industry collaboration in the Slovenian food processing industries is that all the people from relevant scientific disciplines after finishing their doctoral studies either stay at the university or go to various ministries (Ministry of the Economy, Ministry of Health, Ministry of Agriculture, Forestry and Food). Slovenia simply does not have food processing firms which would be large enough to offer attractive career to the most highly educated people.

4.2.3 The guiding principles in science/industry cooperation

The targets of science-industry collaboration should definitely be formulated and set by the food processing firms. As mentioned above, in Slovenian food processing

industry this is a problem because firms are overloaded with current issues and are not able to look beyond a short period. Here, much depends on the management. There are, however, cases of food processing firms which really have made breakthroughs. For example, Vitiva from Markovci pri Ptuju, which produces extracts from rosemary acting as anti-oxidants. Vitiva has grown from a university research unit and now employs 36 people. It was recently taken over by a Japanese investor. Another company in this league is Medex, who also produces herbal extracts, or Valens Int. who has developed products with the use of Coenzyme Q10 being a strong anti-oxidant.

Science mostly looks for science-industry collaboration when it needs partners from the industry for various EU projects. In that case it is normal that it is the science side which defines the targets of the collaboration.

Among the factors determining the success of science-industry collaboration, the identification of common points of interest of both sides is definitely the most important. On the other hand, an important obstacle for more science-industry collaboration is a lack of human resource flows in both directions, but particularly from science to industry sector. This is where the government could try to do something, for instance, by stimulating doctoral students and people with doctor's degree from universities/ministries to go to firms and/or by stimulating science sector – institutes to increase the flow of their people to firms.

4.2.4 The importance of knowledge

Codified knowledge in the strict sense of the word is not really very important for most of Slovenian food processing firms. Brand names/trade marks with well defined recipes behind used to be more important in the past; Slovenia had a number of very well known brand names in the former Yugoslavia. By the disintegration of that market, the importance of these brand names reduced. A number of them are still popular in Slovenia, but Slovenia is to small a market to invest in brand names. New firms could not afford to really codify their knowledge because this is too expensive. They rather act as a supplier of somebody else who is better positioned to supply to retail chains, or they supply directly to retail chains under those chains' own brand names. Small firms hardly afford to 'buy' a shelf in the retail store to promote a new product; this costs approximately EUR 5,000.

4.2.5 Measures to improve the innovation capacities in the sector

On the enterprise level one should distinguish between process and product innovations. As a rule, the process innovation is easier to undertake and that is where most of the development in the Slovenian food processing industries takes place. However, in world of food processing, the most important innovations are in the field of product innovation, for instance, the boom of the pre-prepared food. This

is where the most important potential for further development lies. There are only relatively few Slovenian companies which are able to profit from this trend, for instance the already mentioned Vitiva, Medex, Valens. There is probably some room for the government action in this direction. A relevant contribution would be if the government showed some longer term commitment to its R&D, innovation technology, etc. programmes and instruments, and policy in general. Stop-go behaviour of the government discourages firms for a more long-term approach to R&D and innovation.

4.2.6 What must science and industry change/do in order to improve their cooperation?

In order to strengthen science-industry collaboration, the relevant government policies should consider the following instruments/mechanisms:

- general problem of the science-industry collaboration is the lack of stimulating environment. This is a greater problem than lack of funds;
- establishment of the centre of excellence in the field of food processing;
- Biotechnical Faculty of the University of Ljubljana to establish an institute dealing with activities for firms. Economic and legal issues should be added to technological/technical aspects;
- establishment of spin-off firms should be stimulated;
- development incubators should be established.

4.3 Case 3: Animal Science Department of the Faculty of Agriculture, University of Zagreb, Croatia

4.3.1 The main features of the collaboration project

The collaboration between the Animal Science Department on the Faculty of Agriculture of the University of Zagreb and Emona Nutrition Research and Development Department was initialized by the latter. In addition, Emona invited the Animal Science Department in the EUREKA project as a partner. The aim of this collaboration is to find ways of improving animal meat quality, with the aim of producing meat with enriching nutritive fatty acids, measured by the Omega 3/ Omega 6 ratio. Considering that meat enrichment with nutritive fatty acids improves consumers' health, this is an interesting market opportunity for the business sector. Simultaneously, product improvements imply competitiveness increase for the business sector partners. In this project, meat quality improvement includes testing of the corn hybrids through dietary trials and investigation of the growth performance and possible changes in the fatty acid profile of pork meat. Moreover, the project included testing of other nutrients and their influence on pork meat.

The Department of Animal Science of the University of Zagreb carries out its research in the corn production fields of the BC Institute Rugvica and Klas Nova Gradiska. Additional members included Belje and PIK Vrbovec, animal breeding and processing companies within the Agrokor group, PIK Vinkovci, a pig producer and finally Kulen Sokac (Drenovci) producer of traditional ham. Twenty engineers in Croatia (including three with doctor's degrees from the Department of Animal Science) were involved in this project. The project was put forward to EUREKA in the summer of 2003 and completed in June 2006 (36 months). Total value of the project was 1.45 million EUR, with 40 % of the funding by Croatian partners.

4.3.2 The conditions for science-industry cooperation

External and internal factors influencing the science-industry collaboration. Overall conditions for R&D cooperation in the Croatian agriculture and food processing industry are not encouraging. Primarily this is a result of the privatization process combined with the war in Croatia in the period 1991–1995. Privatization predominantly resulted in the change of firms' ownership with the new owners mostly oriented towards short run profit seeking. Thus, business activities which include investments in risky projects like R&D activities have been neglected. The war caused market loss and weakened industrial production including industry-science collaboration. All these negative socio-economic processes have been accompanied by the moral hazard of new owners, whereby asset sale and expropriation of profits from former socialist business entities emerged as a common business practice. The science-industry collaboration was dramatically reduced in the nineties compared to the situation in the seventies and eighties. However, since 2000, Croatia has put a growing attention to dynamic processes in the economy including the development of the business sector, where the improvements of science-industry collaboration present an important driver of the business sector development.

Therefore, the potential for development of science-industry collaboration in food processing industry exists. Primarily it depends on the quality of business sector management, and its ability to estimate potential revenues from sales of improved products as a result of science-industry collaboration. In the context of the analysed project, R&D cooperation presents risky investment which is simultaneously of a potentially higher yield in comparison to other firm investments. It seems that the existence of R&D department in the business sector is important for R&D cooperation with science sector. However, other things such as financial funds for innovation investments and R&D activities seem to be even more important.

The public science institutions do not have enough financial and material capacity to apply their knowledge in commercial products. Moreover, there seems to be a lack of proper institutional setting, which would put science to a higher

extent in the function of the business sector development. There is also a lack of interest for commercial projects on the side of the science sector and public R&D personnel. Their career advancement does not depend on the commercial projects. They are primarily interested in the fulfilment of the scientific criteria of their work i.e. publishing sufficient number of articles and monographs. Commercial projects may be a source of additional funds for public R&D institutions but without any direct benefit for the staff. There are no spin off companies founded by scientists where their knowledge could be utilized. In short, the scientific career advancement of public R&D personnel is not connected with the diffusion and commercialization of their knowledge, aimed at solving the practical problems of the business sector.

The result of this situation is that the knowledge developed by the Croatian scientists in the field of agriculture and food industries, primarily in animal sciences, is mainly targeted to the meet the demand of scientific journals in the field, and not the needs of the Croatian business sector. Croatian science does not serve enough the Croatian agriculture and food industries. It seems that the parties primarily responsible for the institutional framework of science-industry collaboration, namely the government and the science sector, do not really understand this problem.

Strengths and weaknesses/difficulties in science-industry collaboration. One of the key principles of science-industry collaboration is that each side should be satisfied with the collaboration. In the particular project of 'Influence of Animal Diet on Fatty Acid Composition of Pork', this condition was fulfilled. On the science side, the empirical results of the project were used by the PhD candidate to complete his PhD dissertation. On the business sector side, the expertise which has been developed during the empirical research helped the enterprises involved (BC Institute and Belje) to develop their products and increase their competitive positions.

The main weakness in this project was the absence of a high quality analytical laboratory. So the results of the project were analysed in the laboratories in Hungary and Slovakia. Moreover, the absence of analytical laboratory presented the largest obstacle to the development of this type of collaboration in the near future.

4.3.2 The guiding principles in science/industry cooperation

An important starting point of successful science-industry cooperation is a clear understanding of the main project tasks by all participants. The science partners involved in the project should evaluate the project from the perspective of the business sector, i.e. in which way could the project increase revenues and competitiveness of the business partner. In addition, the business sector partners should perform a similar evaluation from the scientific perspective, i.e. why should the collaboration with business sector be interesting for the scientists. Mutual understanding presents a starting point for successful cooperation.

An additional impulse aimed at increasing science-industry cooperation can be initialized by the industry sector where scientifically inclined staff may be motivated by their desire to achieve academic degrees. In this context, science-industry cooperation could be enhanced both formally and informally. Additionally, formal science-industry cooperation includes more empirical research which increases the knowledge base, where additional knowledge creation is not primarily constrained by profit seeking behaviour of an enterprise. Additional informal cooperation may include increasing exchange of relevant information which may stimulate creation of additional knowledge.

4.3.4 The importance of knowledge

The communication between theoretical and applicative knowledge is crucial. The main frustration in the science-industry collaboration process is the situation in which theoretical knowledge cannot be applied in practice. Since the problems regarding codified knowledge have been noticed (e.g. lack of a more thorough analysis of results of empirical research) it seems that the importance of tacit knowledge is crucial for the increase of science-industry cooperation. Indeed, this cooperation also stimulates the creation of codified knowledge. In this particular project, a type of corn hybrid was developed by the BC Institute.

Science and business seem to have quite a different approach and motivation to codify their knowledge. The business sector partners are more interested in a concrete result of science-industry collaboration, e.g. Agrokor management (included in the project via companies Belje and Križevci) showed high propensity to knowledge protection (via patents) and utilization of the project knowledge on domestic and foreign markets. On the other hand, scientists show low interest in the protection and development of the project results. This can be explained by low scientific capacity for knowledge management where knowledge commercialization should present a desirable purpose of knowledge activities. It seems that the lack of interest for knowledge commercialization on the science side is linked to the fact that it does not contribute to the scientific career. Moreover, low propensity for taking risk (e.g. founding and running enterprises resulting from the project) is observed. This could be explained by social and economic uncertainty which the scientists perceive. Primarily this stems from scientist's prevailing perception whereby there is no foreseeable employment alternative to their positions at the university.

4.3.5 Measures to improve the innovation capacities in the sector

Measures which may improve innovation capacities should be oriented towards development of science capacity and industry capacity. In terms of science capacity development in the agriculture sector, the main obstacle for science-industry

collaboration is the lack of analytical laboratories. The existence of modern analytical laboratories is a prerequisite for quality scientific work which would be aimed at improving production of competitive products (primarily for the foreign markets). The absence of these facilities really presents an obstacle to the quality and relevance of science-industry collaboration.

Another important issue which may improve science sector capacity for science-industry cooperation is a change of career development rules. Scientific advancement should be connected with empirical work in Croatia where higher standard of agriculture (e.g. animal breeding) production similar to the developed countries should be achieved. This could be achieved via better coordination of scientific policy on one hand, and agriculture and economic policy, on the other, where similar priorities should be set in scientific and business community.

4.3.6 What must science and industry change/do in order to improve their cooperation?

There is no particular formula of how to improve collaboration between science and industry on a general level. In general, the efficiency of cooperation depends on a country's development level, while the introduction of special measures cannot really make a difference. The main impulse for this cooperation should come from the industry. But development of this cooperation depends on the business capabilities to pursue cooperation and engagement of policies towards stimulation of the business sector as a whole. The role of science should be to understand what strategies can help industry to improve its results. Government strategy which includes only enhancing R&D capacities cannot improve firms' competitive position. A better solution would be to use economic diplomacy aimed at helping firms to sell products primarily on the foreign markets. In this context, revenues from foreign markets may present a source for risky investments, which include science-industry collaboration.

4. 4 Case 4: Emona RCP – Nutrition Research and Development Department, Ljubljana

4.4.1 The main features of the collaboration project

One of the key research areas of the Emona Nutrition Research and Development Department is research on the impact of different nutrition on the quality of meat in animals. This is important R&D activity for the founding company Jata Emona, which is involved in the production and distribution of feeds for all domestic animal species, including various sorts of mixtures and vitamin enriched feeds. The

research looks into different impact feeds may have on the quality of the meat. The particular project had set forth a task of enriching the animal feeds in a way of producing more Omega 3 fatty acids in the animal's meat, thus contributing to the healthier human diet.

The project was proposed to EUREKA in the summer of 2003 and completed in June 2006 (36 months). Total value of the project was 1.45 million EUR, with 60 % of the funding coming from Slovenian side. The task of the project was to explore the possibility to produce lean meat with a higher percentage of unsaturated fatty acids and lower percentage of saturated fatty acids. In particular, the researchers tried to enrich pig meat with n-3 fatty acids because of their benefit to human health. Because the tissues of mono-gastric, such as pigs are very responsive to changes in dietary fatty acids, the focus was on pig nutrition. In nutritional experiments, different feed mixtures were used with defined nutrient and fatty acid composition. Using Gas-Liquid Chromatography (GLC), the fatty acid composition of different pig tissues was examined, especially the fatty acid composition of muscles. Using rancimat, the oxidative stability of meat was defined. Also measured were the sensorial qualities of meat (colour, flavour and juiciness). In the last phase of the trial, the proper handling of such meat in slaughterhouses, storage and the marketplace was examined.

