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A brief overview of the methodology for mapping the innovation potential of the Czech economy

PHASE 1

project INKA – mapping innovation potential

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Content

1 Introduction: Is the Czech Republic heading towards a knowledge-based economy? 3
1.1 Framework and objectives of the project INKA 2014+ Mapping Innovation Capacity 3
1.2 Development phase of the Czech economy in a European context 4
1.3 Current state of the INKA 2014+ project, structure of outputs 5
2 Conceptual basis of the methodology 7
2.1 Many forms of innovation 7
2.2 The company, the main unit of the analysis 8
2.3 Rank-size hierarchy of companies in terms of innovation 8
2.4 Systemic approach to innovation 10
2.5 The economy as an evolutionary system 10
3 Presentation of the methodology for an analysis of the innovation potential of the economy .. 11
3.1 The various levels of analysis 11
3.2 Thematic areas of the in-depth analysis of innovation potential 14
3.3 Thematic areas of the analysis of innovation potential and their projection into the chapters of the methodology 28
4 Analytical part: recommended use of the methodology as a whole 30
4.1 In-depth analysis of the NIS 31
4.2 Monitoring of the NIS. 31
4.3 Database of companies and its supplementing 32
5 The main findings of the analyses 33
5.1 The international position of the Czech Republic and the importance of foreign direct investment 33
5.2 Knowledge intensity of the Czech economy 34
5.3 Structure and specialization of the Czech economy 35
5.4 Collaboration in research and development, creation and use of new knowledge 37
5.5 Conclusion 38

1 Introduction: Is the Czech Republic heading towards a knowledge-based economy?

The present document is a summary of the work carried out in 2014 as part of the first phase of the project entitled Mapping Innovation Capacity INKA 2014+. The methodological and analytical outputs and results that were created in the first phase of the project are presented in a brief and concise form. The extent of processed methodologies, analyses and other outputs is considerable, and this document cannot adequately describe all of the details or capture all of their features. Nevertheless, it represents a comprehensive overview of the approach to mapping the innovation potential of the Czech economy and is a guide to understanding the various parts of the methodologies and the different outputs of the project.

1.1 Framework and objectives of the project INKA 2014+ Mapping Innovation Capacity

The purpose of innovation policy is to support the components of the economy whose competitiveness is based primarily on the utilization of knowledge. Innovation policy, as part of economic policy, should contribute to strengthening the competitiveness of the national economy, the economic growth of the country and in a broader sense also lead to (more skilled) jobs and contribute to maintaining employment or to its growth. TAČR is involved in the innovation policy of the Czech Republic and plays a significant role in it by *"...preparing and implementing programmes of applied research, experimental development and innovation, thereby contributing to the competitiveness and economic growth of the Czech Republic".* Assuming that a measure of the competitiveness of the economy/a company is its ability to succeed on global markets, the aim of innovation policy and public interventions that are part of it is to stimulate the behaviour of companies, research organizations and other players (triple helix), leading to their assertion on global markets through innovation.

In the above-mentioned context and in line with its mission the role of TAČR, among other things, is to identify entities of the national innovation system which have the potential for growth and development, are part of the knowledge economy in the Czech Republic and have a real and proven or potential ability to assert themselves on demanding international and global markets. This not only means the ability to sell on these markets but also the ability/ambition to grow and expand activities on global markets in the long term.

The above-described basis forms the framework of the project Mapping Innovation Capacity INKA 2014+, whose aim is to ***identify the groups of entities operating in the Czech Republic, regardless of ownership, that are most likely to be target groups of TAČR interventions or directly identify the entities themselves***.

The purpose of the project INKA 2014+ is mainly ***to develop and test methodologies*** for collecting and analyzing the data and information needed to provide the above-mentioned strategic knowledge for the purpose of the innovation policy of the Czech Republic.

The objectives of the INKA project are as follows:

1. To define and justify what needs to be regularly measured in order to evaluate the innovation potential of the Czech economy and how this should be done

2. To propose what data should be regularly collected for this purpose
3. To design a specific method of analysis to evaluate the innovation potential of the Czech economy
4. To verify the functionality of the proposals for data collection and their analytical application

The methodology and validating analytical outputs should then contribute to a greater efficiency of the innovation policy, design of new instruments based on the needs of entities of the innovation system and better targeting of the existing ones. Although the instruments themselves are not proposed in the project, as part of the mapping and analysis of the national innovation system we have identified barriers to innovation and potential market failures, which could serve the proposed interventions.

The present paper briefly presents the main parts of the project INKA 2014+, which constitute the result of the first phase. It describes and justifies which parts of the methodology and analysis are included, what they are for and how they are linked to each other.

1.2 Development phase of the Czech economy in a European context

In order to understand the current state of the economy of the Czech Republic it is necessary to identify the main long-term forces shaping the present and providing the basis for future directions. The current position of the Czech Republic in the context of European and global economic development is a basis of the proposed methodology for the analysis of the innovation potential. On the one hand, it determines the possibilities that open up in front of the Czech Republic, on the other hand it shows the causes of many findings and helps bring the partial results into the necessary context.

The underlying basis of the current position of the Czech Republic in the European economy is its ***geopolitical and economic position*** after gaining political independence in 1989 and after the breakup of Czechoslovakia in 1993. At this time there was ***a significant cost differential in Europe to the west and south of our borders***. This, in essence, despite twenty years of ongoing transformation and the catching up of Central European economies with those of the west, ***has persisted to-date***. This geographically unique and significant ***cost differential determining the cost of inputs*** (especially labour costs) ***makes our economy more attractive for the activities of foreign companies, especially for activities whose source of competitiveness and thus growth is an increase in cost effectiveness.*** The importance of this cost differential gradually increased in the context of ongoing European integration and accession of the Czech Republic to the EU, which has led to an influx of foreign investment. This peaked between the second half of the 1990s and the middle of the following decade and was the main engine of the transformation of the Czech economy.

The reason for the strong inflow of foreign investment into the Czech Republic is its ***proximity and good access to major European markets***, which, combined with its cost-effectiveness, made the Czech Republic an attractive site for the location of the production activities of manufacturing companies from Europe and beyond. Due to the influx of foreign companies and their suppliers (many of which being domestic companies) the Czech Republic now ranks among the most industrialized countries in Europe and its economy is heavily export-oriented.

The Czech Republic still competes on European and global markets more through its cost effectiveness than innovation. ***Although knowledge activities are gradually gaining in importance***

both in domestic and foreign owned companies, it is clear that the set up to the next stage will not take place within the next decade and it is not certain whether it will happen at all. One of the consequences of the current development is the fact that ***in an international comparison the Czech Republic belongs to the group of "moderate innovators"***, however it is at the forefront of the countries of Central and Eastern Europe, at least according to rankings of the innovativeness of economies like e.g. the Innovation Union Scoreboard.

The second fundamental aspect of the mentioned basis having an effect on the present was the several decades-long absence of free enterprise. Due to this the economy lacked experienced entrepreneurs (large and small), the related capital and ultimately the competence to find new customers and opportunities under the competitive conditions of global markets. Although the situation in this respect has considerably improved, the development of the segment of endogenous[1] companies continues to face the consequences of this several decades-long absence of free enterprise.

