Transition from R&D Policy to Innovation Policy: Constrains and Challenges

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1. Introduction

For several decades innovation has become the important topic of focused reflection of social science studies as well as the practical experience of situated innovation actors. Due to such extensive knowledge background it has become possible to construct generally shared views on innovation related practices. They support understanding these issues, orient relevant decision-making, and shape the forms of social interaction and control. Better understanding the nature if innovation, the pattern of its resources, its impact on economic performance and social implications of innovations has resulted in a set of concepts and arguments, some of which appear also in the title of my paper.

Important contribution to social studies of innovation has been made by comparative studies of *national innovation systems* (NIS). They have outlined institutionalised actors of innovation processes embracing academic institutions, their relation to industry, research related efforts of industries, and active role of regulatory policies in support of innovation. In particular, the comparative surveying of innovative firms has specified the scope of their innovation resources as related to their market success. The NIS concept has followed a macro- level mode of reflection; it has been rather siding with science push model and research intensity of innovation, even if the role of interaction among NIS institutions has been stressed. The outcome of micro-level studies has been suggesting different types of ordering of innovation resources, in which the research driven type is representing one type among the other ones. The notion of *infrastructure for support of innovation* has been used to indicate a wider scope of innovation actors, their interactive relationship as well as different ways and strategies in co-ordination of innovation resources in order to attain economic success. In view of these debates and arguments one has come to the strong assumption, that the regulatory policy of governments should get focused not only on the support of R&D but on a wider set of factors influencing the formation of the infrastructure for support of innovation, and consequent growth of innovation performance of countries and their economic actors.

The aim of the paper is to discuss a path of transition of regulatory policy in the Czech Republic (CR) from its mode of R&D policy to a mode of innovation policy with the reference of above-outlined discussion about concepts of innovation systems. I am following this topic in my research for some time since it seems to be fruitful in articulating some new research problems: its study helps understand not only a wider scope of factors of influence on situation of national innovation system but also the study of the ways how innovations are generated and appropriated facilitates our understanding the forms and capacities of social transformations in general. Debates among social scientists and situated innovation actors about this transformation in mode of policy have already outlined scope and complexity of relevant factors of influence on such change. Making use of this knowledge background I claim, that the situation of regulatory policy in the field of science and technology (S&T) in the Middle European new EU member countries, including the Czech Republic (CR), is

[1] The paper presentation is supported within the research projects financed by the Grant Agency of the Czech Republic (No. 402/05/2210) and Ministry of Education of the Czech Republic (research centres programme No. 1M0524).

so far shaped by a mode of R&D policy. Yet, the fact of EU membership of these countries, and the implications of reforms they implemented in the 90s, have challenged their S&T institutional frameowrk by a pull of EU practices in this field. An implementation of regulatory concepts and instruments of innovation policy has been required. A closer study of undergoing changes in the level of regulatory policy in new EU member countries is, however, clearly indicating that the observed shifts in policy level have been representing a „peak of iceberg“ only. Lot of factors have become manifest when implementing a mode of innovation policy. The aim of my communication is to identify them and interpret them with help of empirical knowledge about undergoing changes in the new EU member countries from Central Europe (CE), the CR in particular.

In order to attain the above-indicated aim I will make following steps: first, I will draw attention to key empirical findings, which are important for understanding the situation of national innovation system in its macroeconomic shape on one side and the environment for innovative entrepreneurship in the level of firms on the other one. Doing so I will make use of available indicators, comparative studies and historical insight about both the changes in the distribution of innovation resources and the relevant institutional framework. In the second step I will focus my attention on the description of relationships between the analysed factors: innovation resources, infrastructure for support of innovation and socio-economic effects of innovation. Here, my interpretation will be more focused on the situation of the CR since knowledge about the context of such situation in required. Better understanding of indicated relationship between key factors of innovation system should help me discuss the institutional issues, the role of which I will address in the final part of my communication.

2. National innovation system in the CR - structural dependencies and mobilisation challenges in a comparative perspective

Studies of innovation have been always subject of social sciences, since the social change is a key issue of modern societies. The notion of innovation has been closely related to economic studies, in particular to its Schumpeterian cognitive tradition. Its development in the last decades has brought lot of knowledge about the ways, how sources of modern knowledge have become a key source of competitive advantage in the economic activities and how this fact has influenced other social spheres and the borderlines between market-based forms of social co-ordination and the other institutions. In my view it is well outlined in the so-called *non-reductionistic preconditions,* which have been formulated as a cognitive perspective for the study of relationship between technology and economy (Dosi, Pavitt and Soete 1990). Besides better understanding the factors, which are influencing the interfaces between economy and technology, also the dispute about science push or market pull has been decided in favour of complementary approach: interactive links between both set of factors are of importance. In this cognitive perspective the concept of national innovation system (NIS) has been proposed. It has been supported by extensive empirical knowledge about national innovation frameworks in the OECD countries and cleared up key institutions for support of innovation and possible relations among them. The NIS concept has helped understand a specific set *of institutional universals* in this field (Nelson, 1992). This approach seems to be appropriate to outline a macro-social framework for a growth of innovation resources and their impact on economic performance. Since I am going to apply it in the

following analysis I shall shortly outline key elements, which have gained a systemic nature within regulatory framework of national states:

⇒ Complex interconnection of science and technology distinguished by a specific method of technical design and practices, as well as by a system of growing scientific knowledge surrounding it; the institutional base of this scientific-technical complex is the national education system, which is structured according to it, an effective interaction between the university and industry is, therefore, a source of long-term economic growth;
⇒ Innovation activity of private enterprise actors or businesses, which is contemplated as adaptability to new circumstances (thus, it covers in-house technical and research capacities of firms); the technical competency and orientation of businesses has support in supplier and customer links;
⇒ Activity of government, which supports innovation activities either directly or it creates a favourable innovation environment through monetary, fiscal and industrial policies, as well as by influencing the education system.