While the main partner, the Emona Nutrition Research and Development Department, was primarily involved in the research on the preparation of the appropriate mixture of feeds, the task of the Animal Science Department of the Faculty of Agriculture from Zagreb was to investigate the influence of different corn varieties in the diet of pigs on pork fatty acid composition. It was assumed that there are some differences in the oil content of three corn hybrids and so their chemical composition was. Consequently, testing of the corn hybrids through dietary trials and investigation of the growth performances and possible changes in carcass tissues and the fatty acid profile of pork meat was performed.

The Faculty of Agriculture from Zagreb carries out scientific work and investigations in the field of animal breeding and genetics, experimental planning and biostatistics, and animal health and nutrition. It is also involved in meat science research and biotechnology, in particular with pigs, so it was a highly qualified partner for this R&D project.

4.4.2 The conditions for science-industry cooperation

External and internal factors influencing the science-industry collaboration. Overall conditions for R&D cooperation in Slovenian agriculture and food processing industry are not very favourable, due to the specific characteristics of the sector. There are very few larger agriculture/ food processing companies and even fewer with their own R&D units. R&D units in the industry are a prerequisite for development of closer cooperation with public R&D organisations, because they can provide a link between the specific needs of the industrial process and the

basic knowledge existing at public R&D institutions (higher education or institutes). This lack of appropriate partners in agriculture/food processing industry, along with insufficient understanding of the management of the potential R&D contribution to the business results, seriously limits the opportunities for science-industry collaboration.

Good examples of collaboration can only be found where the partnership has been developing over a longer period of time, where both sides have learned to understand each other. The goals of the public research institutions and the researchers there differ significantly from the objectives of the R&D units in business. The latter have to focus on bringing practical solutions to existing production/product problems. The public R&D personnel are primarily interested in the fulfilment of the scientific criteria of their work: i.e. publishing sufficient number of articles and monographs. With no business R&D unit to 'translate' the objectives of one and/or the other side, it is difficult to establish fruitful long-term collaborations.

Current institutional framework does not take sufficiently into account the specifics of the industrial R&D units. Such units cannot compete for the projects at the same public calls with the public R&D institutions, if the most important criteria in the selection process are the standard scientific criteria. At least for the applied research co-financing, the positive experience of implementing R&D projects and translating them to innovation should be valued as equally important as publishing activity for the public R&D units. The current evaluation and selection criterion applied by the Slovenian Research Agency thus works against the business R&D units and further discourages public-private cooperation.

R&D units in the agriculture and food industry had serious problems with survival during the first period of transition. The fact that several large conglomerates were reorganised and 'broken up' in smaller firms often caused the R&D departments to be transformed into testing laboratories with rather limited functionality. The management was concentrating on other areas, which were supposed to bring fast improvements in profitability: reorganisation of production units, lowering labour costs, different organisational changes, marketing, selling-off certain assets/production lines, etc. R&D function has not yet been approached as an important asset in any field of agricultural and food production (animal husbandry, feeds production, end product development, etc.).

Internally, the collaboration of the Emona Nutrition Research and Development Department with different public R&D institutions both in Slovenia and Croatia has been developed through the years, first on the personal basis (researcher to researcher) and then upgraded into institutional collaboration on specific projects. Even though Emona Nutrition Research and Development Department is a R&D unit of Jata Emona, this does not preclude its cooperation with other enterprises, especially when the cooperation exists between the parent company and these enterprises as well. Several cases of successful R&D and business cooperation were mentioned in the interview.

Strengths and weaknesses/difficulties in science-industry collaboration. One of the key strengths of science-industry collaboration as seen from the viewpoint of the Department is the fact that focus of research is different in each environment. While people at the university (or other public research institutes) have a broader focus on scientific developments internationally and can follow the novelties in theoretical findings, the researchers closer to business needs have a better understanding of the practical dimension, which is often crucial in transferring new knowledge to actual industrial process/product. This complementarity can be a significant strength in science-industry collaboration, especially if the R&D unit in industrial sector is sufficiently advanced to be able to detect the potential of the theoretical advancements for the production process. Also, industrial R&D has to have good knowledge of the complexity of production process and its economics: a theoretical solution which cannot be met at the reasonable cost cannot be transformed to innovation.

Parallel to strengths, the very characteristic of each research unit is also a source of weakness. Public R&D units often have a longer-time perspective, can function at a much more abstract level and find application of rational business approach as limited and short-sighted. The output they look for in their research work is a good internationally published paper, participation at international symposia, maybe eventually some teaching material to be derived from the research, but very seldom the commercialisation of their research is their prime target. On the other hand, a research team in a business R&D unit always has to think about finding practical and realistic solutions and the optimisation of the economic returns to their research endeavours as well. This difference in end objective can cause significant misunderstandings and can prove to be one of the key weaknesses in science-industry cooperation.

It is the current system of science and technology in Slovenia itself that could be considered one of the weaknesses for science-industry cooperation. The already mentioned evaluation of the relevance of science still underestimates the practical application of scientific results. The research groups working in public R&D (university and institutes) do not receive sufficient recognition for their work with industry and are thus less stimulated to engage in applied R&D. There is no systemic promotion of science-industry cooperation in any field and the development of such cooperation is left entirely to individual enterprises. Some more R&D intensive sectors have a tradition in science-industry cooperation; agriculture and food processing industry are not among these sectors as they have always been treated as low-tech, low value-added industries where R&D has a limited role to play. On the contrary, as it can be observed in the activity of large multinationals, this sector needs a lot of scientific input in different segments: from breeding, feeding, processing, storing, etc. The high and growing prices of food are likely to affect also R&D activity in the sector, but closer collaboration of the public R&D and industry in the Slovenian case will be difficult to develop. One of the reasons is the fragmentation of the industry and the other is its low demand for R&D: this has not offered many opportunities for cooperation.

4.4.3 The guiding principles in science-industry cooperation

A clear understanding of each others' objectives and respect for these need to be a starting point in establishing a cooperation. Each side – science and industry – has its own priorities, understanding and approach. There should be no priority assigned to one side over the other, since the objectives need to be mutually recognised and respected. Only in such a situation win-win cooperation can be developed benefiting both, science (also through the feedback of actual working of the theoretic finding) and industry. There is no point in trying to unify the objectives, the understanding should be reached on a mutual respect of each others' objective and the work shared and designed in such a fashion that both sides meet their objectives.

In the case of Emona Nutrition Research and Development Department's experience, the successful cooperation projects work in the following way: testing enables the partner(s) at the university to generate empirically based research suitable for publication, on one hand, and brings a working solution to the industrial process, on the other. The key determinant of the success is the ability of the industrial R&D unit to act as an intermediary between the university/institute and the business company(ies).

Productive cooperation between science and industry does not develop quickly or easily. It takes time and experience before the partners can overcome the prejudice inborn in each segment of research activity and move beyond stereotypes. It is standard to 'accuse' academic research as being too abstract, while the business R&D units are labelled as too commercially minded and short-term oriented. In practice, once the partners understand each other there can be sufficient room in joint research for each to pursue his/her objectives and still achieve synergies from cooperation.

Should the government wish to stimulate science-industry cooperation, the support should focus on the promotion of cooperation on equal footing. Each of the partners needs to have equal possibility to apply for funding (current system stimulates public R&D units as main contractors, since the conditions for the project coordinator require specific scientific criteria to be fulfilled). Business R&D should not be viewed as the one providing co-financing, but equally important also as a creator of knowledge. In terms of researchers' mobility, the schemes supporting this need to be clear, simple and sufficiently long-term to motivate individuals as well as enterprises.

4.4.4 The importance of knowledge

The attitude towards knowledge is relatively underdeveloped in Slovenia in general and even more so in agriculture and food industry. The idea to market their own knowledge is scarcely present in the Department and non-existent in their firm. The management does not see its R&D unit as a potential source of income,

beyond the point of offering their facilities for various testing. But an idea of systematically developing knowledge in the field of their research and marketing it has so far not been present.

To move in this direction, a much more systematic approach would have to be developed. The human resources currently at Department's disposal do not enable it to act in such a way. Also, the national innovation system does not provide for such mechanisms. Systematic marketing of R&D and knowledge transfer would require development of specific skills which the R&D unit alone do not have, neither do they have the time or the resources to engage in. The possession of knowledge or the capability to produce new knowledge is not seen as an asset which can bring financial return, just as investing in knowledge is often not seen as the key element of competitive strategy. While development in this direction would likely pay off, the current situation in the Department and its firm does not allow for such bold thinking. The R&D resources (financial as well as human) are still too modest and the management still too narrow-minded to embark on such an ambitious project.

In view of the specific EUREKA project, the ownership of knowledge derived from the project remains with the two main partners. They need to agree in the contract how the research results are to be protected and how the benefits divided. One of the problems experienced at the end of the project was to find a company commercially strong enough to undertake not only the production of healthy pork, but especially the marketing.[16]

4.4.5 Measures to improve the innovation capacities in the sector

The main barriers for more R&D/innovation in agriculture and food processing firms are: (i) a small size of firms (structural problem), (ii) the lack of awareness about the need for R&D and its potential contribution, (iii) the lack of awareness of specific potential scientific developments in the agriculture and food processing sector, i.e. of the need for development in the field of food consumer interface, (iv) a small number of R&D units in the sector itself, which would act as intermediaries between public R&D and enterprises; (v) inadequate financial instruments for R&D, especially the lack of short-term financing.

The measures to support science-industry cooperation in the agricultural sector would need to be designed with the specifics of the sector in mind. In spite of common belief that this is a low-tech area where nothing much is changing, the

16 On the down-side of the project, which was very successful from R&D viewpoint, is the current crisis in pork industry in Slovenia. Due to low prices of meat, the main potential customer of Jata Emona is experiencing a downturn and has limited resources to invest in pro-active marketing. Without sufficient marketing, the novelty is hardly known to the consumers, which in turn means that there is no additional demand, and no additional demand means no additional profit.

sector has an enormous untapped potential. A good example is how several of their (Department's) ideas have been picked up by the 'big' guys, who were able to provide for better commercial exploitation and therefore profited from rather similar technology solutions. Golden grain brand of Jata Emona was mentioned as such example, where special mixture of feeds was developed for calf-raising. In Slovenia, this was commercially developed on a very small scale, while practically the same project was undertaken by a German conglomerate at a much larger scale and proved commercially very lucrative.

4.4.6 What must science and industry change/do in order to improve their cooperation?

One of the basic (generic) problems to intensify the science-industry cooperation is to change perceptions on both sides. At present, the view of the science is too much that firms are mostly preoccupied with some 'trivial'/everyday problems, while the firms mostly believe that science is too much engaged in some 'high science' topics with a lack of practical, business relevance. One of the ways to change this perception is also the evaluation/ promotion criteria in the academic community, which should treat economic relevance of research as equally important as scientific excellence. The R&D system should be promoting science-industry cooperation not only in the strategy papers, but through all its mechanisms: financing of projects, evaluation/promotion criteria, promotion of specific positive commercial results, as well as systematically building-up awareness of knowledge as an important value-generating input.

The underlying role of intermediary institutions needs to be stressed as well. The best intermediary between science (public) and industry is a research unit organised by the industry. Such units understand the logic of both sides and can act as a very successful intermediary in developing collaboration. The lack of such units in agriculture/food processing in Slovenia seriously undermines the potential for science-industry cooperation.

The weakness of industrial R&D unit acting as an intermediary lies in its lack of know-how in the area of marketing of their knowledge. The research results obtained from science-industry collaboration often can have spill-over effects and can be transferred/sold to other firms in the sector as well. Yet the partners in collaboration have no time/resources/skills to enter the field of active promotion of technology transfer.

Other intermediary organisations could be promoted/supported by the government, yet the existing ones do not have the capability to play the role. They are not sufficiently specialised (various incubators, for example) and focus predominantly on what they define as high-tech areas. It is true, however, that the current size of the sector and the attitude towards R&D and knowledge/technology transfer in the sector could not support a more specified intermediary or even industry focused research institute, as seen in larger EU countries.

4.5. Case 5: Chair of the Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology, University of Ljubljana

4.5.1 The main features of the collaboration project

The Chair has several long term cooperation agreements, among others with Nafta Lendava, a petrochemical company with several daughter firms and with Melamin, Kočevje. The first collaboration was described in detail by the head of the Chair as an example of the highly advanced form of cooperation and the second as the more novel approach to cooperation. In the case of Nafta, the Chair is acting as a permanent outside R&D unit of the company in cooperation with the R&D teams in the company. The cooperation has a format of a stand-by R&D support, where through annual and monthly meetings the programmes are prepared. The Chair is involved both in more systematic research work as well as in 'daily' assistance in solving the product and process technology related problems. In particular, they support the production activities in the area of melamine urea formaldehyde adhesives and phenol formaldehyde resins, where the necessary adjustments of the quality and chemical composition of the product to meet the specific demand of the end buyer are developed on a continuous basis by the research team. On the other hand, the cooperation with Melamin evolves around specific agreed research topics and is gradually moving towards joint applications for public support to R&D projects.