The attractiveness of the economy to foreign companies led to the dynamic internationalization of the economy with all the related pros and cons. The activity of foreign companies was the main driver of the modernization of the whole economy, a significant number of endogenous companies became suppliers of foreign companies and their market position and innovative potential are based on this fact. Foreign companies also contributed to the creation of several forms of dependence of the local economy, with implications for further development which are analyzed in the framework of individual partial analyses.

1.3 Current state of the INKA 2014+ project, structure of outputs

The INKA project is formally divided into 3 phases, with phase 1 being completed. Phase 1 is divided into three sections or levels of analysis and their corresponding methodologies. These include, inter alia, the methodology for collecting and processing data. These levels and their relationships are described in detail and illustrated in the example of export analysis in the text below (Chapter 3.1.).

The main methodological outputs are three sub-methodologies:

- ***Methodology for macroeconomic and aggregate data***
- ***Methodology for microeconomic and individual data***
- ***Methodology for the collection and analysis of primary data (field surveys).***

The main analytical outputs are three sub-analyses:

- ***Analysis of macroeconomic and aggregate data***
- ***Analysis of microeconomic and individual data***
- ***Analysis of primary data (data collected by field surveys).***

The methodologies and their verification through analysis form one interconnected whole. The methodology and its parts are structured so that they:

- explain with which themes, why and how to deal with the mapping of innovation potential

[1] Endogenous company means a company founded, owned and strategically controlled mianly by Czechs

- present the individual analytical tools, describe in detail the procedures used to create these tools (data and their sources, indicators and their structure) and how to utilize them
- describe how to interpret the results and how to draw conclusions using the analytical tools and how these findings combine into larger units
- indicate what methodological difficulties may occur when creating the analytical tools and using indicators or data and how these difficulties can be confronted.

The chapters of the analyses have a similar formal structure to the methodologies (where possible and meaningful) and follow on from the methodologies so that they:

- illustrate the individual methodological procedures and analytical tools described in the methodology
- illustrate how the analysis can be practically implemented and how it can lead to the partial findings using the analytical outputs
- show practical examples of how individual findings can be interpreted in practice in the right context.

Brief overview of the methodology – The guide represents a special output that clearly and comprehensively describes the thematic areas of three detailed methodologies. In particular, it complements the proposed methodology by describing a multi-annual analytical cycle (see Chapter 4), which meets the requirement for repeatability of the methodology and its use in the longer term. The multi-annual cycle begins with a detailed and in-depth analysis of the innovation system and its components and continues by monitoring the innovation system in the subsequent years and an update of the database of innovation entities, and the detailed in-depth analysis is then repeated after four to five years. The analytical outputs - a detailed analysis of the innovation potential – which arises as part of the INKA 20014+ project during the verification of the methodologies, originate from the first in-depth analysis performed at the beginning of the analytical cycle.

In addition to the methodologies and analytical outputs an ***output*** of the project is also a ***proposal for the monitoring of the innovation system and its components***. This is based on the use of a limited range of selected indicators determined during the in-depth analysis and their interpretation in the context of the findings and conclusions of the in-depth analysis.

Other outputs of the project are extensive data files used for analytical work and incorporating the original data, obtained from various sources (e.g. Eurostat, OECD, Czech Statistical Office, UNCTAD and others), as well as the data processed for the purposes of the analyses, i.e. in the form of tables and graphs.

A certain ***unique output of the project is a detailed database of innovative entities***, containing information and data obtained from 137 structured interviews[2] with executives from the most important innovative companies operating in the Czech Republic and from 37 structured interviews with leading research teams that extensively collaborate with these companies. The information on each company is represented by over 300 items containing numeric data, classifications, typology and additional explanatory or descriptive texts.

[2] The standard length of the interview is approximately 60-70 minutes; however, in many cases the interviewee becomes so involved in the interview that the conversation lasts longer. In some cases, the interviewer may even be invited to actually visit the research and development workplaces of the company and see their activities at first hand.

A further output of Phase 1 is a summary of the ***main findings of the analyses*** (see Chapter 5).

Phase 1 is followed by Phase 2 (currently ongoing), the subject of which is a more extensive field survey of companies and research organizations, aimed at verifying the methodology on a larger sample (verification of the typology and new classifications that were the result of Phase 1, verification of the methodologies proposed in response to the results in the first phase of the project), and obtaining additional analytical findings, which among other things will help to refine and develop a qualitative understanding of the behaviour of innovation entities and thereby lead to the refinement and extension of the methodology. Phase 3 represents the connection and consolidation of the results of the first and second phases.

2 Conceptual basis of the methodology

The innovative potential of the economy for the purpose of this project is defined as ***the ability of a company to assert themselves on the global markets through innovation***. The assertion of a company on global markets is assessed through exports, both in relation to the overall turnover and in terms of the territorial structure. At the same time various different levels of market and technological positions of the company in relation to competitors are evaluated. This general definition of innovation potential provides further detail to the basis of the methodology.

2.1 Many forms of innovation

Innovation is a complex phenomenon that takes many forms. In order to create a methodology it is necessary to define innovation, although no universally accepted definition exists. In line with the British innovation "school", innovation is defined for the purposes of this project as a ***process of refining and replacing products and services, including the method of their production, sale and distribution*** (Tidd et al., 2003) [3]. The proposed solution takes into account the diversity of innovation. It works with basic distinguishing characteristics such as technical vs. non-technological innovation and it distinguishes between different types of innovation (product, process, business model).

Attention is paid largely to ***innovations, for whose creation research and development plays an important role***. Therefore, great emphasis is placed on distinguishing the level of innovations. The level of innovation is assessed both on an imaginary axis incremental - radical innovation, and in terms of the complexity of the product (sub-component -module – complex product). The key aspect is the advantage the given innovation brings to the company on the market. Depending on the industry and the situation of the company a lower level of innovation can bring a much greater benefit to the company than a radical innovation associated with significantly greater risks. We distinguish between innovation that gives a particular lead on of the competition and innovation that helps catch up with the competition. Related to this is an evaluation of the level of novelty (new innovation for: a company – a market of the company - the world). This distinction does not mean

[3] Tidd, J., Bessant, J. and Pavitt, K. 2005. Managing innovation: Integrating technological, market and organizational change, 3rd edition. John Wiley & Sons

that the role of innovation that has the character of catching up (imitation) with the competition is undervalued.

The implied diversity of innovation cannot be evaluated without primary data and updated information directly from companies. The contextually conditional economic benefit of the different forms of innovation cannot be obtained by analyzing secondary data but only directly within companies. For an adequate understanding of the innovation potential of the economy it is essential to identify both the areas and actors of radical innovation that are new to the world and understand the range of the approaches of different types of companies to innovation.

2.2 The company, the main unit of the analysis

During the INKA project innovation is treated the same as change (product, process, business model etc.), which validates the market through the monetary "voting" of customers. ***A technical solution (e.g. a prototype) is considered a part of the innovation that needs to be analyzed in the context of the entire innovation process of the company***. Thus, the proposed solution treats innovation as the source of a company's competitive advantage and thus a significant factor in the fulfilment of the objectives of economic policy, especially in the areas of economic growth and employment. The practice of many leading international companies has repeatedly shown that even the best technical solution alone is not enough in providing the commercial success of innovation. How the technical aspects of the innovation process fit into the overall strategy of a company and its ability to repeatedly find solutions to customer needs, for which they are willing to pay, are crucial.