Later, I shall argue that NIS concept can and should be developed by knowledge of the other social sciences and also by advanced social practice. Yet, for the case of the analysis of macro-social situation of new EU member countries from CE its cognitive power is quite promising. The main reason for this claim rests with the fact that this concept is well reflecting not only the functional power of key institutions but also the role of public/private divide. In this perspective the institutional framework for innovation development is formed by a mix of means of the private enterprise and the public (governmental) sectors. It covers namely the profit oriented role of businesses in the competitive market environment (although a part of the industry is nationalised in some countries), publicly supported education systems (although the private sector exists in this area in many countries), academic research (although the scope of such support varies and is also offered by private industry), and state regulated control as well as financial support of the development of domestic innovation resources (even if such support has to be justified in relation to the expectations of private businesses and citizens). Such knowledge is important for understanding of transformation of existing institutions in post-socialist countries. Namely, their current development has not been challenged by a need of growth of NIS functional capacities only but also by a shift from centralistic (hierarchical) regime to a regime, which is shaped by public/private divide. The implications of this divide are well reflected by NIS concept and also for this reason I suggest to apply the NIS concept for the study of transformations of S&T policy modes in the new EU member countries.

2.1 R&D resources in the context of academe-industry relationship

Let us have now a brief look at distribution of innovation resources as indicated by the NIS concept. Growth of resources of academic and industrial sciences is an important indicator of their vitality. The first approximation of their assessment by their impact on economic performance can be gained by help of GERD/GDP indicator as given in the **Table 1**. Following these data it can be argued, that the CR is noted by certain dynamics of R&D resources (together with Hungary, and contrary to Slovenia, Poland and Slovakia); their intensity (to GDP) is lower than EU average (but together with Slovenia it is highest in the group of the new EU member countries from CE).

The R&D resources in the CR have been growing faster than GDP, in particular in the second half of the 90s; certain slow down can be observed in the period 200-2002.

In view of NIS concept it is important to assess *size and dynamics* of academic and industrial science, or of public and private R&D sectors as well as efficiency of capacities intermediating a co-operation between them. As far as the size of both institutions is concerned, and the relative share of industrial and academic R&D in the GERD, the following assessment of the situation in the CR can be made[2]:

- Public sources of funding were growing in the second half of the 90s and afterwards a trend of stagnation, or saturated development, can be observed; the share of public funding in the national GERD dropped from 26.5% (1995) to 23.5% (2002).
- R&D funds of BES have been noted by very slight growth in the second half of the 90s but afterwards certain recovery of growth can be observed; relative share of BES in national GERD dropped from 65% (1995) to 61% (2002).
- Foreign sources of R&D funding grew from 2% (1995) to 4% (2002)
- Distribution of R&D resources by sector of performance has been undergoing radical changes in public sphere: capacities of government sector got decreased from 26.5% (1995) to 23% (2002) and capacities of HE sector grew from 8.5% (1995) to 15.6% (2002)[3]

Public R&D funding has been disposed to the tensions of fiscal policy and uncertainties of political governance while the private R&D funding responded to unintended consequences of economic reforms and uncertainties of corporate governance.

Table 1: Gross R&D expenditures, % GDP

	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU-25	1,84^{s}	1,82^{s}	1,82^{s}	1,82^{s}	1,86^{s}	1,88^{s}	1,92^{s}	1,93^{s}	1,95^{ps}
EU-15	1,88^{s}	1,87^{s}	1,86^{s}	1,86^{s}	1,9^{s}	1,93^{s}	1,98^{s}	1,99^{s}	2,00^{ps}
CR.	0,95	0,98	1,09	1,16	1,16	1,23	1,22	1,22	1,35

Remarks: s – estimate of EUROSTAT, p – preliminary figure,
Source: EUROSTAT (2005)

Table 2: Distribution of GERD by source of funding and sector of performance (in %)

	Sector of funding						Sector of performance					
	BES		Government		Foreign		BES		Government		HE	
	1999	2001/ 2002	1999	2001/ 2002	1999	2001/ 2002	1999	2002/ 2003	1999	2002/ 2003	1999	2002/ 2003
EU-25	55,2^{e}	55,4^{e}	35,4^{e}	34,7	7,2^{e}	7,6^{e}	64,9^{s}	64,7^{s}	14,0^{s}	12,9^{s}	20,3^{s}	21,6^{s}
EU-15	55,6^{e}	56,0	34,9	34,1	7,4^{e}	7,8^{e}	65,2^{s}	65,1^{s}	13,8^{s}	12,6^{s}	20,3^{s}	21,5^{s}
CR	52,6	53,7	42,6	42,1	4,0	2,7	62,9	61,0	24,3	23,3	12,3	15,3

Remark: s – EUROSTAT´s estimate, e – estimated figure,
Source: EUROSTAT – New Cronos (2005)

[2] The assessment is made by help of data of Czech Statistical Office (see Ukazatelé 2005)

[3] The share of BES in R&D performance capacities also got decreased from 65.1% (1995) to 61.1% (2002)

The **Table 2** offers the comparison of the analysed scale and relative weight of sources of R&D funding and performance in relation to EU level. Relative position of BES – both in the sources of R&D funding and the R&D performance - is a bit under EU average, while the position of HE and foreign R&D funds are quite below EU average and the government sector is above the average both in terms of funding and performance. The strong position of BES and weak position of HE sector in the CR are country specific (Slovenia and Slovakia indicate similar pattern). In the CR this situation has specific historical roots. Firstly, it was influenced by tradition of belated and radicalised industrialization (in which industrial science played important role). Secondly, the socialist reforms reorganised academic science (transfer of academic research from universities to the academies) and continued to support industrial science institutes. In the other CE countries the position of industrial science has not be so historically embedded (they followed different path of industrialization) and academic science could keep its position at universities despite of the establishment of academies of sciences (see **Table 3**).