The collaboration is extended also in the area of human resource development. On the one hand, people from the company pursue their postgraduate studies at the Faculty of Chemistry and Chemical Technology. On the other hand, young researchers from the Chair can apply their theoretical research to empirical testing in the companies for the purpose of their own studies (doctoral thesis, for example). The standing cooperation agreement is beneficial for the Chair since it allows for certain level of specialisation of the team.

4.5.2 The conditions for science-industry cooperation

External and internal factors influencing the science-industry collaboration. Overall conditions for R&D cooperation between university and industry are not very favourable, due to the specific characteristics of the two sectors. While on paper there is a lot of attention given to the cooperation, in practice there are several structural barriers on both sides which make cooperation very difficult. Some of these barriers have to do with specifics of the public R&D system, and some with the specifics of the industry.

While there are tendencies on the side of chemical industry (excluding pharmaceuticals) to gradually increase investment in R&D, there are still a lot of prejudices

in terms of cooperation with public R&D units, both at the universities and institutes. The Chair had several cases where due to the past negative experience it was very difficult to enter in any more permanent agreement with an enterprise. They were told that in their previous attempts of cooperating with university/institute the enterprise received 'a lot of paper' and little usable practical advise, that results were given at a too theoretical level and were impossible to implement and that they felt that their academic partners were treating them as if they would not be sufficiently qualified to understand the scientific findings.

As in other cases, also here it was confirmed that existence of R&D units in the industry can help in developing closer cooperation with public R&D organisations, because they can provide a link between the specific needs of the industrial process and the basic knowledge existing at public R&D institutions (higher education or institutes). In the case of the Chair it seems that often this link to the staff in a business unit was built through personal relationship of the head of the Chair, who has worked in industry as a researcher/developer and thus has good working experience of the issues relevant for industry.

Good examples of collaboration can only be found in cases where the partnership has been developing over a longer period of time, where both sides have learned to understand each other. This step-by-step approach has proved to be a key to a successful relationship; on the side of the industry a trust was gradually built, while the science side gained enough experience to better understand and respond to the specific needs of the industrial partners.

Current institutional framework at the university does not support cooperation with industry. This is not only the problem of the evaluation/promotion system, where the experience gained from science-industry cooperation is not valued, but even more so the lack of micro and macro level incentives and infrastructure for establishing the links between the two sectors. There is no systematic promotion of the university-industry contacts which should be developed at the highest hierarchical level, if the tradition of cooperation as known abroad is to be formed. In case that the entire University would have a systematic and regular cooperation with large Slovenian businesses, it would be much easier to build specific contractual partnerships as well. Now the 'selling' of one's knowledge is left to the individuals who have the ambition and personal affinity to work with industry and complement their teaching and basic research with applied and development work. There is no systematic way of either assisting researchers in these efforts or stimulate them in any way towards such activity.

What the Chair sees as the most beneficial aspects of science-industry cooperation is the ability to earn extra resources for research infrastructure which is either relatively old or non-existent at the University. The financial resources gained from the cooperation with industry provide for the co-financing often asked for in the public calls for the research equipment subsidies from the Slovenian Research Agency. Their gradual building-up of cooperation with industry has helped them purchase new laboratory equipment, which in turn, enabled

them to offer new research services to industry as well as to do basic research for the needs of the Chair.

Strengths and weaknesses/difficulties in science-industry collaboration. Besides the ability to gain extra resources to finance research equipment, there are other benefits of science-industry cooperation for the Chair. One of such benefit is a possibility to work on specific issues through the entire process: from the definition of the problem, search for theoretical solutions to developing a response in practice and testing it. In designing the workable solution, the regular exchange of ideas, knowledge and experience is necessary. In such cooperation the gains are mutual. Researchers at the university have an opportunity to test their ideas in practice, as testing and pilot production is often regarded as essential also for successful paper publishing. Building of complementarity of interests is essential for long-term cooperation, where both sides have to see themselves as beneficiaries of the joint work.

One of the weaknesses of current collaborations is the short-term perspective of Slovenian business companies. With the exceptions of few who see R&D as potentially contributing to their long-term competitiveness, most managements value research only as a solution-provider to immediate production problems either at the level of product or production technology. This means that cooperation focuses more on a day-to-day business and not on opening up new potential areas of competitiveness. To be able to move in this direction, the cooperation would have to be based on a long-term vision where resources and time would be available for research in new areas. The Chair even experienced a case where a newly developed technical solution which was economically viable at the level of the enterprise was not exploited since the management decided not to invest time and money in developing the marketing plan. A couple of years later they had to start buying the product from a foreign supplier who in the mean time developed the same solution as offered earlier by the Chair.

It is the current system of science and technology in Slovenia itself that may be considered one of the weaknesses for science-industry cooperation. The already mentioned evaluation of the relevance of science still underestimates the practical application of scientific results. The research groups working in public R&D do not receive sufficient recognition for their work with industry and are, thus, less stimulated to engage in applied R&D. There is no systemic promotion of science-industry cooperation and the development of such cooperation is left entirely to individual actors. Some more R&D intensive industrial sectors have a tradition in science-industry cooperation. In chemical industry, one can see two or three groups of firms: (i) firms that are commercially very successful and see little need for investing in development of new products. They invest in R&D only sporadically; (ii) firms which are barely surviving and have to deal with day-to-day problems and have neither the resources nor the strength to invest in long-time R&D; (iii) firms that have gradually come to recognise the importance of R&D and science-industry cooperation and are building up collaboration. The latter group is still small.

Ownership structure of companies can also have an important impact on the science-industry cooperation; unstable ownership structure brings changes in company's strategy with serious consequences for R&D activities. This was experienced by the Chair, both in positive as well as negative way. In the first case, the change of ownership led to increased R&D efforts in the company and to a relatively successful science-industry cooperation. In the second case, the new owner had an entirely different attitude to the cooperation between science and industry, leading to the discontinuation of the long-term cooperation of the Chair with the particular company.

4.5.3 The guiding principles in science/industry cooperation

As already mentioned, a clear understanding of each others' objectives and respect for them need to be a starting point for establishing the cooperation. There is no point in trying to unify the objectives, the understanding should be reached on a mutual respect of each others' objectives and the work shared and designed in such a fashion that both sides meet their objectives. Productive cooperation between science and industry does not develop quickly or easily. It takes time and experience before the partners can overcome the prejudice inborn in each segment of research activity and move beyond stereotypes. Much of the success in collaboration depends on good trustworthy personal relationships, which is even more important in the case where there are few institutional guidelines according to which a more formalised agreement could be based. Still, this is not a substitute for a more formal agreement, where issues such as ownership of research equipment, patents, commercial impact of new findings, etc. are more precisely defined.

4.5.4 The importance of knowledge

The attitude towards knowledge as a tradable good is relatively undeveloped in Slovenia in general. The idea of systematically marketing ones' own knowledge is not often present in the public R&D units and price-setting is very difficult when negotiating with industry. A frequent perception of the business sector is that basic costs of university research are already entirely covered by public funds; firms, thus, often treat their investment in R&D activity of the science sector as a matter of their benevolence. The perception of firms as R&D partners is also often biased in the public R&D units; they look upon firms as being there to provide finance and not to act as partners in joint process of knowledge generation.

The perception of the business sector that basic costs in the public R&D sector are covered within the existing schemes of public financing often leads to an

undervaluation of the public R&D work by the business sector.[17] In its current cooperation with the business sector, the Chair tended to accept the projects even if it meant starting at a very low initial contract value, because its main motivation was to build up long-term relationships, which may eventually lead to increasing of the contract value as positive experience grew. Gradually, more complex contractual issues are added to the regulation of mutual relationship, such as the ownership of new knowledge, patenting rights, etc. What is difficult for a single relatively small unit at one faculty is to act as a qualified negotiator understanding the legal and commercial conditions of the contract and setting the kind of terms comparable to such cooperation abroad. Their own experience in international projects has made them aware of how the universities abroad negotiate with the business sector: with significantly more confident attitude, with setting a much higher price on their knowledge and with much higher degree of success, too.

To be able to move in this direction, a much more systematic approach would have to be developed at the level of the University. The current attempts are far from satisfactory; in fact some may even be counterproductive. The organisational set-up of the University of Ljubljana with its decentralised, highly differentiated and heterogeneous membership cannot provide for a common Transfer of Knowledge Office, which would coordinate the marketing of university scientific capabilities. At best, the University could have certain broad long-term agreements with larger Slovenian corporations which are among important R&D investors. Also, the national innovation system does not provide for such mechanisms. Systematic marketing of R&D and knowledge transfer from public R&D sphere to the business sector would require development of specific skills which the R&D units alone do not have neither do they have the necessary time or resources.

4.5.5 Measures to improve the innovation capacities in the sector

The measures to support science-industry cooperation can be seen at two levels: (i) one specific for the case under consideration and (ii) another, more general at the level of the national innovation system. Internally, innovation and R&D capacities of the Chair could be enhanced by greater recognition of the contribution the Chair is making to the Faculty as a whole. The measures based on the recognition of the efforts invested in the current cooperation with the industry could be: additional job openings, extra bonuses when the Faculty purchases research equipment or priority treatment when selecting the equipment to be bought.[18]

17 In many businesses, the possession of knowledge or the capability to produce new knowledge is not seen as an asset which can bring financial return, just as investing in knowledge is often not seen as the key element of competitive strategy.

18 Current non-system sometimes results in just the opposite reasoning; the Faculty needs not to invest in equipment needed for research at this particular Chair, since the Chair is able to earn money by itself from cooperation with the business sector. Such argumentation in practice 'punishes' those who put their energy and time in developing links with industry.

At the level of the national innovation system, several measures need to be examined from the viewpoint of their contribution to science-industry links. One of such requirements is the co-financing, with some guidelines as to what and how the in-kind contribution can be assessed. The criteria for the government co-financing of applied and development projects should be based primarily on the record of such projects in the past and assessment provided by the business partner, and less so on the scientific excellence of the project manager. Overall, the cooperation with industry should be higher evaluated in all its different forms, from a joint research work to successful young researchers from industry or joint patenting.

Young researchers, both as an overall measure as well as specifically from industry, are definitely a good measure and have had positive impact on the development of human resources both at the Chair as well as at its partners in the industry. Several people who are today the Chair's key partners in the industry had in the past worked/studied as young researchers at the Chair.

4.5.6 What must science and industry change/do in order to improve their cooperation?

One of the basic (generic) problems to intensify the science-industry cooperation is to change perceptions on both sides, the perceptions that firms are mostly preoccupied with some 'trivial'/everyday problems, while the science is too much engaged in some 'high science' topics with a lack of practical, business relevance. The R&D system should be promoting science-industry cooperation not only in the policy papers, but even more in practice through the mechanisms such as financing of projects, evaluation/promotion criteria, promotion of specific positive commercial results, as well as systematically building-up awareness of knowledge as an important value-generating input.

Universities and research institutes should move beyond fruitless confrontation as to who is more/less privileged in the current public R&D financing and instead jointly push the government towards increasing the funding for research which can be applied in the Slovenian business sector. Additional mechanisms stimulating private sector R&D investment should/could benefit also the public sector R&D. Better and more transparent organisational set-up at the University level (this refers specifically to the University of Ljubljana), where systematic promotion of the science-industry cooperation would be undertaken at the top echelons, is needed. While the current non-system may be profitable for few individuals it does not provide for the systematic transfer of new knowledge to the business sector and it does not help science to move in the areas of interest of the business sector either. Closer and more productive cooperation, which would not be based on day-to-day issues only, needs a framework and systematic promotion, or will it remain sporadic, depending on the good will of individual researchers and managers.

4.6 Case 6: R&D Department of Melamin, Kočevje

4.6.1 The main features of the collaboration project

The present type of cooperation between Melamin and the Chair of the Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology, University of Ljubljana dates back to 2002. At the time, Melamin already had a long lasting cooperation with the University of Ljubljana. This cooperation was very formal and inefficient, and provided few useful results for the company. That is why Melamin's management had a rather negative attitude to science-industry cooperation. In 2002, today's Head of Melamin's R&D Department joined the company. He came from the Chair where he had finished his doctoral studies within the Young Researchers programme and under the mentorship of the head of the Chair. He immediately proposed the strengthening of collaboration of Melamin with the Chair. In view of the negative previous experiences, the management of Melamin was very sceptical about this initiative. Even more so because the development work in Melamin has been very much customer related, applicative, where the customers importantly co-determine the direction of development activities; feedback from customers is crucial for Melamin. The management was of the opinion that collaboration with public R&D institution which is focused more towards basic scientific research cannot really make a useful contribution to their work.

At approximately the same time, Melamin launched a new concept of company development based on two basic premises. The first was that all production of the company should be based on the same raw material base. Melamin is a relatively small company and as such is not really able to negotiate low prices for raw materials. The idea has been that narrowing down of the raw material base would increase the amounts of the raw materials purchased and consequently decrease their purchasing prices. The second premise was to diversify and increase the value added of the products. In this context, the question arose of how to organise the development activities adequately. The R&D department was requested to launch development of new products but due to its focus on customer service was not able to meet these requests. In this situation, Melamin decided to launch the cooperation with the Chair to fill this gap in human resources. The crucial push for this decision came from the fact that the Head of Melamin's R&D department knew well the Chair (Young Researchers programme), its research programme and capabilities. He had good acquaintance with people there, more precisely with the head of the Chair. It was also important that the head of the Chair previously worked in a company and was well aware of what kind of services a company needs from science. On the other hand, Head of Melamin's R&D department has been very much aware of what the Chair needs from collaboration with industry; i.e. some additional finance and an opportunity to design research in a publishable manner. Mutual interest

and acquaintances have been crucial factors for launching and maintaining successful cooperation.