The proposed methodology is thus based on a comprehensive evaluation of the innovation process as a whole; a process that starts on the market and also ends there. The company's ability to identify what to sell, to whom, and for how much is a critical basis of the innovation process. Companies standing in the forefront of technological and market changes intensively work with scenarios of future development in which market and technological trends are linked. These possible images of the future then represent a guide for targeting internal R&D activities. A company's investment in R&D and innovation is "only" a cost. Therefore, the analysis of the corporate innovation process ends back on the market, i.e. in performance and in particular export characteristics. Last but not least, a great deal of attention is paid to the issue of leadership and "corporate governance". The aims of owners and executives, including their interrelationships, are reflected in their overall aspirations and thus the innovation process of the company.

2.3 Rank-size hierarchy of companies in terms of innovation

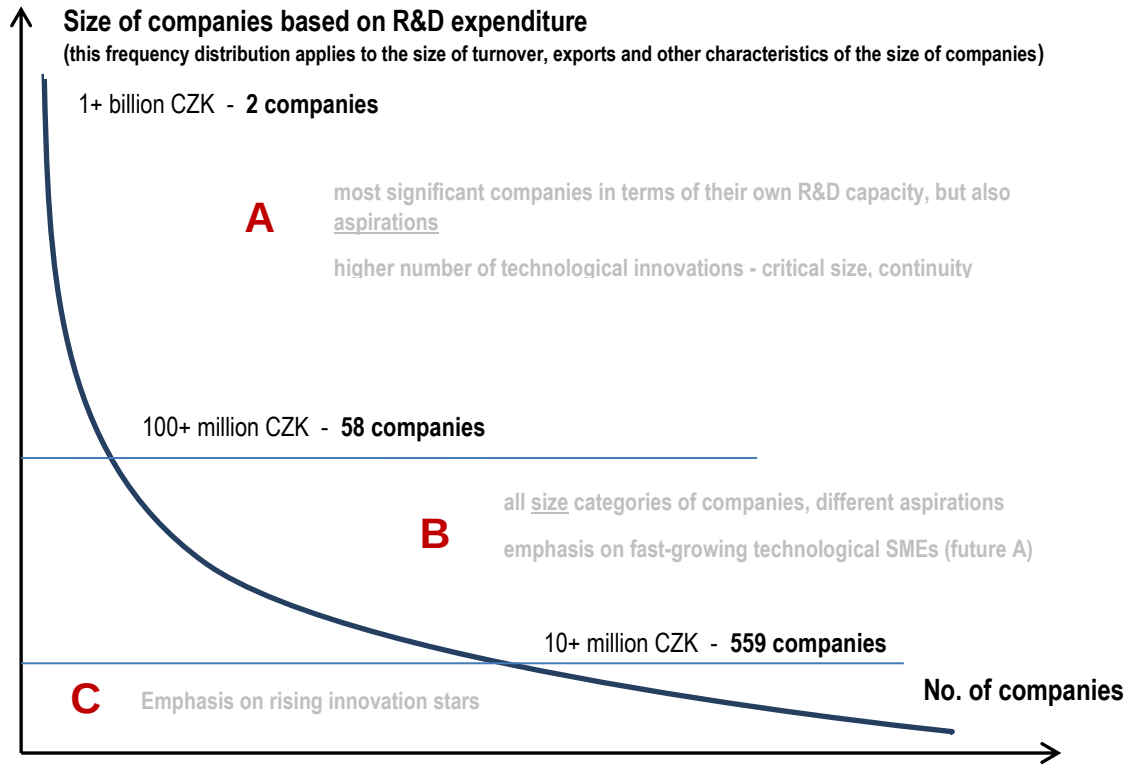
If a company is the basic unit of the analysis and the collection of primary data is only possible from a limited number of companies, a question arises as to the criteria for the selection of the sample companies. The proposed methodology is based on the distinction between two basic types of phenomena according to the statistical distribution of the frequency of their size characteristics (see Hampl, 1998)[4]. Size characteristics of most phenomena are concentrated on various degrees around the average. An example would be the height of a man, the price of hotel room or the length of a child jumping in the 8th grade. The sets of these phenomena - elements of a unimodal symmetrical frequency distribution (the Gaussian normal distribution) correspond to the size characteristics.

[4] Hampl, M. (1998): Realita, společnost a geografická organizace: hledání integrálního řádu. Praha, Karolinum.

However, the reality around us is made up of complex phenomena. Examples include cities, rivers, but also companies. A basic feature of these complex phenomena is their extremely asymmetric frequency distribution based on size characteristics. An example might be the size of municipalities in the Czech Republic - Prague one-million, five other cities with over 100,000 inhabitants and thousands of municipalities with fewer than 1,000 inhabitants. Likewise, the frequency distribution of companies based on turnover, exports and spending on research and development can also be regarded as being asymmetric (see Figure 1).

The principle of "many minimums – few maximums" represents the default element of the methodology for analyzing the innovation potential of the economy. This principle is illustrated by the fact that out of roughly 400,000 registered business entities only approximately 3,000 perform their own R&D activities. In addition, this principle can be represented by the finding that 10 companies with the largest R&D expenditure in the Czech Republic make up 39% of the total private expenditure on R&D in the economy. Put simply: ***if the main attention is on innovation, whose important input is represented by the results of R&D, it is necessary to focus on a relatively small part of the economy measured by the number of companies***. The results of validation analyses also showed that the relatively small number of companies has a significant development effect for the whole economy.

Figure 1: An extremely asymmetric frequency distribution of companies based on size characteristics



The sample set of companies for analysing the innovative potential of the economy mainly includes the largest companies based on their R&D capacity as well as fast-growing companies which establish their growth on the use of R&D for innovation. Further key criteria include the overall entrepreneurial aspirations and presence on global markets. Companies seeking leadership on global markets are more valuable respondents for analyzing the innovation potential of the economy than companies focused solely on imitating their competitors and optimizing their production or products

through the purchase of technology from other companies. However, this must not mean neglecting the situation and needs of the majority group of companies.

The principle of "many minimums – few maximums" is essentially included in the work of the founder of the theory of innovation, J.A. Schumpeter. He stressed that the assertion of more significant innovation is about "... overcoming the reluctance of most to adapt to the radical changes brought by innovators ... ..." (Schumpeter, 1934) [5]. The targeted selection of respondents during the collection of primary data is in accordance with the nature of innovation and considering the emphasis on higher levels of innovations associated with higher demands on internal and external R&D.

2.4 Systemic approach to innovation

Emphasis on the company as the basic unit of a research is connected to the systemic concept of innovation. The proposed methodology emphasizes the influence of factors that are external from the perspective of the company, but also affect the environment for innovation within companies. In this respect, the solution is based on the concept of a national innovation system (Cooke, 1992, 1998) [6]. This includes both a connection with companies in the framework of supplier-customer relationships and a connection with educational and research organizations. Finally, it takes into account the role of the level of knowledge and mechanisms for its dissemination through a shared labour market, the role of regulation and socio-economic factors such as behavioural patterns, etc. Considering the focus on innovation, whose significant input is represented by the results of research and development, special attention is paid to the relationship between research organizations and the application sphere, both public and private.