Table 3: Distribution of R&D resources by source of funding and sector of performace (in %, 2001/2)

	Source of R&D funding			Sector of R&D performance		
	BES	Government	Foreign	BES	Government	HE.
CR	53.7	42.1	2.7	61	23.3	15.3
Hungary	30.6	58.6	10.4	36.7	31.3	26.7
Poland.	31.0	61.1	4.8	27.4	40.7	31.7

Source: EUROSTAT – New Cronos (2005)

Let us have a look at the second issue – the availability and efficiency of *intermediating capacities* between academic and industrial science. This issue is concerning relations of institutions with different functional and practical framework and cannot be, for this reason, described by the quantitative indicators only. The analysis should be accomplished by qualitative methods (comparative studies, surveying) in order to cover differences between institutional setting. I shall come to the institutional analysis later. Now, I will make use of available data, and their combination, which can serve as a first insight into the followed issue. The closer examination of financial flows between the sectors of R&D funding and R&D performance can offer such insight. The **Table 4** gives the picture about this situation in the CR. It can be learnt from it the R&D funds of BES have a self-sustaining nature. Only 4.5% of their R&D funds flow over to the other R&D sectors of performance (and only about 2% to the R&D organisations of academic science). The data about sources of funding are also indicating that the HE sector is not able to "produce" not enough R&D funds from different sources of funding, it is mostly dependent on inflow of public R&D funds (about 94% of R&D performance at HE is covered from public funds). With references to the above-indicated data it can be claimed that R&D sectors tend to be "closed" (locked-in); the interfaces between academic and industrial research indicate have been noted by very low intensity.

The **Table 4** is also indicating some other evidence which is not so closely related to the examined issue but concern our analysis. One can learn about the distribution of public R&D funding and its comparatively high engagement in support of government R&D performance capacities. It is concerning the fact that the R&D institutes of

Academy of Sciences belong to government R&D sector.[4] Another interesting information can be gained about the distribution of inflow of foreign R&D funds: as mentioned above their size is not so high (anyhow, it is lower in comparison with Poland and Hungary, and rather fluctuating); the pattern of their distribution is responding to the question, which R&D sectors are attracting foreign funds: more than half of them flows into R&D organisations of BES; the other part is covered by academic and public science institutions.

Table 4: Distribution of R&D resources by sector of funding and sector of performance in the CR (2002, mil. CZK, current prices)

Funding/performance	BES	Government	HE	PNP	Total
BES	15 160	651	42	23	15 876
Government	2 181	5 855	4 331	66	12 433
HE	1	49	88	.	137
PNP	286	10	3	5	304
Foreign	423	222	155	1	802
Total	18 051	6 878	4 619	95	29 552

Source: Ukazatelé 2005

Some data about the level of cooperation between local universities and firms are collected by WEF and presented in its Global Competitiveness Report. The data are based on surveys of expert standpoints and evaluation. Following these data the situation in the CR is not so critical as indicated by the above-mentioned statistical R&D data. The assessment is in the level of average figure for EU-25 (in 2004 EU-25 = 3.85 and the CR figure = 3.80), and a bit lower than the figure for EU-14 (4.30 for the same year). The Czech situation is here identified as better than that one in Poland (3.10) and Hungary (2.80).[5] The difference in the assessment of industry-academy relationship between both data sources can be caused by the fact, that the foundation of regional universities (which has expanded in the last decade) has been very much supported by local industries and authorities. The regional universities have been also more actively co-operating with industry than traditional universities. Such situation is, of course, better reflected by surveying the views of involved actors than by "hard" figures of statistical questionnaires about research contracts between industry and universities.

Academy – industry interfaces have been noted by low intensity; their growth seems to be constrained by restructuring the institutional setting in both spheres.

2.2 R&D resources in the context of manufacturing industries and services

Let us go over to another realm or level of NIS – R&D background of firms in manufacturing branches & services. This issue can be approached both from the structural point of view and the context of firms´ activities in favour of innovation. The former approach can rely on data about the distribution of R&D resources by manufacturing branches and services; the latter one can be empirically supported by

[4] In the current situation of the CR the term „academic science" is covering also a part of Government sector, even if it is not consistent with normative framework of such research. It has been rather a tactical outcome of democratic political changes in the 90s (of last century), during which the researchers of Academy of Sciences refused an opportunity to join HE sector and preferred to stay within Government sector.

[5] The mentioned figures are taken from Global Competitiveness Report (Global 2004).

data of Community innovation Surveys (CIS).[6] As far as the structural factors are concerned one should keep in mind that wider empirical evidence about innovation activities in manufacturing branches has urged a need to have a much more differentiated concepts in order to the study an impact of production mode on scale and intensity of innovation activities (Castellacci 2004, Arundel, Hollanders 2005).

The situation of R&D organisations in industries has been influenced by institutional changes rather than better adaptation to specific challenges of manufacturing branches. During economic reform (1990-1995) the size of industrial R&D resources was essentially reduced without changing proportions among branches. During post-reform development (1998-2003) one can observe some selective pressures – R&D base of traditional branches (machinery and chemistry) has been losing its leading position (Műller 2004) and industrial R&D of fast growing and export oriented branches strengthen its position (automotive production, selected branches of electro engineering, computer technology and services).