The idea of collaboration between the Chair and Melamin was that the Chair should make the basic part of research – collection of the relevant literature on the subject, analytical and laboratory phase of research – which would then be used by Melamin's development department in the applicative stage. The Chair uses doctoral and other students and Young Researchers for these purposes. The Chair is also the information point of Melamin. People in the Chair are well informed not only about what is new in their field of science but also about the developments in the relevant field in Slovenia and wider. The actual collaboration began in 2002 and in a two years time the Chair completed the laboratory phase of research initiated at the beginning. Currently, the project is coming in the pilot production phase and Melamin is preparing a patent documentation for a melamine-based foam. For the pilot production phase, Melamin recently applied for co-funding from the Slovenian Technology Agency (www.tia.si), within the programme 'Direct Incentives for Joint Development-Investment Projects – Projects 2008'– a new measure specifically designed to help bring scientific results to a production phase. The decision has not yet been taken by the Agency.

Institutionally, the collaboration between the Chair and Melamin is formalised in a long-term contract with very precisely specified topics of collaboration. The Chair sends invoices every three months. The amount paid to the Chair is relatively small for Melamin, i.e. 1 % of its total R&D costs, but is increasing. The partners believe that a kind of ad hoc collaboration with specific contracts for individual tasks would not be a feasible solution.

Recently, Melamin launched a new project based on the Chair-Melamin collaboration. The project relates to the micro-encapsulation of various materials with melamine-based resin. This is becoming an increasingly interesting field for the next 5–10 years with a broad variety of applications in paper industry, civil engineering and pharmaceutical industry.

4.6.2 The conditions for science-industry cooperation

In the past, Melamin did not really pay much attention to the external factors of science-industry collaboration. They simply had the contract on collaboration with the Chair and they were satisfied with it. Melamin has never applied for government resources to begin with a project. It has always launched a project and only then applied; therefore, the realisation of a project has never depended on whether they were successful in getting the government funding or not. The problem with public funding of R&D and science-industry collaboration is that the timing of government calls for the submission of project proposals only by chance coincides with the timing of project launching and development. The solution would be that government calls would be permanently open for submitting proposals.

As regards the internal factors influencing the science-industry collaboration, probably the main problem is low R&D capacity of most Slovenian enterprises. All in all, there are probably not more than 100 enterprises in Slovenia capable of collaboration with science. This is the main structural problem for strengthening the science-industry collaboration in Slovenia. Consequently, for public R&D institutions in Slovenia, it is and will be difficult to get partners in the industry sector. To tackle this structural deficit, the government should think of the following strategies/policies/measures:

- establishing clear sectoral priorities of industrial and corresponding R&D policy;
- identifying/searching for perspective firms and assisting them in technological upgrading. Clustering around the most propulsive firms may have a positive impact on other enterprises which are their suppliers and customers and may trigger their development as well;
- attracting green-field FDI in technologically sophisticated projects. Until now, Slovenia has not been successful in this regard.

4.6.3 The guiding principles in science-industry cooperation

Basically, the objectives of science-industry collaboration should be set by industry in cooperation with science. At the end of the day it is the industry which is the ultimate user of innovations/new technological solutions. The science should assist the industry in setting these objectives.

The main success criterion of science-industry collaboration is the satisfaction on both sides. Both sides should be able to realise their objectives and motivations. Successful cooperation is reflected in a long lasting cooperation. *Ad hoc* cooperation has fewer chances for success.

4.6.4 The importance of knowledge

Speaking of the types of knowledge of relevance for science-industry collaboration, one should first distinguish between more general knowledge of the research institutions (not only in Slovenia but in general) and more specific knowledge of the firms. Only the firms can be really specific in R&D work, specific enough to develop innovative products for markets. This is a very important point for science-industry cooperation; it often seems that industry has a wrong idea of what it can get from research institutions. This results in misunderstandings and disappointments. That is why having own R&D department in a company is absolutely necessary for a successful science-industry collaboration.

The agreement between the Chair and Melamin on their collaboration specifies that all the knowledge which results from the collaboration is the ownership of Melamin. The Chair goes only up to the laboratory phase of product development, further on it is the Melamin who leads the game. The Chair can

publish all the results of its basic research arising from collaboration, but only the data until the end of the laboratory phase may be used. The Chair does not get the application data and does not know who the end customers of Melamin are. The Chair always sends the scientific papers to be published for approval to Melamin. There have never been any ideas about joint patenting; the Chair does not have enough resources to assume financial obligations and risks of patenting and is not really interested in patenting. The interest of the Chair is elsewhere, i.e. in getting additional financial resources, publishing, training its staff.

Melamin has patented some of its solutions. The benefits of this patenting are, however, only limited. Products which Melamin patented could be produced within large multinational companies without Melamin having any possibility to control it. Large companies produce and use a lot of products within their systems. Still, since the Melamin's focus is on the niche markets, patenting may have prevented a move into this area by some of its larger competitors.

4.6.5 Measures to improve the innovation capacities in the sector

Openness of the companies to the international market, competition and access to information are crucial determinants of their R&D activity. Especially openness to the flow of information is crucial. Slovenian companies lag behind in this respect. There is a lack of information flow among R&D departments of companies in the chemical industry and in general; not the information flow about confidential issues of companies, but flow of information regarding organisation and management of R&D departments, etc. This is probably one of the areas where the government could do more.

The companies outside Ljubljana often lack highly-skilled personnel for R&D work. Melamin's experience is that companies who would like to attract R&D staff need to offer some special benefits; for instance family housing under more favourable conditions.

4.6.6 What must science and industry change/do in order to improve their cooperation?

The government may consider the following measures in support of science-industry collaboration:

- Recently the Slovenian Technology Agency launched a programme of stimulating researchers to move from science to industry sector. This may be useful for some companies, but Melamin has not used this opportunity until now.
- One of the best measures of Slovenian policy in the field of science-industry link is the Young Researchers programme. It proves to be useful in the case of Melamin as well.

- Habilitation criteria at the universities should be changed; practical experiences from companies should be added as a criterion.
- Advisers in incubators and parks are often too young and inexperienced. Often the first job of a student after graduation is an adviser in an incubator/park. The role of advisers should be taken over by experienced people, even the retired ones.
- One of the factors which inhibit more intensive R&D activity and science-industry collaboration in Slovenia is ownership of companies. The process of transition ownership consolidation is still not finished and the awareness of existing owners (portfolio investors, speculators, state and para-state funds, etc.) of the need of company development, R&D and innovation is low. Their motives are often related too much to short-term profitability and buying/selling of equity shares.
- Another problem of science-industry collaboration is the lack of knowledge on how to formally shape the collaboration and formulate contracts. The Chair, Melamin and Aero Copy (company in the field of paper industry) initiate talks on collaboration but they are faced with a lot of problems to formulate the agreement. In the case of the cooperation between the Chair and Melamin, this problem was not present because of acquaintance and mutual trust between the head of the Chair and the head of Melamin's R&D Department. This is why some preliminary acquaintance of prospective collaborators is so important.

4.7 Case 7: Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry Slovenia, Ljubljana

4.7.1 The main features of the collaboration project

Science-industry collaboration of the Laboratory is concentrated on pharmaceutical producer Krka, cement producer Salonit and chemicals producing company Silkem. The subject of cooperation is: (i) in the case of Krka, which is a generic producer of pharmaceuticals, structural determinations and texture analysis of pharmaceutical products, (ii) in the case of Salonit, investigations and development of environment-friendly cements, (iii) in the case of Silkem, investigations of synthetic zeolites and their applications. In all three cases the cooperation is formally based on a long-term framework contracts, with specified annual programmes of collaboration. A certain minimum amount of money for a certain minimum amount of tasks is foreseen by a contract, the actual amount and contents of annual cooperation is then specified annually or occasionally as needed. The expectations of the collaborators have mainly been fulfilled. The main proof for that is that collaboration is still ongoing. All the problems are being resolved jointly and swiftly.

The nature of the collaboration differs among the three firms. On the one hand, there is a collaboration with large pharmaceutical producer Krka, which has a big own R&D department, clearly set R&D objectives and which invests a significant amount of money in R&D. Since the field of pharmaceuticals is not the core activity of the Laboratory, it does not cooperate with Krka in the development of medicines. The Laboratory only collaborates with Krka on very specific tasks, i.e. structural determinations and texture analysis of pharmaceutical products. On the other hand, there are Salonit and Silkem, which do not have really strong own R&D departments and whose field of activity/products perfectly matches with the Laboratory's main activity, i.e. inorganic chemistry.

In the three cases, the collaboration was initiated on a rather different basis. In the case of Silkem, the basis for the initiation of collaboration was personal acquaintance of the head of the Laboratory with one of the leading people in Silkem. At the beginning, the researchers of the Laboratory made some research/testing services to Silkem free of charge. This has gradually developed into a long-lasting collaboration in the field of zeolites, which are used in the production of detergents. In the case of Salonit, the collaboration began with a specific request from Salonit to the Laboratory to help them in upgrading quality of cement needed in oil drilling. Salonit had problems with fulfilling the adequate characteristics of this cement and the Laboratory helped them in removing these problems. This has gradually developed into a permanent R&D collaboration. The collaboration has been further strengthened by the fact that actual head of research department in Salonit finished his doctoral studies under the mentorship of the head of the Laboratory. This has been realized as a part of the Young Researchers programme of the Slovenian Research Agency. In the case of Krka, the collaboration began with including one of Krka's employees in the research project of the Laboratory. Now, the main subject of the collaboration between Krka and the Laboratory is the use of Nuclear Magnetic Resonance (NMR) in analysing structural determinations and texture analysis of pharmaceutical products. This is necessary for Krka to assess whether its generic medicines fulfil the patenting requirements. The main interest of Krka for collaboration with the Laboratory is the fact that the latter has the particular equipment for the specific testing purpose.

One of very important modes of collaboration between the Laboratory and the three firms is Young Researchers programme. The Laboratory permanently educates young scientists who are then employed in these three firms. Several students who finished their doctoral studies as Young Researchers in the Laboratory are now employed in the three firms. They are the best link and assurance of successful cooperation between the Laboratory and the firms.

The main messages of the above are that: previous acquaintance of people from both sides is very useful for the initiation of collaboration, strong or at least some R&D capacity in a firm is necessary for cooperation, and Young Researchers programme has proved to be very good for science-industry collaboration. The latter in the sense that some of the young researchers who completed their doctoral

studies within the Laboratory now act as researchers in firms. Strong personal relations obviously ease the collaboration.

4.7.2 The conditions for science-industry cooperation

External and internal factors influencing the science-industry collaboration. The existing external factors (legal and institutional framework) for science-industry collaboration do not hinder but also do not directly stimulate the collaboration. The government institutions are rather passive in this regard; this specifically relates to the Slovenian Technology Agency, which is supposed to be the main institution in this regard.

As far as internal factors and criteria for collaboration are concerned, the following criteria are relevant: establishment of joint R&D capacities, sharing of R&D costs, experiences for students, practical verification of theoretical findings and especially good experiences in collaboration. The basic philosophy of the Laboratory is that it is its duty as a public research institution to cooperate with industry. Most of the Laboratory's collaborations with industry began rather informally/spontaneously and without any real financial considerations involved at the beginning. The formalisation of collaboration came only later in the course of its upgrading. The basic precondition for collaboration on the science side is that science should be willing to cooperate. To conclude, there has not been any setting of selection and collaboration criteria in advance. All the Laboratory's collaborations with industry have developed gradually and in a rather spontaneous way.

Strengths and weaknesses/difficulties in science-industry collaboration. The main advantage of collaboration for the science side is that it is in contact with practice and could test some of its more theoretical premises. Of course, the money is important as well; 20 % of Laboratory's budget comes from collaboration with industry.

The problem of Slovenia's framework for science-industry collaboration is that there are basically no instruments to stimulate this kind of collaboration on either side. Slovenian Research Agency introduced 'collaboration with industry' as one of the criteria in the assessment of research projects financed by the Agency, but in practice this has very little weight, if any at all.

4.7.3 The guiding principles in science-industry cooperation

Laboratory's collaboration with firms is more or less based on firms' needs and objectives. The starting point of collaboration is, thus, the definition of needs and objectives by firms. Objectives and course of collaboration is set in advance in the framework contracts, which are then regularly concretised on joint meetings held 2–3 times a year. Still, there are important differences between collaboration with individual firms. In the case of Krka, which is quite a large company with very strong own R&D department, and where the subject of Laboratory's collaboration is basically not in its core activity, the objectives of collaboration are clearly

set by Krka. In the case of Silkem and Salonit the situation is different. Here the objectives and the course of collaboration are set jointly by both partners. The reasons behind are that Laboratory's R&D is really crucial for the core activity of both companies, and that in both firms R&D personnel has been educated in the Laboratory.

One of the problems of the Slovenian science is that it tends too much to set objectives of its R&D on its own, without taking into account the needs of the industry. Another problem is that the critical mass of research staff in Slovenian universities and research institutes is very low. The consequence of this situation is that Slovenian researchers do too much of everything and they are often not specialised enough. As a result, the Slovenian science often has difficulties in responding to and following the needs of the industry. This may lead Slovenian industry to increasingly search for more scientific solutions abroad. Some of the cases (Silkem, for instance), however, show that this is not necessarily an easy solution for companies.