2.5 The economy as an evolutionary system

The national innovation system in a proposed methodology is set in a network of relations constituting the global economic system. Large multinational corporations, some of which have a turnover exceeding the GDP of many national economies, are the basis of the global economic system. These corporations control or indirectly affect production and value networks across national economies. At the same time, the environments of individual national economies offer various different conditions for the performance of various types of economic activities. In this respect, the Czech Republic is comparable with selected countries which are in various different stages of evolution. This is characterized after a certain degree of simplification as a gradual transition of economies from competitiveness based on the availability of cheap resources, through the stage in which the competitiveness is based mainly on efficient use of resources to competitiveness based on new knowledge and its role in innovation. The position of individual companies in these production networks and their arrangement are time-varying. These changes significantly affect the overall environment for innovation in the various national economies and the character of the evolution of the economy in terms of the predominant sources of competitiveness.

[5] Schumpeter, J. (1934): The theory of economic development. Cambridge, Mass, Harvard University Press.
[6] Cooke, P. (1992): Regional innovation systems: competitive regulation in the new Europe. Geoforum, 23, 365 – 82.

3 Presentation of the methodology for an analysis of the innovation potential of the economy

The basis of the methodology mentioned in the previous section leads us to the main questions that are examined simultaneously on three levels of detail (see Chapter 3.1):

1. What is the role of innovation as a source of competitive advantage of the Czech economy and how it is evolving?
2. What are the conditions and barriers to innovation in companies?
3. What is the structure of the national innovation system, how does it develop and what are the conditions of this development?
4. Which companies are the main actors of the national innovation system and what are their specific needs and problems?
5. In which sectors and product areas of companies from the Czech Republic do leaders who set trends and changes in the global market belong to?
6. What new (future) supporting specializations are dynamically developing in the economy?

The dynamic development of the global economy is accelerating, placing considerable demands on the timeliness of knowledge of the innovation potential of the economy. The proposed methodology therefore allows for cyclical updates of mapping and analysis of the innovation potential of the Czech Republic, including re-examining the validity of several of the underlying issues. The answers to these questions, supported by the evidence, represent an essential input for political decision-making about which market and coordination failures represent the current priorities to be solved by instruments of innovation policy. These preliminary questions are general and complex. Their answer is based on multi-level decomposition into sub-questions that can be answered through quantitative data or codified information.

3.1 The various levels of analysis

Mapping the innovative potential of the Czech economy involves a series of analyses carried out on three levels. Each level provides different information, which is interrelated in terms of answers to the initial analytical questions (see Chapter 3.2). The three levels are as follows:

1. **Macroeconomic level**

   The level is based on the available macroeconomic and structural statistics from both domestic and foreign sources. The analyses are aimed at creating a coherent macroeconomic framework for the assessment of (i) economic performance, (ii) knowledge intensity and (iii) innovative performance of the economy. At the same time they lead to knowledge of the development of economic structures relevant for a more detailed assessment of innovation potential. An example might be the export specialization or institutional structure of the national innovation system.

2. **Microeconomic – secondary sources**

   This level is thematically similar to the macroeconomic level; however, it works with microeconomic data (i.e. on individual entities or sub-groups of entities), which are not

always widely publicized. Microeconomic data for the purposes of this methodology represent information either about very detailed structures of the economy or targeted aggregation of individual data (e.g. exports to SITC 4-digits, size structure of companies with internal R&D capabilities in the relevant field defined according to NACE 3-digits, etc..).

3. **Microeconomic – primary field data**

   This is the most detailed level of the methodology, which is the heart of the whole methodological approach. To understand the innovation potential of the Czech economy it is essential to have a thorough insight into the internal corporate environment. Without reasonably robust knowledge of the conditions for innovation within companies it is not possible to sufficiently understand the behaviour of the NIS as a whole or the links between its parts (e.g. the interaction between companies and academic institutions). This is due to the important role of an individual actor, whose behaviour is influenced but not determined by the existing structure. Here this actor is the company[7]. Companies react differently to the workings of the same structure of the innovation system and thus this structure is gradually shaped and reshaped. Analysis at this level provides a basis for the assessment of important factors of innovation e.g. aspirations of a company to make leadership changes and their approach to managing their future performance, etc. One of the outputs of this section is a unique database of innovation bodies of the Czech economy containing this type of information.

When repeating the entire analytical cycle it is necessary to take into account the following methodological links between the different individual levels:

- ***The first (macroeconomic) part of the methodology*** serves as the primary, roughest level of knowledge of the state and trends of the national innovation system. However, it does not provide a detailed understanding of the structure of the national innovation system and in particular its causal justification. The findings obtained at this level should be seen as a basis for hypotheses and analyses at other levels. This level is therefore important for formulating the tasks of further, more detailed analyses, the results of which are used retroactively to correct or expand macroeconomic or structural (sectoral, etc.) analyses. At the same time, it is easier to perform an international comparison of the Czech economy at this level.
- ***The second part of the methodology***, based on microeconomic data from secondary sources, stands between macro-analysis and direct methods of data collection in the field (primary data collection). Additional information and the new or more detailed explanations it may bring - e.g. the internal structure of selected industries and their capacity to innovate in terms of volume and distribution of R&D capacity - can be added to the macro-analysis. At the same time the analysis carried out at this level is essential preparation for the field survey. It is an important source for the formulation of questions and the selection of themes which the field survey will focus on.
- ***The third part of the methodology,*** based on the primary collection of field data directly from entities of the innovation system, is a distinct and very important part. This helps obtain

[7] The roles of individuals within the company are taken into account to a reasonable degree. However, due to the objectives of the project the basic unit of action is the company not the individuals within the company.

unique information about the innovation environment and the behaviour of companies. This part provides a real understanding of what is hidden (the causes) behind macroeconomic, sectoral or otherwise aggregated data. In retrospect, this part of the methodology serves to expand and supplement the analysis performed in the previous parts.

The three levels of the methodology and analysis applied to the example of exports

The three levels of the methodology and analysis can be illustrated on a sub-theme analysis of export specialization, which we deal with on all three levels. The analysis of export specialization focuses on the determination and description of the capabilities of companies located in the Czech Republic to assert themselves on global markets, which group of companies (variously defined e.g. SMEs with high investment in R&D), what products or services are sold and on which markets, how do they develop their exports and how does this relate to innovation.

On a macroeconomic level the analysis is based on the context of the export performance of the Czech economy, as measured by the share of exports in the GDP of the Czech Republic. This is followed by an analysis, which evaluates the Czech export specialization by comparing the share of NACE sectors (in 2 digits) on Czech exports in relation to the corporate capacities measured by R&D expenditure. This analysis is then supplemented by a revealed comparative advantage index according to gross exports, according to the domestic value added and for selected sectors an analysis of the structure of exports in the given sector (in terms of development and in comparison with selected countries) according to the source of the creation of value added (imported, re-imported, created domestically by subcontractors and created domestically in the export sector).