In my earlier study I have paid closer attention to the analysis of innovation activities of firms in the CR (Műller 2004a). It has been based on the findings of CIS for the years 1999-2001. In general they are in accordance with similar surveys in other accessing countries and indicate a set of structural dependencies being in force in these new EU member countries: (i) the innovative intensity of firms is lower than the EU average; (ii) most of the research capacities in the innovative firms has been covered by large firms; (iii) the largest part of innovation expenditures is taken up by investment into equipment; (iv) a change can be observed in the re-orientaion of innovation from process innovation to product innovation. Following these data innovation activities in the CR are reported to be more intensive than in the other new EU member countries (see **Table 5**). The detailed data are, however, more sensitive to enterprising environment. The differences among new EU member countries seem to be bigger (in terms of available data) and also their interpretation is more demanding. For this reason I shall be more focused on the situation in the CR.

Table 5: Share of innovation-based firms in total number of firms (%) and type of their innovative activities (1998-2000)

	Product or process	product.	process	Product and process.
EU-25	36,2	12,3	8,4	14,3
EU-15	39,0	13,5	9,4	15,8
Czech Republic.	28,5	11,9	5,2	11,5
Hungary	21,1	8,5	4,2	8,3
Poland	16,8	.	.	.
Slovakia	17,2	10,7	2,0	4,5
Slovenia	20,2	5,6	1,8	12,8

Source: EUROSTAT – New Cronos, Community Innovation Survey – CIS3

Table 6: Innovation expenditures by type of costs and size of firm(2001, %)

Firm/costs	Intramural R&D	Extramural R&D	Equipment acquisition	Extramural consulting	Training	Market introduction	Design
Small firms	14.4	3.5	41.2	12.5	3.9	22.0	2.5

[6] Czech Statistical Office has wide experience in surveying of innovation; in the 80s of last century the specific methodology was designed and implemented in order to survey innovation activities of state-owned companies. In the second half of the 90 after some experimenting the methodology of OSLO manual has been implemented and the CR could, therefore, join last two rounds of CIS (1999-2001, 2002-2003).

Medium firms	33.5	8.6	38.4	5.0	1.1	11.0	2.3
Large firms	20.1	9.1	47.8	9.9	2.8	7.7	2.6
Total	22.0	8.1	44.8	9.3	2.6	10.7	2.5

Source: CIS II, ČSÚ, 2003; http://www.czso.cz - technical innovations

The most typical data for the internal situation of innovating firms in the CR are summed up in **Table 6**. They are indicating that innovation efforts of the firms are facilitated first of all by equipment acquisition (embodied technology) while the dis-embodied sources of technology are oriented to input of intramural R&D and marketing activities, in lesser scale to knowledge resources of extramural origin. From the **Table 6** some other interesting information can be gained about the level of innovation activity by size of firm. In the case of the Czech situation the medium-sized firms are reported to be quite active in the innovation efforts: they make use of intra-mural and extra-mural R&D as well as marketing activities.

The above-indicated data about internal innovation resources of firms are, of course, shaped by the responses of firms to their environment. The environment for innovative enterprising can be accomplished by some other figures of CIS. Respondents of CIS are required to identify importance of enumerated (internal and external) factors influencing their innovation efforts. The outcome of both surveys is giving evidence that external market oriented factors (extension of product and service assortment, growth of market segment, improvement of product quality) are of greater importance than internal factors (production flexibility, growth of production facilities, cost reduction). The role of investment and funding resources is not usually mentioned in this set of questions, since their deficit is generally felt as a crucial constraint of innovation activities (it takes the highest position when the respondents are asked about the constraints of innovative activity in the firms). The above-indicated pattern of external – market oriented - factors can be also supported by data about influence of type of market on innovating firms: regardless their size the innovating firms are orienting their production to foreign markets (small firms nearly half of the whole output, medium sized and large firms in the size of more than two thirds of this output).

Another study on innovation in the CR, which was focused on operation of innovating firms in the regional pattern, has also confirmed the above-mentioned conclusions even in a more explicit way (Inovace 2003)[7]. According to its outcome the management of firms - when asked about the factors which influence the *competitiveness of their firms* - gave the following assessment (the significance of the factors is assessed using a scale from 1 to 5: 1 = most significant; 5 least significant):

1. Trademark, the brand of product, the goodwill of the firm	1.73
2. Quality of the product or service	1.75
3. Flexibility in supplies and rendered services; terms of delivery	1.79
4. Technical standard of products and services	1.82
5. Support schemes of sales	1.89

[7] The results of this survey of innovating firms were gained in the framework of project „Bohemian Regional Innovation Strategy“ (BRIS), which was carried out in the years 2003-2004. The distribution of studied firms was adopted to cover SMEs and larger firms; the core of surveyed firms was in the group of firms with 10-49 employees.

The least important factors are ordered as follows:

- Availability of investment resources in adequate size and pattern
- Costs of raw materials, sub-deliveries, energy
- Quality of sub-deliveries
- Expenses for research and development

In response to the question how they assess the barriers they face when implementing innovations the respondents indicated the following barriers:

1. A lack of financial funds for operating the firm	2.27
2. An overload of management by current (everyday) operations	2.28
3. A shortage of human resources to meet the firm's anticipated aims	2.94

The above outlined insight into the operation of innovating firms is indicating some contradictory processes, which are influencing their activities. On one hand they are driven by more specific challenges of market demand. yet on another hand they have troubles in organising sub-deliveries as well as in raising funds for new production. Consequently, the firms have to rely on internal resources rather than the external ones. The role of (domestic) R&D factors is not considered to be important while the shortage of specific profile of qualified personnel starts to be felt as an important constraining factor.

That said, the assessment of NIS from the point of innovating firms can be summed up as follows:

Economic environment of innovating firms has been influenced by a mix of internal and external factors, in which there are prevailing (i) pull of market demand factors and (ii) constraints in co-ordination of external resources have been pushing the innovating firms in a position of self-reliant strategies.