4.7.4 The importance of knowledge

In the case of Laboratory's collaboration with industry, the tacit knowledge is far more important than the codified one. Companies are able to patent some of their solutions but in most cases they find it too costly and not really profitable. One of the reasons may also be that Silkem and Salonit are not producers of final products. The exception is Krka, which is a generic producer of pharmaceuticals and for which patenting is absolutely crucial.

As far as knowledge creation is concerned, the situation again is different in the case of Krka and other two companies. For Krka, the Laboratory is not a core partner from science. Krka has its own processes of knowledge creation of the type characteristic for generic producers of pharmaceuticals. In the case of collaboration with Silkem and Salonit there is much more joint conceptualisation and joint learning. Laboratory's collaboration with Silkem and Salonit began as a typical problem-solving type of collaboration. This has gradually developed into a more long-term development-oriented collaboration, where problem solving aspect remains important.

4.7.5 Measures to improve the innovation capacities in the sector

Chemical and especially pharmaceutical sectors are among the most successful in Slovenia as far the innovation activity is concerned. For the pharmaceutical sector, permanent R&D and innovation is a *sine qua non* of survival. In general, companies in the chemical sector permanently look for novelties. The same is true for chemistry as a science. Slovenia has a long tradition of strong research institutes in chemistry; National Institute of Chemistry is the second largest research institution in Slovenia with more than 250 employees. Scientists in the chemistry

are among the most prominent in Slovenia; together with those from physics they have the highest ranking in terms of articles in high level journals (Science Citation Index journals) and in terms of citations in these journals. More of a problem is the Faculty of Chemistry and Chemical Technology of the University of Ljubljana, which has good staff but is inadequately equipped.

4.7.6 What must science and industry change/do in order to improve their cooperation?

The quality of Slovenian universities is decreasing. This is a consequence of extensive establishing of new universities, which often do not fulfil the necessary quality criteria. Slovenia is a small country with a limited number of teaching and research staff. Extensive establishing of new universities results in engaging under-qualified teaching staff and/or in engaging the same teaching staff in an increasing number of universities. The same people are offered positions in an increasing number of universities. They are overloaded and the quality of the education process is deteriorating.

Probably the most interesting best practice of Slovenia in the case of science-industry collaboration is the Young Researchers programme of the Slovenian Research Agency and the corresponding programme of Technology Agency for the young researchers from the industry. Financing postgraduate study and research training for young researchers is an important scientific policy instrument at both Agencies. The programme has been going on with great success since 1985, and has made an excellent contribution to increasing the amount of research going on in Slovenia, and reducing the age profile of research groups.

4.8 Case 8: Krka, Novo mesto

4.8.1 The main features of the collaboration project

Krka has a wide and well-developed collaboration with various public and private R&D universities and institutes in Slovenia and abroad. High R&D intensity of pharmaceutical activity and the fact that content of R&D needs to be well protected to avoid leaking of sensitive information determine the main features of the cooperation with science. The nature of Krka's work calls for a systematic development of all phases of the research process: (i) from basic research, which is mainly done internally due to the highly specific knowledge required, (ii) to several testing phases, which need to be carried out internally and in close cooperation with specialised scientific institutions, (iii) to monitoring of the quality, where again very specific outside knowledge is being sought. In each case of outsourcing R&D, the cooperation has started on a relatively small, well defined topic, which, if the

results were satisfactory has later expanded in a more permanent broader contract. This was also the case in their cooperation with the National Institute of Chemistry, where they have cooperation agreements with several laboratories.

The Laboratory for Inorganic Chemistry and Technology is capable of providing Krka with specific analytical work, which is closely monitored by the internal research team. They are well aware of the capacity and expertise of the Laboratory and have assessed their net potential for cooperation as highly beneficial. The Laboratory possesses good knowledge in specific specialised analytical technique and has specific knowledge/skills, which are insufficiently available internally (especially in number of human resources, not so much in the knowledge possessed by the researchers). The Laboratory also possesses specific equipment not available in Krka. The basic principle of work is team work of the staff inside the company with the staff at the Laboratory, which leads to significant level of cross-fertilisation of knowledge. The nature of work dictates very close cooperation on a daily basis with continuous monitoring of progress and active participation of the internal staff.

The same principle is applied across the board in Krka's cooperation with public science teams, including other laboratories within the National Institute of Chemistry. With each of established partners they have individual contract (not at the level of the Institute, but Laboratory, just as the contracts are not signed with University as such but with individual Chairs/Departments) for a longer period (usually five-years), which gets regularly annexed with specific annual programmes of cooperation. Since co-operations are carefully entered into and develop only after the satisfaction with 'trial deals', Krka had experienced high level of satisfaction with its cooperation with public R&D institutions. Still, the responsiveness is sometimes less than wanted due to relatively small size of human resources in public sector, where in spite of the efforts on both sides, amount of work is larger than the capacities permit. In principle, Krka would like to increase its cooperation with science sector in Slovenia, but has to look for collaborations abroad as well, since the supply of R&D capacities in the country for their specific needs is insufficient.

4.8.2 The conditions for science-industry cooperation

The specific nature of the sector is such that cooperation with science is a must, regardless of the overall institutional framework. Krka has always worked directly with different institutes and universities in its field of interest and paid little attention to various policy measures (or lack of them) for the promotion of closer science-industry links. Even when different instruments were applied (support measures for R&D co-financing), Krka's experience was not positive at all – the applications required a lot of administrative work, were often asking for disclosure of information which is not acceptable for Krka and, at the end, resulted in very small financial benefit.

Even the Young Researchers' programme, which has been received very positively by smaller firms, has only recently gained more attention in Krka. Krka has always had a very active recruitment policy and used several different ways to secure a sufficient inflow of human resources: different scholarships, competitions for best research studies and diploma works at the universities as well as direct cooperation with professors at the departments at universities. Recently, Krka is, however, experiencing problems in human resource area, where it cannot find sufficient number of graduates in its area of work.

The most important criteria in Krka's search and selection of partners from the public R&D sphere are the type of service/specific knowledge which can be provided. Since they have well-defined needs, they know exactly what they are looking for. Their long experience in cooperation with researchers in public R&D in Slovenia puts them in a position of a well-informed partner, who knows where the capacities and expertise is and how it can be best employed by Krka. Their systematic support to certain research areas has a long-term effect on joint research project development in the areas of interest. In cases where the type of knowledge needed cannot be provided in Slovenia, Krka searches for cooperation partners abroad as well and already has a wide network of R&D partners in different countries.

The key difference between Krka and other, especially smaller actors in the business field is that in their case, the cooperation with public R&D has always been there and is essential for day-to-day business. This is why better or friendlier national innovation system would be good for Krka, but it is not instrumental for starting the cooperation. They are, however, aware of several problems which inhibit the overall cooperation between science and business, stemming from different objectives (pressure on bibliometric results in public R&D sector, fast implementation of research results in business sector) as well as organisational drawbacks (slow response to new demand in public R&D, small and highly heterogeneous research capacities, etc.). Of the support measures, the one that they feel has benefited them most, were recently introduced tax incentives. Also, they have decided to apply for the support to joint development projects, a new measure launched in 2008 by TIA (and supplemented by Structural Funds), since the measure is designed for larger projects (above EUR 1 million). But already during the preparation of documentation they observed that the procedure is rather complex with lots of demanding paper work.

4.8.3 The guiding principles in science-industry cooperation

The goals and the content of their cooperation contracts with public R&D units are set by Krka as a clearly dominant partner. They expect their partners to respond in reasonably short time, be flexible in adjusting to their needs and have a high level of knowledge and expertise. This dictates that they are very careful in selecting their cooperation partners and why they develop the relationship slowly, step-by-step to avoid risk exposure. In general, they see a need for

gradual development of mutual understanding of each other's needs and objectives, with business sector having some level of priority in content and dynamics setting. Ability to participate in a team work in developing new knowledge and adjustability of the researchers is crucial: this is often achieved best by continuous exchange of personnel or by close interaction of the key personnel from each partner all through the work on a particular issue.

Krka never starts the cooperation with direct financial effect in mind, and they never calculate the 'rate of return' on the funds invested in cooperation with public R&D units. This is not something which they would find necessary – if from the context of work such cooperation is needed and makes sense, this is a sufficient incentive to engage in. The satisfaction of cooperation is measured by the implementation of joint projects and efficiency in the work produced by the cooperating partner (timely testing and analyses). It is common that the commercialisation of the research results is something done entirely in house and it therefore depends on their business strategy, on which the cooperation results have limited influence.

4.8.4 The importance of knowledge

Here, too, the area of work specifies Krka's behaviour. In pharmaceuticals, the codified knowledge is the most important. Krka has build in a specific clause in all its cooperation agreements to protect the knowledge derived from joint R&D work. Since the new knowledge and even the area in which the research is being conducted can be an important business secret, Krka expects its partners to act accordingly. In the case of research papers, their publication is often delayed to account for the time of obtaining the patent and is always checked by the responsible contact in the company. Even when any information is given from the company for diploma or doctoral theses at the universities, their content is carefully checked. The leaking of knowledge can be extremely harmful for the company, so they exert extreme care in this area.

Krka has no experience so far in any sharing of the intellectual property rights with its R&D partners from public R&D units. On the one hand, they feel this is their property and their need to protect it and use it, since this is in their prime business interest and, on the other hand, the partners from public R&D have limited capacity and interest to cooperate in such a fashion.

4.8.5 Measures to improve the innovation capacities in the sector

The pharmaceutical sector is among the most innovative. Therefore, there is little need to further increase the innovation capacities of the two large companies in Slovenia (Krka and Lek, subsidiary of Sandoz). On a more general level, more systematic assistance could be given to high tech, high research intensive small and even micro firms which do emerge occasionally in Slovenia and often find

limited public support for their activity (from venture capital to support in finding appropriate business premises at reasonable rates). Here the general climate for high tech relatively risky business undertakings is not sufficiently stimulating, in fact the people, who undertook such ventures, often complain of unfriendly, even jealous reactions in their environment instead of the recognition of their success.

The one indirect measure to support innovation capacities in the sector that the government could undertake is the support to higher education in the relevant fields (students in the area of pharmaceuticals, chemistry, bio-technology, as well as interdisciplinary profiles). Krka is already experiencing shortage of human resources and cannot find locally all the profiles it needs for successful development. If even a large corporation like themselves is faced with human resource shortage, the situation must be much more difficult for smaller firms, who cannot offer the same kind of attractive and stable working environment. Slovenian higher education output, as well as R&D base, is relatively small and to support further the ever more demanding industries, they will need to grow both quantitatively and in quality as well as become more specialised.

4.8.6 What must science and industry change/do in order to improve their cooperation?

This kind of question is difficult to answer across the board. In the area of Krka's activity, the entry point both in production as well as in R&D is relatively high and without long-term cooperation the success is not possible. This is why the links have been traditionally established and they work regardless of the government policies. Krka has always relied on itself in organising its co-operations in a way needed to support the business process. In their case, the spectrum of cooperation is highly specialised activities for which they themselves must find the most appropriate cooperation partner and in fact through working relationship also develop the kind of joint capabilities which correspond best to their needs.

This can be applied to a more general level as well: more contacts with each other, the business sector and the public R&D units, need to be established via various joint forums. One of the key issues seems to be in-built mistrust among the two communities: scientists having the impression that the business interest is solely the profit, while to the business people the scientists are people with little sense of time pressure and inability to respond quickly to a specific request. No doubt that the existing evaluation criteria both for the public financing as well as for promotion at the university create additional pressure for research personnel in public R&D units. The necessary attention paid to basic research which will be publishable does not raise their credibility in the eyes of business sector, where the applicability is the main success criteria. Often the burden of meeting the scientific criteria limits the capacity (time) to work on the type of research, which would have a more direct impact on business. Also, Slovenian smallness and lack of priorities both in economic and in R&D development leads to the

lack of specialisation, which may be less risky (from choosing the wrong priority), but may also leave the knowledge at a too generalist level to be able to contribute to business competitiveness, where only the best and the fastest can catch the momentum.

From Krka's experience, good cases of science-industry cooperation have always developed slowly in a well-defined area of joint activity, thrived on close personal relationships and mutual trust, which have extended beyond standard contractual terms and respected the interests of both partners to the maximum extent possible.

5. LESSONS OF THE CASE STUDY INTERVIEWS IN VIEW OF THE POLICY OBJECTIVES AND PROGRAMMES OF THE SLOVENIAN GOVERNMENT IN THE FIELD OF SCIENCE-INDUSTRY COOPERATION

5.1 The main features of the collaboration projects

The case studies show that in all the interviewed cases partners are quite satisfied with the cooperation and that the results of cooperation have mostly met their expectations. A different story is the opinion of the interviewees of the science-industry collaboration in Slovenia in general. Here the views are generally quite pessimistic.