This basic overview shows which sectors are important for the competitiveness of the Czech economy on global markets and suggests the role innovation plays in it and the important role of inputs in the form of R&D. It does not provide information about the internal structure of the sector or the character of the markets in which a company located in the Czech Republic trades because the selected sectors are too approximate.

On a microeconomic level based on aggregated data (in particular COMTRADE broken down into 4 digit SITC classifications) it is possible to get a better understanding of the more detailed structure of exports in the given sector. Here we can follow in which items the share of Czech exports in world exports of the given item is increasing, in which items the Czech Republic has a larger share of world trade with the given item than the average share of Czech exports in world exports, and in which items whose share of world exports is increasing is the share of Czech exports increasing faster than world trade with the given item. Put simply, in which growing global markets are Czech exporters succeeding to assert themselves. The analysis based on export items is made for groups of NACE (in 3 digits) and provides a detailed insight into the structure of exports of important sectors in the Czech Republic. In relation to knowledge intensity (private expenditure on R&D as a share of value added) it shows which groups in the given sector are successfully exporting and are most likely constituting their competitiveness on knowledge intensity and not merely cost-efficiency.

This analysis shows, among other things, in which sub-sectors or export items even outside the main Czech export sector successful groups of companies manifest themselves, and therefore in which sectors potential future growth can be sought.

On a microeconomic level based on field survey it is possible to describe in detail the character of the markets (small, mass, niche markets) in which companies located in the Czech Republic successfully (or less successfully) assert themselves, it is possible to monitor the geographical focus of exports (advanced economies, Eastern Europe and the CIS, the world ...) and it is possible to better (or at all) identify the processes and conditions leading to successful assertion on the markets and the role of innovation, research and development in them. Here, among other things, we deal with how the proximity to the technological leadership in the given field is associated with export success.

Only information from field surveys allow us to identify and analyze in what and on what markets companies successfully compete in global trade, what types of products or services they are able to sell, in which

production networks they operate and what is their position in the value chain. It also allows us to identify barriers that prevent companies from asserting themselves successfully on challenging global markets.

Each of the above-described levels of analysis provide different types of information, and only by linking all of this information together we can obtain a clear picture of the character of Czech competitiveness, its causes and its barriers.

3.2 Thematic areas of the in-depth analysis of innovation potential

This chapter briefly presents the content of the analysis of innovation potential in terms of thematic focus. At the same time it explains the fundamental links between the issues forming the tasks of the individual analyses and the thematic areas of the analysis of the innovation potential of the economy. These links are explained, in more detail, in the relevant chapters of the different methodologies and documented in the relevant analyses performed to validate the proposed methodologies. A basic overview is given in Table 1 (see below).

The text of this chapter is structured according to the themes listed in Table 1. These are further divided internally. How this division is performed and the logic behind the analytical questions is such a complex issue that requires a more detailed explanation than can be given in this brief overview of the methodology. Detailed explanations of each sub-methodology, their bases, the proposed procedures and analytical tools are included in the detailed methodological outputs of Phase 1, which are the main (though not the only) output of the project.

Table 1: Relationship between the preliminary questions and thematic areas of the evaluation of the innovative potential of the Czech Republic

INKA Project	Thematic areas of the in-depth analysis of innovation potential							
	Economic performance	The position of the Czech Republic in the global economy	Economic structure of the national innovation system	Innovation and performance in companies	R&D capacity of companies	People and skills for innovation	collaboration with companies in public research organizations	Framework conditions for entrepreneurship and innovation
Key questions								
What is the role of innovation as a source of competitive advantage of the Czech economy and how it is evolving?								
What are the conditions and barriers to innovation in companies?								
What is the structure of the national innovation system, how does it develop and what are the conditions of this development?								
Which companies are the main actors of the national innovation system and what are their specific needs and problems?								
In which sectors and product areas of companies from the Czech Republic do leaders who set trends and changes in the global market belong to?								
What new (future) supporting specializations are dynamically developing in the economy?								

1. Economic performance

This thematic area provides a framework for further analysis because the developments and changes in the knowledge economy and innovation-based competitiveness take place in the context of the development of the national and global economy. Partial analyses should therefore be put into the economic context and the results interpreted in this context. At the same time the preliminary analysis raises many questions to which answers must be sought in other thematic analyses, therefore the preliminary analysis is used to clarify the tasks of further work.

Economic performance is also evaluated because the purpose of innovation policy is to contribute to economic growth; therefore it is necessary to deal with both the growth itself as well as what creates the conditions/requirements for an increase in the role of innovation in it.

The preliminary analytical questions are:

- What is the economic performance of the Czech Republic in comparison with other countries and how is it changing?
- What are the sources of growth on a macroeconomic level?
- How does productivity develop in the context of the world economy or relevant countries?

The analysis compares the Czech Republic with a selected group of countries which are regarded as competitors (countries of Central and Eastern Europe), countries whose level the Czech Republic aspires to achieve, and also likely global competitors. If the Czech Republic is only slightly below average compared to the EU in terms of economic performance then in terms of productivity it is lagging behind more significantly. Therefore, the analysis in this theme (but in different parts of the analysis) also deals with the causes of the achieved level of economic performance and differences of its development in different countries.

The predominant source of competitiveness of the Czech Republic was (and probably still is) mainly cost-effectiveness, whereas elements of competitiveness based on knowledge are a source of future growth. A description of the initial conditions (e.g. an analysis of productivity) to strengthening knowledge-based activities in the economy provides a framework for more extensive analysis of the innovation potential in various other thematic areas.

Part of the theme of economic performance is the issue of the creation of sufficient jobs. Due to the dual nature[8] of the consequences of innovation for the labour market this is an important issue that should be included in a broader evaluation of the innovation potential of the economy. The proposed partial methods relate to the following questions:

- How many jobs are there in the economy and how does the ability to create jobs evolve over time?
- How does the scale and structure of the workforce in the Czech Republic develop?
- What is the ability of the Czech Republic to utilize its human capital?

[8] Innovation that optimizes existing activities leading to a gradual economy-wide decline in the number of employees needed to ensure the units of production of goods or services. In addition, innovation leading to the development of new, as yet unrealized, activities leading to an increase in number of employees. In the long term, this principle leads to a shift in the labour force from the primary sector, through the secondary sector (esp. industrial production), to the tertiary sector. A growing number of experts warn that the release of the labour force due to the increased efficiency of activities in all sectors is associated with a rise in unemployment because another sector of economic activity has yet to appear that would absorb the free labour force.

Methodological approach

The theme of economic performance is dealt with in detail in the macroeconomic analysis of aggregate data. This utilizes internationally comparable data on GDP and its real growth (GDP/per capita in PPS, GDP/per employee in PPS, annual GDP growth in %).

Sources of growth of economic performance in relation to the scale and structure of the labour force are measured using the demographic structure and its development, the age structure of skilled workers and its changes, an analysis of employment and economic activity, and the position of the Czech Republic in GCI in areas related to human resources (education, the labour market). The sources are data on the labour market, population development and the position of the Czech Republic in the GCI rankings (World Economic Forum).