2.3 National R&D system in the CR and its political and regulatory framework

The policy level is representing the third formative issue of NIS analysis. The framework of my analysis has been already outlined in the introduction to this paper. In the following I shall outline the pattern of regulatory provisions and assess their impact on context of innovating firms and the other actors of NIS. The general political and regulatory framework has been influenced by a radical economic reform and its unintended consequences. Elsewhere, I have labelled this situation as a transition from laissez faire to state activism (Müller 2002). Political actors have been able to reflect unintended consequences of radical economic reform and to introduce corrective measures into the regulatory regime. [8] In view of these provisions also the approach to the issues of science and technology (S&T) has been changed. Since this time two trends in the evolution of S&T can be identified: (i) increasing public

[8] The strategy of economic reform in the CR followed the advices of Washington consensus and its actors could gain also prevailing support of the political public for such orientation of reforms (1992-1995). Political reflection of negative social consequences of the reform led to change of political representation and corrections of economic strategy (1966-8).

R&D funding together with re-orientation of research to economic aims (of competitiveness of domestic production), and (ii) implementation of concept and regulatory means of innovation policy. So, public awareness of re-orientation of S&T policy from a mode of R&D policy to a mode of innovation policy has been articulated. In the further discussion I will analyse these political and regulatory efforts from two standpoints. First, I will describe the situation from position of domestic actors and regulatory provisions, which have been implemented. Second, I will make use of assessment, which was prepared by EC authorities in the course of accession of the CR to EU member country.

The corrective measures of S&T policy were finalised in the Government resolution "*National Research and Development Policy of CR*" (January 2000). Its provisions can be outlined in the several issues:

- *Public GERD* were planned to grow to the level of 0.7% GDP; such level of public R&D funding was expected to be attained in the year 2002;
- New pattern of distribution of public GERD was suggested: 20% of funds should go to so called non-oriented research (Academy of Sciences, HE) and 80% to the so called *oriented R&D*; the aims of this provision is to facilitate support of applied research and experimental development.
- National *Program* of Oriented R&D was proposed to design *priorities* for the oriented R&D; the foresight technique was used to prepare the program.
- The support of HE research sector should be carried out after the evaluation of long term projects of Universities and their faculties (supported also by private funds and carried out preferably in mutual co-operation of faculties) has been made; the selected projects could gain public funding and legal status of *Research Centres at Universities*
- Serious deficiencies in the way of co-ordination of executive branch in favour of support of R&D and its orientation to economic competitiveness have been identified and the preparation of scheme for *harmonisation of executive branch* in this perspective was initiated.

In the preceding five years the regulatory provisions have been made in order to attain the objectives of the national R&D policy. One has been successful in all points except the first and last ones: due to fiscal constraints and low growth of public R&D funds the projected level of GERD has not been reached; also a problem of harmonisation of decision making about S&T issues in the executive branch has not been solved.

The reflection of positive steps and unsolved issues, and the current pull of EU regulatory practices, have influenced political actors and government to update its resolution about national R&D policy. In July 2005 the Government approved the resolution about "*National Innovation Policy of the CR for the years 2005-210*". It identifies challenges and shortcomings of innovation processes and suggests relevant provisions to be taken. The critical shortcoming is seen in technological performance (as assessed by intensity of patenting in high-tech branches) and low flexibility of firms (as assessed by emergence and support of spin off firms). The other deficiencies are seen in the sector of HE (assessed by low share of students at engineering and natural science faculties, low level of permanent education), low level of R&D funding (from both the public and the private sources), low activity of venture capital in support of innovative projects of firms and low innovation activity of

firms (as assessed by indicator of new products for firms).[9] The objectives of proposed innovation policy follow in principle the issues of previous policy document, suggest more focused measures (public funds of GERD should be increased to 1% of GDP by the year 2010, public funds should be better linked to identified priorities) and add some new provisions (better protection of intellectual property rights, indirect support of innovating firms by tax reductions, support of public/private partnership in R&D funding and of regional activities in favour of innovations).

Let us make use of a side look at policy issues, which has been offered by an assessment of innovation policy in the CR within the framework of EU regulatory practices. Such document was prepared in the course of accessing process of the CR to EU membership (Innovation Policy 2001). The advantage of this assessment rests in the fact that it has availed itself not only of available databases but also of comparative research of institutional framework of different EU countries including also the concept of NIS[10] and the general trend in transformation of industrial (techno-economic) regimes in CE countries. As far as the latter is concerned the following assumptions have been formulated:

- Decline of economic growth in the 90s of last century was brought about by insufficient dynamics of technological changes and low rate of investment;
- Enterprising environment has been noted by extensive uncertainties in foundation of new firms, what has resulted in low level of risk and investment sharing; consequently, SMEs are not oriented enough to the challenges of innovations;
- The rate of impact of FDI on development of domestic firms is low;
- Structure of education and apprentice training does not correspond to demand of labour market;
- BES does not create sufficient demand for R&D findings.

Within the above-identified common pattern of industrial issues in the CE countries the specific situation of the individual countries has been analysed. The perspective of institutional analysis has oriented the authors to cover also some specific issues like public awareness about the role of education and innovation, political awareness of innovation as a key instrument of economic reforms and challenge for regulatory practices, role of SMEs in innovation process, role of diffusion of technological knowledge within manufacturing branches and services. In this approach also the factor of cultural resources and the role of innovating actors has been stressed – an attempt to combine macro-social and micro-social perspectives. With reference to the above-mentioned analysis of structural framework (**Table 7**) and challenges for situated action (**Table 8**) the following picture about the situation in the Czech innovation policy has been formulated (Innovation Policy 2001: 27-29):

Table 7 Structure-based factors:

Assets	Challenges

[9] The assessment of weaknesses of innovation processes in the CR has been prepared by help of quantitative indicators of European Innovation Scoreboard (EIS). The lowest level of the indicators in the relation to EU average figures has been understood as a best evidence of existing shortcoming (see.Národní 2005)

[10] the reference framework has related to approved EU innovation policy guidelines (Green Paper 1995).