5.1.1 Types of science-industry cooperation

The analysed cases represent a relatively broad variety of types of science-industry cooperation. However, by far the most important type present in all of the analysed cases is an open-ended permanent cooperation formalised in long-term contracts within defined field of cooperation which is then specified in more detail in the annual plans or *ad hoc* requests. As interviewees pointed out, the good examples of collaborations can only be found where the partnership has been developing for a longer period of time, where both sides have gained trust and understanding of each other. Cooperation experiences help science partners to better respond to the specific needs of the industrial partners, and business partners to be aware of the motivating factors on the science side. Science partner often acts as a permanent external R&D unit of the company, in close cooperation with the R&D teams in the company. The cooperation has a format of stand-by R&D support, where through annual and monthly meetings the programmes are prepared. Science partner is involved both in more systematic research work as well as in 'daily' assistance in solving the product and process technology related problems. Even if the collaboration is formalised in a long-term contract with relatively precisely specified topics of collaboration, the actual work programme is then specified in regular meetings, two to three times a year. The contracts usually stipulate a certain minimum amount of money for a certain minimum amount of tasks, while the actual amount and contents of annual cooperation is then specified within the work programme as needed.

The second type of cooperation is the everyday informal support of the science institutions to the firms. This is usually a part of a long-term contract, very rarely

on *ad hoc* basis. The example of such science-industry cooperation was given in the case study 1; here the science partner makes frequent free of charge consultancy to firms. The advantage of this kind of science-industry cooperation on the side of the firms is that they get immediate and free advice. The advantage for the science partner is the acquisition of knowledge as to what goes on in firms and where the key problems are.

The third type of collaboration relates to education and training activities. The most important aspect of this type of cooperation is the Young Researchers Programme of the Slovenian Research Agency and Slovenian Technology Agency (see Box 3). Within this programme, science partners are the base for young scientists to complete their postgraduate studies, working on the research programme relevant for their current or future employer. In all the case studies, this programme has been put forward as an example of a successful policy measure. For instance, in case study 7, the science partner permanently educates young scientists who are either during their studies or upon their completion employed in the firms with which they collaborate. Several students, who finished their doctoral studies as Young Researchers in the public R&D institutions (science partners) are now employed in the collaborative firms. They are the best link and assurance of successful cooperation between the public R&D organisations and the business sector.

Cooperation in the form of education and training activities is going on also outside the Young Researchers Programme. For instance, in case 1 students prepare applicative B.A. and M.A. thesis on particular topics, which are of interest to particular firms. In this case, it is usually a firm who specifies the problem which could be elaborated in a thesis. The student then works under the mentorship of the faculty member in the firm itself. In such a case, all the actors gain: (i) a firm gains a solution for its current open problem, (ii) a student learns something in practice, completes the studies and (often) gets a job, (iii) a science partner gets a better insight into the developments at a firm level, satisfied students and firms. In this way the science partner also assures permanent future cooperation with its former students and firms in which they are employed.

5.1.2 Motivation for cooperation

Mutual interest on both sides is essential for long-term cooperation; both industry and science need to have benefits from joint work. While on the industry side, the motivation for science-industry cooperation is more or less obvious, this is not the case on the science side. It is often claimed that there is a lack of interest for cooperation with industry on the side of science. The cases show that the institutional and policy setup do not really provide incentives for the cooperation to science. The main motivation for science to enter into cooperation with industry is additional finance and, in some cases, better opportunities to do research in a specific area where testing is required to publish scientific articles. Earning extra resources to finance modern research infrastructure, which is either relatively old or non-existent at the University, is important. The financial resources gained from the

cooperation with industry provide for the co-financing often asked for in the public calls of the Slovenian Research Agency for research equipment subsidies. Gradual building-up of cooperation with industry has helped the public R&D institutions in purchasing new laboratory equipment, which in turn enabled them to offer new research services to industry as well as to do basic research for their own needs. Cooperation with industry also strengthens science's capacity for publishing and testing theoretical ideas in practice; i.e. possibility to work on a specific issue through the entire process, from definition of a problem, search for theoretical solutions to developing a response in practice and testing it. In cooperation with industry, the university researchers get the opportunity to test their ideas in practice, and testing and pilot production is often regarded as essential also for successful paper publishing.

If better possibilities for publishing and additional resources for scientific work and equipment are clearly recognised as important motivation of science for collaboration with business, the issue of direct financial benefits of such cooperation for the researchers in the public R&D sector seems to be completely ignored. Based on the interviews, this issue is not tackled in a systematic manner, it is usually resolved on *ad hoc* basis in different institutions. While in some parts of the academia it is nearly a regular practice that the academic staff works for the business sector on their own account, others try to systematically institutionalise such cooperation. The issue is highly sensitive: on one hand the researchers in the institutes with more tradition in links with industry complain that individuals (especially from university circles) present unfair competition to them, since their costs need to include the institutional costs as well, the business sector in the short run sees the cost factor as a prevailing motive. Universities tried to institutionalise the cooperation, but have often proved very inflexible in finding an appropriate division of received additional income between the staff involved in such tasks and the institution. There are even some legal barriers on the salaries of the public employees – which is the category for the university staff, making design of stimulating system even more difficult. The notion of establishing spin-offs has been poorly exploited in the Slovenian system so far.

The motivation for cooperation on the industry side has proved to be both sector specific as well as size specific. In highly competitive and R&D intensive pharmaceutical sector, the cooperation with public R&D institutions is considered a natural way of doing business, while in food processing the need for such cooperation is of a more secondary nature. Case studies also confirm that science-industry cooperation is much more developed in the case of medium and large companies, while small companies are hardly found as partners to public R&D institutions.

5.1.3 Mutual trust

Mutual trust, understanding of the requirements and the capabilities of each other and previous acquaintance of the prospective partners in science-industry cooperation prove to be the main incentives for the initiation and successful upgrading

of cooperation. In all the analysed cases, there has been previous acquaintance of the most relevant people on both sides. A typical example is that the head of the company R&D department was during his studies involved with the science partner (often under the Young Researchers programme) and, therefore, has good acquaintance with people in the same public R&D institution. It is also important that the head of the research in the science partner previously worked in industry and/or has good awareness of what kind of services a company needs from science. Mutual trust and acquaintance have been crucial factors for launching and maintaining successful cooperation. Mutual trust and acquaintance are very important in a situation where not everything can be formalised in a contract and even more so where there are very few institutional guidelines for a more formalised agreement to be based on.[19]

Quite often, the basis for the initiation of collaboration is a personal acquaintance of the people from the science partner with one of the leading people in the company. To enter the cooperation, public R&D units sometimes provide some research/testing services free of charge, partly to have a possibility to test some of their own work and partly to convince the business partner that they can do useful applied research work. The collaboration can be spurred by a specific request from the company to the science partner to help them in upgrading quality of production or resolving a very specific problem. Successful completion of one task can gradually develop in a more permanent R&D collaboration.

5.1.4 Absorption capacity

Adequate absorption capacity in the form of own R&D capacities/department in companies has proved to be essential for establishing and maintaining cooperation with scientific institutions. This seems to be a problem for a large majority of Slovenian companies, especially smaller ones. This problem is put forward in all the cases. It has often been stressed that only a limited number of Slovenian firms is capable of establishing science-industry collaboration, since these could only be the firms with adequate absorption capacity of new knowledge. They must be willing and able to cooperate: they have to have sufficient human and financial resources for such cooperation. Small firms often have significant problems in adequately formulating their needs, they lack human resources in R&D area or in management and are too much involved in day-to-day business to consider R&D as relevant for their operations. For example, due to the restructuring that took place in the Slovenian agriculture and food-processing industry, most of the Slovenian

19 An important reason for the lack of more formalised agreements of science-industry collaboration is that these collaborations are, as a rule, quite small in financial terms; should they present a more substantial segment of income/costs for the participating partners, they would probably require a more formal, legally certified contractual agreement as well.

food processing firms are not able to articulate their needs as far as the science-industry collaboration is concerned. A number of Slovenian food processing firms used to have their own R&D or at least development departments. However, the need for large fixed investments, loss of the former Yugoslav market and increased pressures to reduce costs have led to a situation when there is no more money for people in R&D departments. As a rule, R&D departments have been transformed in a way to handle everyday tasks of testing rather than developing new products. R&D units in the industry are definitively a prerequisite for development of closer cooperation with public R&D organisations, because they can provide a link between the specific needs of the industrial process and the basic knowledge existing at public R&D institutions. Even more, R&D unit in a company is often a key determinant for the success of science-industry collaboration.

The main messages of the above are that: mutual interest and previous acquaintance of people from both sides are very useful for the initiation of collaboration, strong or at least some R&D capacity in a firm is necessary for cooperation, and Young Researchers programme has proved to be very good for science-industry collaboration. As a rule, cooperation is first established on a personal researcher to researcher basis, very rarely on an institutional basis. Institutional collaboration develops only gradually. Young Researchers programme is important in the sense that some of the young researchers who completed their doctoral studies within the public R&D unit now act as researchers in firms. Strong personal relations obviously ease the collaboration.

5.2 The conditions for science-industry cooperation

A rather commonly accepted view is that overall conditions for R&D cooperation between university and industry are not very favourable. While on paper there is a lot of attention given to the cooperation, in practice there are several structural barriers on both sides which make cooperation rather difficult. Some of these barriers have to do with specifics of the public R&D system, and some with the specifics of the industry. When assessing the conditions for science-industry cooperation we distinguish between external, systemic, institutional factors and internal, science units and companies' related factors which influence the cooperation.

5.2.1 External factors

The existing legal and *institutional framework for science-industry collaboration* does not hinder but also does not directly stimulate the collaboration. The government institutions are rather passive in this regard; this specifically relates to the Slovenian Technology Agency, which is supposed to be the main institution in stimulating science-industry cooperation. The problem of Slovenia's framework for science-industry collaboration is that there are few instruments to stimulate

this kind of collaboration on either side. Slovenian Research Agency introduced 'collaboration with industry' as one of the criteria in the assessment of research projects financed by the Agency, but in practice this has very little weight. The evaluation criteria of the relevance of science still underestimate the practical, business application of scientific results. The research groups working in public R&D (university or/and institutes) do not receive sufficient recognition for their work with industry and are, thus, less stimulated to engage in applied R&D. There is no systemic promotion of science-industry cooperation and the development of such cooperation is left entirely to individual actors. Also, people in scientific institutions are overloaded with teaching and publishing (required for the habilitation), while there is no motivation to do more practical/consulting work for the industry.

Current *institutional framework does not take the specifics of the industrial R&D units sufficiently into account*. Industrial R&D units cannot really compete for the projects with public R&D organisations at the same public calls where the most important selection criterion is the standard scientific excellence (publishing). At least for the applied research co-financing, the positive experience of implementing R&D projects and translating them to innovation should be valued as equally important as publishing. The current evaluation and selection criteria, applied by the Slovenian Research Agency, thus work against business R&D units and further discourage science-industry cooperation.

Food processing industry is faced with another problem. Here, the government 'classifies' the *food processing industries in the primary sector* (agriculture). As such, food processing industries are eligible to those economic policy instruments which are intended for the primary sector (agriculture), while they are not eligible for standard industrial policy instruments. It is the latter and not the former what food industries actually need. The result is that food processing industries are not eligible for the standard R&D support instruments, which focus on the promotion of science-industry cooperation and which are offered by the Slovenian R&D and industrial policy.

The *current institutional framework at the university* also does not support cooperation with industry. This is not only the problem with regard to the evaluation/promotion system, where the experience gained from science-industry cooperation is not required/valued, but both at micro and macro level of establishing the links. There is no systematic promotion of the university-industry contacts, which should be developed at the highest hierarchical level, if the tradition of cooperation as known abroad is to be established. In the case of Ljubljana's University, it was suggested that systematic and regular cooperation of the entire University with large Slovenian firms would make it much easier to build specific contractual partnerships as well. Now the 'selling' of one's knowledge is left to the individuals who have the ambition and personal affinity to work with industry and complement their teaching and basic research with applied and development work. There is no systematic way of either assisting researchers in these efforts or stimulating them in any

way towards such activity. Yet another inhibiting factor for more science-industry collaboration is that most people after completing their doctoral studies tend to either stay at the university or search employment in the public sector.

One of the problems of universities/public institutes in science-industry cooperation is that the *government and its agencies, as well as firms often understand them more or less as a 'public good'*, which is there free of charge. The problem is that there is no clear demarcation line between the role of the institutions as public entities and the services which they should provide in this role, and their role as a provider of specific analytical and R&D services to firms and the government. A possible solution is a creation of university spin-offs or joint ventures with consulting firms. The problem in itself is also the University of Ljubljana framework, which does not offer a proper support for science-industry collaboration.

Industrial sector seems to have quite some prejudices against cooperation with the science sector. Science partners have often indicated cases where due to the past negative experience it was very difficult to enter in any more permanent agreement with an enterprise. They were told that in their previous attempts of cooperating with university/institute the enterprise received 'a lot of paper' and little usable practical advise, results were given at too theoretical level and were impossible to implement and they felt that their academic partners were treating them as if they would not be sufficiently qualified to understand the scientific findings.

5.2.2 Internal factors

In analysing internal factors of relevance for science-industry cooperation, we distinguish between internal factors on the science side and internal factors on the industry side. In fact we look at the factors of the lack of cooperation capacity on the side of companies and on the side of universities/institutes. The main accent of the interviewees, from science as well as from the industry, has been given to the lack of capacity on the industry side.