2. The position of the Czech Republic in the global economy

This thematic area describes the extent and nature of links between local and global economies. The Czech Republic is a small, open economy and as such it is influenced by developments on global markets in a stronger way comparing to large and developed economies. Its ties to global markets are important for economic growth. At the same time the extent, form and nature of integration into the global economy:

(i) affect innovation companies (e.g. their position in value chains may hinder higher level innovation or product innovation, direct foreign investors and their global strategies affect the demand for innovation in the economy)
(ii) affect the structure and specialization of the economy (e.g. the ownership structure is influenced by the volume of FDI, which also influence the size structure of companies and their sectoral composition) and thus also affect the structure of the national innovation system
(iii) affect the competitive advantage of the Czech Republic through specialization and in connection with the nature of production networks affect the innovation behaviour of companies, their demand for innovation and preference of certain types of innovation
(iv) are one of the manifestations of economic attractiveness for investors, whereas the type of investors for which the economy is attractive or the type of investments/activities heading to the economy are just one of the indirect clues to the level of development of the economy.

Therefore, an analysis of the links that determine the position of the Czech Republic in the global economy, a description and analysis of the implications of this position form an important framework for the analysis of the innovation system and innovative behaviour of companies that are affected by their position in relation to global markets. At the same time, the development of the innovation system contributes to changes in specialization, changes in the structure of the economy, and thus changes in the position of the Czech economy in an international context.

This thematic area seeks to answer the following questions:

- What forms and to what extent is the Czech Republic involved in the global economy and how is the involvement of the Czech Republic changing? What is the nature of this involvement?

- What is the specialization of the Czech Republic in the global economy and how is it changing?
- How and why does the Czech economy differ from most advanced economies[9] in the world?

We monitor the position of the Czech Republic in the global economy through exports and their focus, based on the extent and nature of foreign direct investment and through analyses which can (often indirectly) be used to deduce the position of the country in global production networks (GPN), and the global value chain (GVC).

The importance of individual forms of integration into the global economy is determined by the stage of development of the Czech economy (predominance of production activities, the strong role of FDI, etc.), whereas a major role is played by preceding development, in particular the existing specialization and historical experience (e.g. the impossibility to conduct business prior to 1989). The economy of the Czech Republic is at the beginning of a gradual transition (structural change) from competitiveness based largely on the efficiency achieved with lower costs and an uptake of innovation (imitation) to competitiveness based on new knowledge and its application in innovation. The stage of development of the Czech economy, the dominant source of competitive advantage and the related specializations of the economy strongly affect the innovation potential of the economy. Therefore, we focus on the following issues:

- What is the level of development achieved by the Czech economy?
- What are the sources of competitive advantage of the Czech economy and Czech companies?
- Can we build even further on these resources? (How sustainable are they and what control do we have over them)?

Methodological approach

We monitor the method, extent and nature of the integration of the Czech Republic into the global economy through several sub-thematic analyses.

1. Analysis of exports and export specialization.

This analysis is performed with several levels of detail, which are sufficiently described in the example of multiple levels of analysis in the box in the previous chapter.

2. Analysis of foreign direct investment (FDI) and its development.

This analysis looks at the importance of FDI based on its condition and inflow in comparative economies, the development of FDI based on changes in the type of invested capital (equity capital, reinvested profit) and also based on its allocation among manufacturing and services. Field survey then focuses on the ownership of companies and its implications for corporate strategy, the ambitions of owners and how this manifests itself in the domestic economy and the links between the origin of the owners and innovation as well as the commercial behaviour of companies.

3. Analysis of the integration of the Czech Republic into global production networks and value chains.

[9] Defined as high-income countries according to World Bank methodology.

This analysis is primarily a matter of field survey; analyses based on secondary data have more of a supplementary character because although they allow a comparison of different economies it is not possible to reliably identify the causes of the differences between economies without further knowledge (e.g. Slovakia or Hungary have an average position closer to the end demand and are therefore higher in the value chain than the economies of Germany or Austria).

An explanation of the relationship between the position of the Czech Republic in the global economy, its partial analyses and characteristics and their relation to the innovation behaviour of companies, as well as a more reliable answer to questions about the nature and sources of competitive advantage can only be obtained from field survey.

The analysis of exports, FDI and the position in the GVC/GPN is projected into or combined with other analyses, thus linking this thematic area with other areas: e.g. the detailed analysis of selected sectors (analysis of economic structures) includes the importance of FDI in the given sector, the structure of the sector based on ownership, the (average) position of the sector in the GVC, the analysis of export specialization directly points to sub-sectors (NACE groups, NACE 3-digits) or to export items that make up a significant part of the exports of a given sector (NACE divisions, NACE 2-digits).

4. The position of the Czech Republic in international rankings

Part of the analysis of the position of the Czech Republic in the global economy (and competitive or comparative economies) and how this position changes, is an evaluation based on the rankings of competitiveness and innovativeness of the economy and their sub-elements. The Global Competitiveness Index (WEF), the Doing Business ranking for rating entrepreneurship and the business environment and the Innovation Union Scoreboard (IUS) for evaluating innovativeness of the economy and its context are used for the comparison.

This is a supporting assessment which has mainly a comparative significance, enabling a quick insight into the changes of the position of the Czech Republic. However, it cannot explain the causes of the changes in the rankings without additional knowledge and analysis. The analytical significance of this method of evaluation is therefore limited and its influence on planning may even be negative because concentrating effort on changing the values/indicators from which the position in the rankings is derived usually leads to avoiding of the complexity of the conditions of the national innovation system. In the methodology the value of this type of evaluation depends chiefly on the fact that it is a simple way of highlighting certain events or features whose better understanding should then be sought in further analysis.

3. Economic structure of the national innovation system

An analysis of the structure of the economy involves all parts and themes of the mapping of innovation potential and conditions that influence innovation potential in the Czech Republic. Structure is understood as not only sectoral structure and the internal structure of individual sectors, but also as the structure of companies based on ownership or size. Although a sectoral perspective is dominant, it is often supplemented or combined with other perspectives on the structure of the economy. Economic structure means the statistical distribution of companies or other entities based on features that significantly influence the innovation environment of a company or vice versa based

on features that infer the innovative character of a company, taking into account its affiliation to a certain category of companies.

Analysis in this thematic area is based on the following facts, which have been confirmed by numerous studies in recent decades:

i) Despite certain similarities in the management of innovation, the character of innovation and the innovation process differs considerably from company to company and across different disciplines (e.g. production of steel structures vs. medical equipment)
ii) The size of a company substantially affects the capacity and nature of investment in innovation
iii) Ownership of the company has an impact on strategic decisions and the way strategic decisions are influenced or controlled, on business behaviour, and directly or indirectly on the innovation processes within the company
iv) The set of companies in each economy has an extremely asymmetric distribution based on size characteristics (turnover, exports, spending on R&D etc.)

A comparison of the economic structures from the above-mentioned perspectives and their characteristics/features (e.g. creation of added value, exports, specific employment of R&D personnel, etc.) is the most common and most frequently used analytical technique, which has many different forms and this methodology also uses a wide range of analytical tools in many different partial thematic areas. Economic structure on the one hand affects the characteristics and behaviour of the entities of the national innovation system[10]. On the other hand, the behaviour of entities of the innovation system gradually transforms this structure and stimulates the dynamics of the whole innovation system. An example would be the decision of several large multinational corporations to develop (or extend) their R&D capacity in production plants in the Czech Republic.