• Industrial strengths in branches with high intensity in technology and their growth • FDI intensity • Strong position of industrial R&D in the national R&D system • Export intensive country • Relatively high levels of skilled technology workers • Strong position of engineering in education system • Liberal environment for firm creation	• Unsuccessful privatisation of large enterprises and lack of dynamic SMEs • Rise in unemployment and need to adapt further the workforce to new types of activities • Need to increase scale and flexibility of HE • Negative implications of transformation of industrial R&D • Relatively low level of patenting activity • Reform of legal institutions legging behind

Table 8 – Innovation performance

Innovation resources and drivers	Innovation constraints
• FDI plays a role in providing advanced learning opportunities for workforce • Revival of growth of industrial R&D • Growth of academy-industry co-operation • Tradition of production co-operation • Training in innovation management • Growing impact of venture capital • Role of NGO in raising public awareness about innovation	• Lack of bridges between academic and industrial science • Technology spin-offs from foreign-owned firms are limited – fragile networks of domestic firms • View on innovation restricted to the technology development

It is the advantage of the above-mentioned analytical approach that it draws attention to the structural factors and their impact on the capacity of action. It assumes that capacity of action can be pulled by unfavourable distribution of resources (i.e. by structural dependencies) and need not have, therefore, any positive impact on the intended objective of change in a mode of S&T activites. Consequently, it is only reproducing current practices. On the other hand some capacities of action can grow because of favourable structural environment. Consequently, niches of change can emerge. The conceptual approach which takes into account structural dependencies as well as locations of action with potential of change seems to be particularly relevant for the situation of radical institutional shifts since in such environment both sides are mobilized – resisting social actors who are disposing of extensive resources and actors who can increase their capacities of action while finding prospective localities of action (and being free of resource dependencies). The above-applied approach which takes into account the impact of structural dependencies and mobilisation options (**Tables 7** and **8**) is also much more

productive in identifying barriers and drivers affecting changes in the mode of policy. The **Table 9** outlines the situation in S&T policy in the CR and a perspective of its transition to a mode of innovation policy.

Table 9 – Main characteristics of Innovation Policy in the CR

Main policy initiatives for innovation	Policy challenges
• Public support of R&D at HE and co-operative research projects across R&D sectors • Industrial zones • Regional centres for support of enterprising • Programs for re-orientation of R&D activities to innovation efforts in economy and society	• Establish an integrated policy framework for policy • Develop a legal framework favouring linkages and spin-offs effects in the system • Develop incentives for new firm creation • Secure budget resources for policy programmes and introduce tax incentives for R&D and innovation

Even if both above-described documents address similar set of objectives and provisions, which are related to an implementation of innovation policy in the CR one can observe a difference between them. They offer different interpretation of the relevant situation. Domestic policy document attempts to balance coherence between available means and formulated objectives without taking into account the different positions and interests of the situated actors. The analysis from the standpoint of EU practices is more focused on the issues of communication, role of communities, institutional reflexivity of available resources and options for effective actions. The latter approach is much more aware of the role and nature of institutional change in a formation of innovation policy in the CR[11]. The discussion about the role of government in promotion of innovation policy has come to the evident conclusion, that

> the change of regulatory policy in the field of S&T from a mode of R&D policy to an innovation policy is representing a process of social trans-formations affecting not only changes in the pattern of available resources, internal changes in organisation pattern of government bodies but whole institutional framework of NIS.

3. Institutional resources in the context of transformation of S&T policy

The above–formulated assumptions about the important role of institutional factors in the analysis of the chosen issue, and the organisation of the analytical arguments have prepared a cognitive background for the concluding step to be presented in my communication. The presented analytical data have offered a picture about macro-social situation as well as the activities of the situated actors. These data have well

[11] Both discussed documents count with institutional change but they evidently differ in the interpretation of its nature. The concept of domestic actors follows rather an instrumental approach trying to identify optimal relation between pattern of (indicated) resources and formulated (and formal) objective. Social background of the intended transition is black- boxed. The EU analysis prefers evidently the concept of institutional change as a balancing of countervailing processes of dis-embedding form current practices and embedding in a framework of new practices.

described the distribution of resources by the established institutions and indicated where there is a certain overlapping or sharing of resources – a signal of inter-institutional linkages. The (micro-social) data about the innovative firms have described the intensity of linkages of BES actors to the other institutions of NIS. The distribution of resources by these levels has indicated what resources are bound to regulatory agencies and may be employed as a source of their ("top-down") influence on regulated situations and what resources are bound to independent (self-regulatory) agencies and institutions and their possible ("bottom-up") influence on their environment. The findings of **paragraph 2.3** have followed this way of description and indicated locations or forms, in which the top down and the bottom up processes are mobilised. So, an understanding of NIS could leave a static perspective, indicate some driving or constraining factors and get a dynamic shape.

The outcome of the **paragraph 2.3** has also indicated that analysis of driving and constraining factors has to respect the context of this or that country, even if one could observe some common trends across the countries (national states) and certain similarities for some of them. Recently, the NIS concept has been enriched by identification various types of social arrangement among its actors.[12] A better understanding of types of social interaction is a precondition for a closer study of institutional framework. Evidently, the advance of NIS studies is approaching its "black box" – understanding the role of institutions in mediating relationship between innovation resources and innovation performance. The above-mentioned achievement in typification and institutionalisation of NIS has been attained in inductive way - by generalisation and combination of the available analytical data. The claimed conclusions of these approaches are still open to discussion. The situation in the new EU member countries is different for two essential reasons: (i) the role of institutional factors in the study of NIS, as well as the other institutionalised areas, has been quite evident and become an urgent issue not only for political action but also for social science reflection, and (ii) in the situation of institutional change the reliability of databases is lower than in the situation of embedded institutional framework. Both reasons urge for a more powerful conceptual approach. Certain help in such cognitive effort could be gained from the other social sciences, which have been studying the role of institutions in human societies. Elsewhere, I have already attempted to make use of two possible sources for institutional analysis: (i) conceptual knowledge about a nature of institutions, which has been gained by innovation studies (Műller 2004a), and (ii) concepts of institutions which have been developed by several social sciences and their implications for an application of interdisciplinary approach to a study of institutions (Műller 2005). With reference to these findings I will outline a concept of institutional analysis of NIS and apply it in order to specify institutional context of current transformations in the domestic NIS.