Lack of capacity on the industry side. Probably the main reason for low science-industry collaboration in Slovenia and the main factor which will inhibit more of this cooperation in the future is low R&D capacity of most of Slovenian enterprises. It was suggested that there are probably not more than 100 enterprises in Slovenia which are capable of collaboration with the science sector. Numerous Slovenian companies still have a rather short-term business perspective and are preoccupied with survival and lowering the costs as the only strategy. With the exceptions of a few who see R&D as potentially contributing to their long-term competitiveness, most managements value research only as solution-provider to immediate production problem either at the level of product or production technology. This means that the cooperation focuses more on day-to-day business problems and not on opening up new potential areas of competitiveness. To be able to move in this direction, the cooperation would have to be based on a long-

term vision, where resources and time would be available for research in new areas. There are some industry specific characteristics in this regard.

In chemical industry, one can see two or three groups of enterprises: (i) firms which are commercially very successful and see little need for investing in development of new products – they invest in R&D only sporadically; (ii) firms which are barely surviving and have to deal with day to day problems and have neither the resources nor the strength to invest in R&D; and (iii) firms which gradually come to recognise the importance of R&D and science-industry cooperation and are building up collaboration. The latter group is still small. An exception to this case is the pharmaceutical sector, where investing in research is a necessity and has thus been developed both in-house and on an outsourcing basis.

The situation in the food industry is even less encouraging. R&D units in food processing had serious problems with survival during the transition. The fact that several large conglomerates were reorganised and 'broken down' to smaller firms often caused the R&D departments to be transformed into testing laboratories with rather limited functionality. In their attempts to survive and increase profitability, the management was focusing primarily to other areas, such as: reorganisation of production units, lowering the labour costs, different organisational changes, marketing, selling-off certain assets/production lines, etc. Until these days, R&D function has not been approached as potentially important source of competitiveness. Thus, most of the Slovenian food processing firms are not able to articulate their short or medium term needs as far as the science-industry collaboration is concerned. R&D activity in the Slovenian food processing firms is weak. With regard to development, they are mostly interested in developments, which would help them in cost reduction; these are mostly rather routine improvements in processes. A more long-term research and consequently investment in new products/processes are simply beyond their reach.

Lack of capacity on the science side: There is obviously also a lack of capacity for collaboration on the science side. There is not enough specific knowledge in the science sector. Due to small size of the scientific institutions there is often a lack of people dealing with specific topics. The fact is that Slovenia is a small country with a small number of people involved in science. In principle, there is a lack of human resources overall, and even more so in the areas of more specialised issues of interest to business sector. Slovenian science has been allowed to develop independently of the industry and is currently more of a generalist than specialist nature, in a sense of covering a broad range of topics (which is good from the viewpoint of higher education) but with no specific focus in specific commercially relevant areas. This could only be achieved via closer cooperation with business sector. Here we run into a typical 'chicken and egg' story: you do not have the specific knowledge to be of interest to business, because there is lack of science-industry cooperation.

5.3 The guiding principles in science-industry cooperation

Three issues stand out from the case studies as far as the guiding principles of science-industry cooperation is concerned, i.e. the importance of clear understanding between the partners, who initiates, conceptualises and gives direction to cooperation, and what is the perception of a success of cooperation.

5.3.1 Importance of understanding between the partners

The interviewees put forward the importance of clear understanding between the partners, if the cooperation is to be successful. A clear understanding of the main project tasks by all the participants presents a starting point of successful science-industry cooperation. Each side – science and industry – has its own priorities, understanding and approach. There should be no priority assigned to one side over the other, since the objectives of each need to be recognised and respected by the other. Only in such a context win-win cooperation can develop, where both the science and the industry can benefit. There is no point in trying to unify the objectives, the understanding should be reached on the basis of mutual respect of each others' objectives and the work shared and designed in such a fashion that both sides meet them.

It is beneficial if the science partners try to evaluate the project from the perspective of the business sector, i.e. in what way the project can increase revenues and competitiveness of the business partner. On the other hand, the business sector partners should perform a similar evaluation from the scientific perspective, i.e. why should the collaboration with business sector be interesting for the scientists. This can increase the level of mutual understanding and contribute to successful cooperation.

Productive cooperation between science and industry does not develop quickly or easily. It takes time and experience before the partners overcome the prejudices inborn in each segment of the research activity and move beyond stereotypes. It is standard to 'accuse' academic research as being too abstract, while the business R&D units are labelled as too commercially minded and short-term oriented. In practice, once the partners understand each other there is sufficient room in joint research for each to pursue his/her objectives and still make synergies for the other side.

5.3.2 Who initiates, conceptualises and gives direction to the cooperation?

It is often claimed that one of the problems of the Slovenian science is that it tends too much to set the R&D priorities on its own, without taking into account the needs of the industry. In spite of the need for mutual creation and development of cooperation, in the majority of the analysed cases it is the firms who are the main initiators of collaboration, who conceptualise it and define the objectives.

Business sector partners believe that the objectives of science-industry collaboration should be set by the industry in cooperation with science. At the end of the day, it is the industry which is the ultimate user of innovations/new technological solutions. The science should assist the industry in setting these objectives.

In some cases, the priority setting and direction of cooperation depend on how developed firm's own R&D sector is. The starting point of collaboration is, thus, the definition of needs and objectives by firms. Objectives and a course of collaboration is set in advance in the framework contracts, which are then regularly operationalised on joint meetings held two to three times a year. Still, there are important differences between collaboration with individual firms. In case of larger companies with strong own R&D departments the objectives of collaboration are clearly set by the company. In case of smaller, less R&D intensive firms the objectives and the course of collaboration are set jointly by both partners and the public R&D unit can also take some initiative in suggesting potentially interesting avenues to explore. Occasionally, the science partner can be acting as a permanent outside R&D unit of the company in cooperation with internal staff in the company.

5.3.3 Perception of success of the collaboration

The main success criterion of science-industry collaboration is the satisfaction on both sides. Both sides should be able to realise their objectives and motivations. Successful cooperation is reflected in a long lasting cooperation. *Ad hoc* cooperation has fewer chances for success. Among the factors which determine the success of science-industry collaboration, identification of common points of interest is definitely the most important. In the case studies, the merit of success was very simple: if it works we go on to the next project, if the cooperation is unsuccessful, we drop it. The rate of success was never measured by tools such as increased rate of income or profitability or number of (joint) patents or publications.

5.4 The importance of knowledge creation, sharing and transfer

5.4.1 The attitude towards knowledge

The attitude towards knowledge as a tradable good is relatively underdeveloped in Slovenia in general. The idea of systematically marketing their own knowledge is not often present in the public R&D units. The management of public R&D units does not see their R&D activity as a potential source of income from the business sector, beyond the point of offering their facilities for various testing. A thought of systematically developing knowledge in the field of their research and marketing it has so far not been present. To move in this direction, a much more systematic approach would have to be developed at the level of the universities. The organisational set-up of the

universities in Slovenia, and the University of Ljubljana as the largest one in particular, with its decentralised, highly differentiated and heterogeneous members, makes coordination of such an activity very difficult. There have been various attempts to provide common Office for Knowledge Transfer, where coordinated marketing of university scientific capabilities would be performed, but up to now the results have been limited. Many departments have their own individual deals which they secured by gradual building of trust with particular partners from the industry and they see no advantage in giving up these contacts for a broader cooperation agreement at the University/Institute level. According to the response from business, such centralisation is not seen as advantageous by business partners either. The most important contribution of such an Office seems to be improving of the visibility of capabilities and research specialisation of various departments within the University.

At the moment, the national innovation system does not provide for mechanisms which would really promote knowledge transfer from science to industry and science-industry collaboration. Systematic marketing of R&D and knowledge transfer would require development of specific skills which the R&D units alone do not have, neither do they have the necessary time and resources to engage in. For universities and public institutes price-setting is also difficult when negotiating with industry. The perception that basic costs of university research are already covered through public funds is often present in firms, who still often treat their investment in public R&D as somewhat benevolent activity.

5.4.2 General versus specific knowledge

Speaking of the types of knowledge of relevance for science-industry collaboration, one should distinguish between more general/theoretical knowledge of the research institutions (not only in Slovenia but in general) and more specific knowledge of the firms. This is a very important point for science-industry cooperation; it often seems that industry has a wrong idea of what it can get from the research institutions. This results in misunderstandings and disappointments. Only firms can be really specific in R&D work, specific enough to translate R&D results in the innovative products/services for the markets.

In fact, the above should be treated as an advantage and used as a stimulus in the science-industry cooperation. While people at the university (or other public research institutes) have a broader view on the scientific developments internationally and can/should follow the novelties in theoretical findings, the researchers closer to business need to have a better understanding of the practical dimension, which is often crucial in transferring new knowledge to actual industrial process/product. This complementarity can be a significant strength in science-industry collaboration, especially if the researchers at both ends are able to detect the potential of the theoretical advancements for the production process. This skill can only be a result of systematic cooperation on a longer time basis (not just one time research contract). Also, industrial R&D has to have good knowledge of the

complexity of production process and its economics: theoretical solution which cannot be met at the reasonable cost cannot be transformed to innovation.

Parallel to the potential strengths, the difference between science and industry view of the R&D and knowledge can also be the source of weakness. Public R&D units often have a longer-time perspective, can function at a much more abstract level and may find application of rational business approach limited and short-sighted. The output they look for in their research work is an advancement of science *per se*, which will result in a good internationally publishable paper, participation at international symposia, maybe eventually in some teaching material to be derived from the research. Very seldom is the commercialisation of their research their prime target. On the other hand, the research team in business R&D unit has always to think about finding practical and realistic solutions and the optimisation of the economic returns to their research endeavours as well. This difference in end objectives can cause initial misunderstandings and can, if not overcome, prove to be one of the key weaknesses in science-industry cooperation.

5.4.3 Codified versus tacit knowledge

Scientific sphere shows low interest in the protection and development of project results. This can be explained by a number of reasons: (i) first, it is the industry side which is interested in it and this is stipulated in the agreements on science-industry collaboration, (ii) second, low scientific capacity for knowledge management where knowledge commercialisation should present a desirable purpose of knowledge activities, (iii) third, low propensity for taking risk (e.g. founding and running enterprises – spin offs, resulting from the project) among scientists, and (iii) third, codification of knowledge is not relevant for scientific career advancement. On the other hand, there is industry, which in principle is interested in protecting its knowledge by codifying it. Still, in the analysed cases, the tacit knowledge is by far more important than the codified one, with one exception, i.e. the large pharmaceutical firm Krka. There the nature of its business depends on codified knowledge. But in other cases, even where the companies were able to patent some of their solutions, they decided not to. They find that this would cost too much and would not be really profitable.

A typical example of knowledge ownership issues in science-industry collaboration in Slovenia is the agreement between Faculty of Chemistry and Chemical Technology of the University of Ljubljana and Melamin, which specifies that all the knowledge which results from the collaboration is the ownership of Melamin. There has never been any ideas about joint patenting; the Faculty also does not have enough resources to assume financial obligations and risks of patenting and is not really interested in patenting; the cooperation not really refers to the Faculty as a whole, but is established between the business company and a small team of researchers in one of the Chairs of the Faculty. The interests of this specific Chair is much more down-to earth, i.e. in getting additional financial resources for the research equipment and

maybe junior research staff, in getting interesting research opportunity which might generate some publishing, in training of its staff. Objectives such as joint patenting, sharing of the income derived from intellectual property rights, etc. go much beyond their framework. On the other hand, the company has patented some of the solutions which derived from their partnership with public R&D unit. Yet even they assess that the benefits of the patenting were only limited.

5.4.4 Type of knowledge in the food industry

Codified knowledge in the strict sense of the word is not really very important for most of Slovenian food processing firms. Brand names/trade marks with well defined recipes behind used to be more important in the past; Slovenia had a number of very well known brand names in the former Yugoslavia. By the disintegration of that market, the importance of these brand names reduced. A number of them are still popular in Slovenia, but Slovenia is too small a market to invest in brand names. New firms could not afford to really codify their knowledge because this is too expensive. They rather act as a supplier to somebody else who is better positioned to supply retail chains, or they supply directly to retail chains under the chains' own brand names.

5.5 Measures to improve the innovation capacities in the business sector

Measures to improve the innovation capacities in the sector proposed by the interviewees relate to:

- the policies on how to increase the share of companies with R&D activities;
- the changes of the criterion for R&D project managers, required by the government agencies in the case of public co-financing;
- the need for increased information flows and cooperation among R&D departments in industry;
- the specific issues of relevance for innovation capacity of food processing industries.

5.5.1 Increasing the share of companies with R&D activities

R&D capacity of most of Slovenian enterprises is low. In the opinion of some interviewees, there are probably not more than 100 enterprises in Slovenia which have the capacity to develop long-term collaboration with the science sector. This is one of the main structural problems for strengthening the science-industry collaboration in Slovenia. To tackle this structural deficit, the proposals to the government are to think of the following strategies/policies/measures:

- to establish clear sector priorities of industrial policy;

- to identify/search for perspective firms and assist them in technological upgrading. Clustering around the most propulsive firms may have a positive impact on other enterprises which are their suppliers and customers and may trigger their development as well.
- to attract green-field FDI in technologically sophisticated projects. Until now, Slovenia has not been successful in this regard.

5.5.2 Changes in the criterion for R&D project managers, required by the government agencies in the case of public co-financing

The criteria for project managers of applied and development projects should be based primarily on the record of success and experiences in such projects and on the assessment of the project provided by the business partner and less on the scientific excellence of the project manager. Overall, the cooperation with industry should have a higher impact on the overall ranking of the researchers. This should be done for all its different forms, from joint research work to successful young researchers from industry or joint patenting.