On the one hand, detailed knowledge of economic structure and combinations of its features allows us to describe the innovation system and its framework and also to identify and explain its important and specific features, but on the other hand it is one of the sources for explaining its changes because it is a basis for understanding how the entities of the innovation system influence the economic structure.

Analytical questions related to economic structure therefore permeate the entire methodology and all of its parts. In this section we focus on the following questions:

- What sectors and specific disciplines are crucial for the performance of the Czech economy, how does their significance change over time?
- What is the internal structure of these disciplines and their interrelationships, and do they transform internally?
- What types of companies (large vs. small; controlled from the Czech Republic vs. from abroad; dynamically growing vs. undergoing restructuring etc.) make up the main disciplines?
- How does an assessment of economic structure affect the innovation potential of individual disciplines and thus the economy as a whole?

[10] This applies not only to companies but also to research organizations (RO). For example, the number of companies on the market as technology leader (or “attacking” this position) significantly affects the content of the demand of companies for research collaboration with local ROs.

The second and third questions in particular cannot be answered reliably without detailed information on the structure of the sector, and especially without a field survey of companies, as well as a detailed analysis of the sector. For example NACE 3-digit groups may still show considerable diversity, which can distort the resulting generalization. [11]

Methodological approach

Given the importance of a sectoral perspective, the analysis of economic structure focuses strongly on the specialization and character of selected sectors and thus is closely linked with the evaluation of the position of the Czech Republic in the global economy. The analysis of individual sectors and their internal structure and features represents the most extensive part of the analyses and a significant part of the methodology, because in addition to performing a framework comparative analysis to identify the key sectors each sector is analysed separately. Due to the different nature of the innovation process in various sectors, cross-industry comparisons are unsuitable or their suitability is limited.

The main analysis of economic structure utilizes a wide range of indicators based on the following main groups of features.

1. Employment, in which the overall share of the sector in employment in the national economy and in the manufacturing industry and their development, and employment of specific groups of workers, e.g. researchers or employees in ISCO categories 2 and 3, etc.
2. Creation of added value, where the share of the sector in value added in the national economy and in the manufacturing industry, and the structure of value added in exports, according to ownership and other characters.
3. Labour productivity and its international comparison, its development in terms of employees and the link between productivity per employee and average personnel costs.
4. Knowledge intensity, considered as a share of BERD in the given sector, the share of BERD in value added, etc.

A detailed sectoral analysis also takes into consideration non-investment expenditure on R&D, the size characteristics of individual sectors and others.

A comparison of the features of the economic structure, particularly in terms of knowledge intensity, should be carried out as an international comparison of the same sectors. This makes it easier to identify the position of the sector in terms of investment in the creation of new knowledge. The individual sectors inherently vary significantly depending on the intensity of R&D inputs for their innovation processes.

4. Innovation and performance in companies

[11] A typical example in the Czech Republic is NACE 26 Manufacture of computer, electronic and optical products. This sector includes the manufacture of computers and the manufacture of optical and electron microscopes as well as the manufacture of mobile phones and radar systems). Computers and mobile phones in the Czech Republic are assembled from imported components and their value added is very small (however computers represent one of the most important export items). On the other hand, in a certain group of electron microscopes the Czech Republic is at the forefront of developments and world exports and holds more than 20 % of the relevant market. A whole range of similar examples can be found.

This thematic area provides key information on how companies approach innovation as a source of their competitive advantage. In accordance with the basis of the methodology we focus on the interaction between companies and their specific markets. The internal innovation process of the company is evaluated in relation to the company's market position and its strategy. The innovation process also includes corporate leadership aspirations. These are in fact a virtual source of energy and they are a driving force focusing the entire innovation process.

Knowledge of the internal environment of a company is essential for understanding both innovation barriers and interactions between the internal company environment and its surroundings, changes in which (e.g. collaboration network with RO) target interventions in innovation policy. Without knowledge of this environment it is not possible to adequately understand the different reactions of companies to the effects of the same environment. An example could be completely opposing views of companies from the same sector and region on the availability of skilled workers.

Great emphasis is placed on distinguishing the different forms of innovation and assessing their importance for the growth of companies. The relationship between different forms of innovation and their impact on company performance is seen as a variable depending on the specific situation of the company. This procedure helps avoid making sweeping conclusions about innovation.

Basic analytical questions for this thematic area are as follows:

- What is the current environment for innovation in companies in the Czech Republic and what factors transform it?
- What are the main perceived barriers to innovation and strengthening the competitive position of companies on the markets?
- What are the causes of these barriers?
- What are the types of companies in the economy in terms of attitude to innovation?

A survey among companies represents a key source of information for the analysis allowing us to answer the above questions. This is qualitative research aimed at identifying the different ways in which different companies in different industries approach innovation. The set of companies and the proposed methods of analysis are based on an extremely asymmetric distribution of companies according to their size characteristics (see the basis of the methodology). Therefore, focus is on companies that are in Czech terms large R&D investors. At the same time, the selection is connected with the results of the analysis of export specialization by determining the minimum share of companies from selected disciplines.

Methodological approach

An evaluation of the innovation environment of companies reflects the concept of innovation as a process that begins and ends on the market. As in other thematic areas, we combine analyses based on secondary data with data and information that can be only obtained by field survey; ***in this thematic area, however, field survey is dominant, whereas the analysis of secondary data represents a context that in some cases may be misleading*** (e.g. the results of the Community Innovation Survey).

1. The main sources of information for the analysis were therefore interviews conducted in companies and their subsequent analyses, which have the following content:

- Character of products and the company's market position
  This part leads to knowledge of the target markets, customers, and uses of the products or their alternatives. At the same time the aim is to identify the key milestones in the development of the company and their implications for the current focus of the company and its innovation process. This information is important for understanding the subject of competition, which is then linked to the issue of the technical competence of the company.

- Vision and strategy
  The basis of the innovation process as a whole is business aspiration. This is examined both in terms of growth of the company and its market position. In the case of growth, the various corporate growth characteristics (e.g. profitability vs. turnover and employment) are distinguished. In the case of the company's market position, we investigate the achieved position and aspirations in terms of leadership changes on the world market - e.g. changes in both markets and technologies. Subsequently, we examine the specific ways the company wants to fulfil their aspirations.

- Sources of competitive advantage
  Corporate strategy should be based on specific sources of competitive advantage. These sources of advantage have their causes - specific processes or competencies of the company. Competence of the company means the ability of groups of people within the company to achieve a specific result. The competence of individuals is therefore only a partial source of the competence of the company. Processes, management and internal forms of collaboration that generate competencies of the company are important.

- R&D and its role in the innovation process
  In the area of research and development attention is focused on the balance between technical and non-technical competencies as well as the R&D process itself. This balance means whether and how the technical aspects of innovation (development, design and production) are linked with activities focused on defining what, to whom, where, when and for how much the company will sell. In the case of R&D the analysis is focused on capacity, specialization and collaborative networks.