The NIS concept has reflected the impact of differentiation of modern institutions into specific functional fields or social sub-systems: institution of academic science; institution of industrial science and state authorities with their regulatory power and instruments. Functional approach to the study of institution understands its nature to be granted by evident human needs, and its social functioning, governance (control) and justification can be attained by social norms, which are embedded in and

[12] such line of theorizing has been followed in particular by those authors who have started to study closer an impact of different patterns of manufacturing structure on the performance of NIS (Castellacci 2004).

supported by valuation pattern of human activities.[13] Closer studies of science-industry-government relations are, however, reporting that crucial factors of justification of current institutional framework are not related to functions of institutions only. Important legitimising effort has been emerging out of *tensions among institutions*, at the borderlines of relevant institutions. It means that in such situation the function of institution cannot be justified by ex ante valuation; new reasons of its valuation are emerging out of tensions among the established institutions. For this particular reason an institutional change cannot be understood only within a functional perspective, as a redistribution of resources or an implementation of a more effective organisational pattern. It has, therefore, to comprise also shifts in cultural resources and value orientations, which are mobilised by different and growing opportunities for action and cannot be attained without *intensive reflexivity, learning, and experimentation*. Such an institutional environment has become typical for innovation-based activities. That said, one can even claim, that

> The more innovative are the functional means of social action, the more reflexive should be current practices. And vice versa: the higher are expectations for innovations, social change and the improvement of life, the more responsive and innovative should be the functional resources - including those of S&T.

The above-indicated challenge has been reflected and worked out in the concept of an *institutional framework for innovative situations* (and societies), which has been suggested by Hollingsworth. In his view, institutions should be studied at several levels – **(i)** the level of basic norms, rules, conventions and habits; **(ii)** the level of forms and capacities to co-ordinate, like markets, hierarchies, obligation networks, associations, the state, communities and clans; **(iii)** the level of the institutional sectors of society, like, for example, suppliers, funding sources, regulators etc.; **(iv)** the level of organisations and their structures; **(v)** the level of outputs and the performance of institutional components - their flexibility and variety (Hollingsworth 1998, Hollingsworth 2000). An institutional analysis should proceed at each level and identify the specific social context, rules, incentives, procedures for enforcing compliance, and measures for reducing the costs of compliance.[14]

How can we develop our approach to institutional analysis of NIS with reference to the above-suggested concept? So far, the analysis tried to be in touch with available data and in this position it has been claimed, that institutional issues can be reflected in a combination of data about structural factors (which are more visible in macro-social perspective) and challenges for a productive action (which are better visible in a micro-social perspective). The analysis of regulatory issues has shifted our cognitive aims to a more advanced position: with help of available data one could even identify which structural resources can facilitate innovation-based action, and

[13] In social terms the acceptance of a function as a justification of this or that emerging institution has its ground in the realm of basic human needs. If an institution responded to a basic human need, it could gain an autonomy and mobilise self-regulatory practices. In such historical circumstances the function of science as well as of technology has justified an independent (self-regulatory) forms of its existence (less in case of technology as its immediate impact on performance of economic, military and political institutions was quite early understood and shaped by their objectives as well).

[14] Hollingsworth justifies his approach with the assumption that institutions are "embedded in a culture, in which their logic is symbolically grounded, organisationally structured, technically and materially constrained, politically defended and historically shaped by specific rules, habits, conventions and values" (Hollingsworth 1998:14)

which innovation based actions can promote restructuring of resources. The Hollingsworth´s concept widens our look at factors of institutional change: it claims, that besides the functionally shaped cluster (phenomena in level iii/ and iv/) one should introduce into institutional analysis also the changes in forms of social co-ordination (level ii/) and cultural resources in their informal pattern (level i/). It is quite interesting input into the institutional analysis. It introduces into the institutional analysis new factors – the forms of social co-ordination[15] and informal cultural factors[16]

How can we enrich our interpretation of the studied issues by the suggested concept of institutional analysis? How does it influence NIS concept? The NIS concept is explicitly orienting the analysis on functional capacities of institutions (academy, industry, R&D sectors) and in an implicit way indicates some features of regulatory and self-regulatory environments (programming efforts of industrial policies, indirect support by fiscal and monetary policies), its hierarchical setting ("top-down" and "bottom up" interfaces), constraining and challenging factors of action, which have been reflected by macro-micro perspective of analysis, or by look at structural factors or spaces for creative action. The suggested concept of institutional analysis looks at institutions not only through their functions but also through *interfaces between their external and internal environment*. Consequently, three new points of view and issues of NIS have been stressed: (i) organisations with their capability to organise not only themselves but also in relation to the other relevant organisations, (ii) interface between institutions (with their functional profile) and their social environment which is using diverse forms of co-ordination, and (iii) the general impact of culture and its symbolic power.