5.5.3 The need of increased information flows and cooperation among R&D departments in industry

Openness of companies to the international market, competition and information are crucial determinants of their R&D activity. Especially openness to the flow of information is crucial. Slovenian companies lag behind in this respect. There is a lack of information flow among R&D departments of companies (in the chemical industry) in general. This does not refer to the information flow about confidential issues of companies, but flow of information regarding organisation and management of R&D departments, experiences related to science-industry cooperation, experiences with government support measures, etc. This is probably one of the areas where the government could do more.

5.5.4 Specific issues of relevance for innovation capacity of food processing industries

In the food processing industries, science-industry cooperation is the most important for medium-sized firms. Large multinational food-processing firms (not present in Slovenia!) have their own research departments which are stronger than any university research capacities. If they need relevant cooperation with the science sector they have several ways and means to secure this either through offering much better working and salary conditions to scientists or contracting out the R&D work to relevant university departments. On the other hand, small firms often lack the human and financial resources and even more the long-term

vision which is needed for investing in and undertaking R&D and innovation activities.

The problem of low R&D/innovation activity of Slovenian food processing firms is directly linked to the above 'firm size' issue. As mentioned above, Slovenia has a lot of small firms, with the main food processing firms actually being relatively small meduim-sized firms. In this situation, it is the government who should take the action. The action should go in several directions:

1. to allow for some consolidation/concentration of the food processing industry in order to increase the size of a typical food processing firm and make it better fit for the development of R&D activity. For instance, Slovenian meat producers want to consolidate and increase their size to be able to compete, because they face a mid-size Austrian meat producer just across the border which is larger than all the Slovenian producers together. On the other hand, the consolidation of Slovenian meat processing firms may be problematic from the competition policy point of view, if one defines the 'relevant market' narrowly. The situation asks for some policy measures on the side of the Ministry of the Economy to allow consolidation in the food processing industries.
2. Even the EU has no policy schemes for mid-size firms, it concentrates on small firms, while large multinational food processing firms are able to take care of themselves. The EU has no policy scheme for companies like those being the main food suppliers in Slovenia. This is where Slovenian policy-makers should intervene and create some policy measures for this kind of firms.
3. To set clear priorities and stimulate creation of networks of existing food processing firms for R&D/innovation activity purposes. The precondition for successful science-industry collaboration is a joint formulation of the main issues, clear commonly agreed priorities on what is the most important and what is to be researched.

New products in the food processing industries are increasingly a result of interface with consumers, knowledge and understanding of consumer behaviour. In Slovenia, new food products do not result from the interface with consumers but more from new equipment and ingredients imported by food processing firms. Therefore, it would be important to increase the general level of knowledge of food consumers, invest in the 'soft' factors of competitiveness, informatisation, etc. This is not a firm-specific knowledge and, therefore, it is convenient for being supported by the state, i.e. by economic policy. A proper solution here would be to establish a kind of common research platforms which would assist them in defining and performing of R&D. Slovenian policy does not offer such an instrument for this sector. One of the recommendations of the ongoing Technology Platform 'Food for Life' is to establish a centre of excellence for food processing industries. In a number of other industries, centres of excellence have been established, but not one for food processing industries. The main reason is not the lack of money but the lack of firms' awareness of a

need for such a centre. An interesting example of such a common platform is the 'Food Valley' in Netherlands (see Box 3).

5.6 What must science and industry change/do in order to improve their cooperation?

Most of the interviewees are of the opinion that the main impulse for science-industry collaboration should come from the industry side. In this regard, it would be rather important to change the perceptions of each other's side, which are frequently rather biased. At present, the view of the science is that firms are mostly preoccupied with some 'trivial'/everyday problems, while the firms mostly believe that science is too much engaged in some 'high science' topics with a lack of practical, business relevance. To increase mutual understanding and to come to adequate perception of each other, it is important to recognise the fact that the goals of the public research organisations and the researchers differ significantly from the objectives of the R&D units in business sector. Interviewees propose a number of policies/measures to improve the environment for science industry collaboration. They refer to more flexible institutional solutions at the university level, strengthening of the absorption capacity in the industry sector, increasing the incentives for researchers to seek for employment in the industry sector, changing the criteria for co-financing the research projects, Young Researchers Programme, etc.

5.6.1 More flexible institutional solutions at the university level

Universities/institutes need more flexible institutional solutions in support of specific needs of science-industry collaboration. Present organisation of the science sector is too rigid to respond to the needs of the firms and the existing instruments for the promotion of science-industry cooperation lack flexibility. Possible solutions suggested in this direction are:

- to promote establishing of spin-off firm(s) which would tackle the industry needs to a higher extent;
- to allow for a short-term supporting mechanisms of three months or so to solve a particular problem in a company;
- to introduce other 'non-technical' knowledge in the teaching/researching/consulting processes, in particular economic, business and legal aspects;
- universities and research institutes should move beyond fruitless confrontation as to who is more/less privileged in the current public R&D financing and instead jointly push the government towards increasing the funding for research which can be applied in Slovenian economy;
- better and more transparent organisational set-up at the University level, where systematic promotion of the science-industry cooperation should be undertaken at the top echelons;

- closer and more productive cooperation needs a stable framework and systematic promotion, or it will remain sporadic, depending on the good will and affinity of the individual researchers and managers;
- election criteria at the universities should be changed; practical experiences resulting from the work with the companies should be added as an important criterion;
- The R&D policy should promote cooperation not only in the strategy papers, but through all its mechanisms: financing of projects, evaluation/promotion criteria, promotion of specific positive commercial results, as well as systematically building-up awareness of knowledge as an important value-generating input.

5.6.2 Strengthening of absorption capacity in the industry sector

Strengthening of absorption capacity for science-industry collaboration in firms, in the form of own R&D departments and R&D staff, is necessary if to intensify this collaboration and to increase its benefits for the industry sector. R&D departments in firms are the best intermediary between science and firms. Such units understand the logic of both sides and can act as a very successful intermediary in developing collaboration. The lack of such units in Slovenia seriously undermines the potential for science-industry cooperation.

5.6.3 Increasing the incentives for researchers to move to the industry sector

Yet another inhibiting factor for more science-industry collaboration in Slovenia is that many science and technology graduates prefer to stay at the higher education institutions or research institutes or seek employment in the public sector. The government should try to stimulate doctoral students and people with doctoral degrees from universities/ministries to go to firms and/or by stimulating science sector – institutes – to increase the flow of researchers to business sector.

5.6.4 The government should change the criteria for co-financing the research projects

Should the government wish to stimulate science-industry cooperation, the support should focus on the promotion of cooperation on equal footing. Each of the partners need to have equal possibility to apply for funding (current system stimulates public R&D units to be the main contractor, since the conditions for the project coordinator require specific scientific criteria). Business R&D should not be viewed as the one providing co-financing, but equally important also as a creator of knowledge. The schemes supporting researchers' mobility need to be clear, simple and sufficiently long-term to motivate individuals as well as the enterprise.

5.6.5 Young Researchers Programme

Probably the most interesting best practice of Slovenia in the field of science-industry collaboration pointed out by almost all the interviewees is the Young Researchers Programme of the Slovenian Research Agency (see Box 3).

5.6.6 Supporting institutions

Most respondents feel that there is a lack of support for science-industry cooperation. Even though they are aware that there are university incubators and technology parks and similar, they fear that in most cases, the staff employed in the intermediary institutions is often too young and insufficiently experienced. There are many cases where the first job of a student after graduation is being an adviser in the incubator/park. The role of advisers should be taken over/combined with by experienced people, maybe the retired yet experienced business people.

6. CONCLUSIONS

There is little doubt that science-industry relationship has attracted a lot of attention in Slovenian R&D and innovation policy. Several different policy measures have been designed in this direction and more financial support has been made available in recent years (for details, see Trendchart country reports 2007, 2008 forthcoming). Due to their relative novelty, it is difficult to appraise these measures fairly, yet some observations can be made on the basis of the case studies. What surprised us is little or nearly no awareness of these measures among those who do cooperate, especially on the side of the business partners. This opens a serious question as to the visibility of the innovation policy and its measures in their target group. The respondents feel that the overall environment for the cooperation is not stimulating, but at the same time they have limited knowledge of the measures the government has introduced to support this cooperation. If the information on support measures does not even reach those interested in cooperation, one can be rather sure that they are even less known to many of them who have no cooperation at all.

The interviewees who are familiar with some of the support measures and who have applied for various funds (R&D subsidies, Young Researchers Programme, tax incentives, special grants, etc.) have all complained about the heavy bureaucracy accompanying these measures. A heavy dose of mistrust is felt from the documentation required by the government agencies, often asking for the type of data not easily obtainable or even of confidential nature. With the co-financing coming from the Structural Funds, the procedural details have gotten worse, but since the amounts have increased, there is still a motive to apply. Simplification, coordination and better visibility of the support measures is therefore required.

The message coming from the business sector is that much more needs to be done to observe the actual situation in each and every sector when designing the support measures. The design of the measure needs to respond to the Slovenian specific needs and not just copy-paste the best practice in a more developed environment. Most of Slovenian companies are small or medium-sized firms, who have limited business potential, problems with the lack of qualified human resources in many fields of their work, as well as small R&D units focusing more on development than research. A very specific type of knowledge is required to initiate cooperation with such firms. As all the case studies show, what needs to be taken into account is the importance of personal contact, informal relationships, building alliances not through formal contracts, but by step-by-step cooperation experiences. Support to various activities where representatives of the two

communities, i.e. science and business, can meet and openly discuss the issues related to their cooperation can be a valuable instrument. The same goes for the activities in favour of more cooperation within science or business community; for example, more contacts among heads of firms' R&D departments. This may provide a basis for better understanding and sharing of knowledge and experience within and between the two sectors.

Fascination of public authorities with measurable impact of science-industry cooperation – in the sense of how much the sales income of the participating partners have increased as a result of participation – is not really understood and appreciated by the cooperating partners. On the side of public R&D units, the measurable impact might be the extra income derived from the cooperation, the ability to purchase research equipment or maybe afford more (young) employees in the laboratory/department. Yet even here there are several 'soft' effects of such cooperation which cannot be expressed in financial terms. Through the cooperation with business, the research teams are exposed to real-life problems, have the possibility to test their theories in practice, contribute to the solution of a specific problem and sometimes use the results of the empirical work also for their scientific publications. The question on measuring of the impact of cooperation has also been met by surprise in the business sector, where it is self-understanding that one does not engage in an activity which does not bring about the expected results. Still, the results of science-industry collaboration are not measured in terms of the increase in income or increase in sales, but more specifically in terms of new knowledge gained, the fulfilment of specified tasks (testing, measuring) or some other pre-set objectives. The view of the interviewees from the business sector is that if the results are not forthcoming or are unsatisfactory from the point of what was expected, the relationship is terminated. A successful relationship involves a lot of joint work and selection of any single indicator of success is hardly possible or practical. This message should be taken on board by the policy makers who design complex schemes in evaluating the impact of each specific joint project or cooperation case; the monitoring of the cooperation in an artificial and formal manner does not serve any purpose and only de-stimulates cooperation.

So far the policy measures have been concentrated on the promotion of cooperation for the business sector. What seems to be missing is a proper support mechanism at public R&D institutions to stimulate researchers for the work with industry. The case studies have shown that in the science sector, the current incentives for cooperation are rather poor and sometimes even counterproductive. There is little system incentive through improved income to individual researcher participating in cooperation with industry. Also, industry cooperation is not recognised as a habilitation criterion, in fact it may even diminish the chances for promotion, since work with industry may result in a lack of time for more 'serious, publication-oriented' research. In a small country and a small science community, one needs to be flexible as to the excellence criteria and respect both types of science: the more basic kind as well as the applications helping country's business

community. Striving towards internationally recognised scientific excellence may lead to serious shortage of research capabilities in the areas useful for national economy, leaving the business sector without modern knowledge. In the world where new knowledge is the key competitiveness factor, this can only lead to lagging behind. Low competitiveness of the business sector sooner or later results in lower funds for scientific research.

The case studies have produced several interesting suggestions as to the possible policy changes, which are included in section five. What seems to be a universal message of all discussions is that in designing the policy and specific support measures, one needs to understand and respect the specifics of the country, the sector, the traditional relationships of the specific sector in industry and in research, before copy-pasting measures from abroad. Much more creativity and innovation is called for if the support is to achieve the target. The nature of the science-industry relationship is determined significantly by the development level of a particular sector (observe, for instance, differences between food and chemical sector in Slovenia), by the size of actors in a specific area (both the business and research capacities are highly heterogeneous in different areas in Slovenia) and by the very size of the country itself. Some of the best practices, regardless of how well they function in their own original environment, simply do not transfer well. One such example is the university technology transfer offices, which can be highly successful in the USA due to the type of higher education system there, but have only limited applicability in Slovenia.

The science-industry cooperation is affected also by the overall institutional framework for R&D and innovation. Here one of the conclusions is that frequent changes in policies and in support measures are not creating a positive environment for any cooperation. Stability in the policy, the evaluation criteria as well as in the support measures is what makes the framework more supportive to the risky undertakings such as science-industry cooperation. One cannot enter a long-term contract without knowing that the system is providing for certain stability in overall conditions.

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INDEX