What can we learn from the advanced concept of institution building for our case? How can it be applied in the institutional analysis of NIS in new EU countries, and the CR in particular? Anyhow, we have learnt several essential implications: (i) social environment among the institutions of NIS is influenced by larger set of factors and is more complex than assumed by NIS concept, (ii) the social environment is noted by diversified interests which are embedded in NIS institutions and tend to grow into conflicting situations, and (iii) an assumption of systemic nature of NIS becomes questionable, and should be revisited, and (iv) there is uneven coverage of suggested levels of institutional analysis by analytical data and empirical studies. Comparatively wide knowledge background has been gained about the functionally shaped cluster of institutions supporting innovation as well as new social environments emerging among them (phenomena in level iii/). One can mention e.g. the studies supported by Triple Helix project[17] or other empirical studies guided by NIS concept. Sufficient and diversified scope of data can be gained about the innovating firms (phenomena in the level iv/). In this perspective there are available

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[15] The other social sciences are using for this social phenomenon different notions; e.g. in sociology one speaks about media of power (market, public reputation, truth etc.), or generalizing principles of mutually binding / reciprocity-based obligations. In their perspective the pattern of co-ordinating forms is richer than that one mentioned by Hollingsworth.

[16] In this case the narrower concept of culture is used taking into account the role of social norms and values only; of course, more focused study of culture would have to follow an influence of both the material and the non-material factors of culture building.

[17] The Triple Helix project has well documented this situation; its concept has attempted to transcend narrow analysis of resources of the established institutions and cover also the situations of an institutional change. Yet, this vast research efforts have been mostly shaped by NIS concept (see e.g. Etzkowitz,Leydesdorf 1997)

CIS data or data about innovation activities of firms within branch specific environment.[18] Similar line of research is supported by the EXIS concept, which intends to describe various types of environment for innovating firms.[19] Less abundant data and research findings there are about forms of social co-ordination (level ii/) and cultural resources in their informal pattern (level i/). Here, one is challenged by the problem, that the *forms of social co-ordination cannot be approached in analytical way* since they are intertwined with institutions (each institution combines various forms of social co-ordination) on one side and on the other one with cultural milieu (which is evaluating the role of the particular institutions and shapes a ground for their normative and legal regulation). Some shifts in this social spaces have been already identified: e.g. long time trend of resistance to establish (formal) hierarchies into horizontally organized ("open") systems of market or science; in similar way a comodification and marketization of some established institutions is proposed in order to facilitate horizontal linkages and reflexivity among institutions.[20] Similar experience has been gained by MONIT project, which has been focused on the study of governance issues of innovation systems. Following the outcome of wide set of NIS case studies it has come to the conclusion, that "the coherence of innovation policy across ministerial boundaries is a key to successful governance" (Governance 2005a:7). An improvement of horizontal relations among ministries is even identified as a challenge for a new generation of innovation policy (Governance 2005).

Summing up the above outlined discussion about the institutional analysis of NIS it can be claimed that two cognitive perspectives have been emerging. The first perspective is related to the regulatory practices of the core EU countries as well as comparatively reliable reflection of current NIS situation (in terms of analytical databases and conceptual approaches). Within this perspective it is possible to articulate weakness of current institutional framework and suggest provision for an improvement of regulatory practices (fine-tuning approach). The second perspective is promoted by specific situation of new (EU) member countries, which have been influenced by social transformations – de-institutionalisation of current practices and re-institutionalisation of innovation based practices. The issue of institutional change should, therefore, stand in a forefront of social studies. Within this perspective a specific concept of institutional analysis is required: it should be sensitive to available analytical data but also active in constructing concepts of institutional changes not only within NIS but also in the context of current transformations of institutional framework. For such purpose the above-discussed model of Hollingsworth is instructive, yet closer understanding of its regulatory and cultural patterns should be developed in order to understand the situation in the new EU countries. It is now a crucial cognitive question, how such issues can be approached?

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[18] Such support is given by the outcome of CIS but also by application of Porter´s concept of competitive advantage in manufacturing branches (see Porter 1980)

[19] The EXIS project has been developed in a critical view to NIS concept and with the idea, that a conceptual generalisation about innovation system should be better justified by analytical data about enterprising environment in the level of firms (Arundel, Hollanders 2005)

[20]The issues of closer interactions of science institutions with the other institutions have been followed by social studies of science and technology and led to various interpretation frameworks and concepts (see closer Nowotny at al. 2001).

The discussed model of institutional analysis is suggesting various forms of social co-ordination (governance), which can be studied in their particular form, or in the combination of various forms, like the currently suggested forms of public-private partnership. This approach is, however, not fitting to the situation of new member countries since they have to re-establish roles of basic divides – regulatory / self-regulatory one, public / private one formal / informal one. In such situation it is important to involve into the study both the structural factors and their impact on the context of activities as well as the impact of the particular actors on changes in re-distribution of resources and structural shifts. With reference to the discussed issue of NIS the structural factors are given by historically embedded forms of *social organisation* and the relevant distribution of resources. In a process of dis-embedding from such forms the role of those actors and agencies is important, which are situated at the borderlines among the institutions. The social impact of the *situated actors* is, of course, conditioned not only by a will to action, available resources and competitive advantage but in particular by *reflexive interaction* with its relevant environment.

The analytical and conceptual approaches to the study of NIS in the CR, which have been presented in the **paragraph 2.3,** have indicated, that the forms of current social organisation of NIS are laden by powerful constraining factors. On the other hand also some niches of situated activities and agencies have be identified within and among the NIS institutions. However, level of institutional reflexivity seems to be crucial weakness and constraining factor in an appropriation of concepts and regulatory instruments of innovation policy. Of course, the issue of reflexivity, of flow of knowledge and information among the agencies and institutions in the competitive or hierarchical environments is very much dependent on capacities of protection / insurance against risks, and in particular on the social environment of trust. Closer study of this issues and understanding forms of its impact on current institutional framework seems to be the crucial topic not only of institutional analysis of NIS but also the wider institutional frameworks, which are articulated by concepts of knowledge based economy or modern societies.

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