- Human resources
  Last but not least is an assessment of barriers in the field of human resources. Here we distinguish between the barriers on the level of the various functional departments of the company. Sources of the innovation culture and endeavour are also determined.

2. Analysis based on aggregated secondary data

At the level of analysis of aggregated macroeconomic data, a standard comparative analysis is performed both in terms of multi-criteria assessment of the innovativeness of the economy (e.g. data from the Community Innovation Survey, employment in the high-tech sector, number of employed R&D workers) and in terms of sectoral specifics (e.g. detailed analysis of export items by COMTRADE in SITC 4-digits and compared with the knowledge intensity of NACE groups, private non-investment expenditure on R&D in a detailed sectoral breakdown).

5. R&D capacity of companies

The R&D capacity of the business sector is an important area, according to which it is possible to evaluate the development of the knowledge economy in the Czech Republic. Although R&D capacity is only an input to the innovation process, it is the most measurable variable of the innovative process on all levels of analysis. The theme therefore permeates the whole analysis of the innovation potential of the Czech Republic, i.e. parts of the analysis on aggregate data, analysis of microeconomic data and field survey. The R&D capacity and its use in the business sector are therefore assessed on the level of the whole economy (and in an international comparison) as well as in each individual sector and their parts (NACE subgroups) and individual companies.

a) **Evaluation of the capacities for corporate R&D (especially human and financial) focuses only on an analysis of the potential of companies to carry out research and development. The main issues examined include:**
   - How intensively does the Czech Republic invest into the creation of new knowledge (and how does the private sector contribute)?
   - How does investment expenditure on R&D develop in various sectors of the Czech economy?
   - Which sectors and disciplines show the highest increase in the employment of research workers?

b) **Evaluation of the significance of corporate R&D for achieving the objectives of companies.** Here we focus on the evaluation of the relationship between R&D capacity (and therefore the knowledge intensity of companies), the economic performance of companies, and their market and technology position. The main questions include:
   - What are the links between the knowledge intensity of companies and their economic performance?
   - How do the needs, scope and nature of corporate R&D capacity differ in relation to corporate aspirations and their approach to innovation?
   - What link does the knowledge intensity of companies have to their business aspirations?

c) **Evaluation of the barriers of companies in the area of R&D capacity** analyses the barriers that restrict companies increasing the knowledge intensity of their activities and using it to achieve their business objectives. The main questions include:
   - What barriers do companies face in the development of internal R&D capacity?
   - What barriers do companies face in the development of external R&D capacity and how do they overcome them?
   - Does public support for R&D contribute to increasing the knowledge intensity of companies?

Methodological approach

Answers to these questions are obtained by combining the outputs of the following analyses:

1. Comparative analysis of expenditure on R&D and human resources in R&D
   A detailed comparative analysis of the Czech Republic, EU countries and selected countries outside the EU was performed based on data and indicators of OECD (MSTI Database) and Eurostat (Science and Technology Database) and the use of international multi-criteria indexes (e.g. IUS). Emphasis was placed on the overall characteristics of the knowledge

intensity and characteristics which allow us to analyze the internal structure of the R&D capacity.

2. Analysis of the specialization of corporate R&D capacity
   Subsequently, more detailed data from the CSO was used to perform an analysis of the concentration and structure of corporate R&D capacity at different levels of detail according to the NACE classification of economic activities. This analysis went in to such detail that at the level of subject groups the size structure of private investors in R&D was identified.
3. Evaluation of qualitative data from the surveys of companies
   Using the information from the interviews with companies we conducted a thematic analysis of the barriers and their causes in the development of corporate R&D capacity. Part of this analysis was also an evaluation of the external networks of collaboration.

6. People and skills for innovation

People are a key component of innovation capacity both on a company level and the entire economy. The availability and quality of human capital can be a factor that enhances the innovative capacity of companies and their competitiveness and also hinder their growth and success on the market.

In this context, it is necessary to focus on two themes. The quality and availability of human capital in the economy is significantly affected by the education system. This is also an important context of the innovation performance of the country. It is important to assess its overall quality in an international comparison, and also how it prepares young people for future careers in technology- and knowledge-intensive occupations. The education system has an important role in shaping personal aspirations and the motivation of individuals.

The evaluation of the quality of the education system is a theme for a separate project. However, when assessing the innovative potential of the economy it cannot be avoided. Taking into account the depth of the analysis it is based on the following questions:

- What is the quality of the education system?
- Is the quality of STEM education internationally comparable?
- Does the education system provide its graduates with the knowledge and skills necessary for business?
- Does the education system arouse the interest of its graduates in business?

This part of the evaluation is not an in-depth analysis of the education system. It deals with selecting themes and relating them to the NIS, of which the education system is an integral part. In order to answer the questions we use mainly macroeconomic data and data from specific international surveys that allow us to evaluate the quality of the education system through the knowledge and skills that the population acquire during early education. An important task of education is to arouse interest in the various areas of knowledge, including an interest in business, which is important for the implementation of innovation.

At a company and economy level it is then necessary to determine what is the availability and quality of people who are vital to innovation and development - both in an international comparison and across different sectors of the Czech economy. Great emphasis must be placed on assessing the

perspective of the company - whether they perceive barriers in this area and what needs to be addressed as a priority.

The evaluation of the human capital necessary for innovation is based on the following questions:

- Is the Czech Republic competitive relative to reference countries in terms of the population's access to tertiary education?
- Does the sectoral structure of tertiary education meet the needs of an innovative economy?
- What is the international position of the Czech Republic in terms of the availability of researchers and engineers?
- Is the Czech Republic attractive enough for the highly educated population?
- Does the Czech population have enough confidence to start a business?

Methodological approach

To determine the role of the availability and quality of human capital both on a company level and in terms of the entire economy it is necessary to use both quantitative and qualitative methods.

1. The broader framework of the international position of the Czech Republic

In this case, the questions are answered mainly using secondary data, either from statistical studies or publications that are issued on the basis of international studies. Analyses are focused on data on the quality of the education system and the situation on the labour market. For comparison we use existing comparative analyses like the Global Competitiveness Index (availability of experts, productivity, brain drain/brain gain, etc.), specific studies on e.g. the quality of the education system, such as PISA (the level of functional literacy of students in different countries etc.) and data sources like OECD and Eurostat which analyze the position of the Czech Republic in terms of demographic trends and the effectiveness of the use of human capital.

2. Evaluation of the knowledge intensity of the Czech economy and its sectors in terms of human capital.

These analytical tools also rely on quantitative analysis based on secondary data from statistical surveys. They focus on monitoring trends in the employment of researchers and highly qualified professions and on an analysis of productivity across sectors and in an international comparison.

3. Human resources as a factor in the technological advantage of Czech companies.

In this case, mainly microeconomic data is used, which allows for a deeper insight into the sectors that attract the most highly qualified professionals. Furthermore, an analysis is performed showing the extent to which the aging population poses a threat to the availability of these highly qualified professionals.

4. The basis of qualitative methods is field survey.

The field survey focus on identifying the main causes that restrict businesses from developing innovative processes and internal R&D activities, on determining the meaning in this context is attached to the issue of human capital and on describing the links between the nature of the competitive advantage of companies and the competencies that companies need to develop the most in this context.

7. Commercialization and collaboration with companies in public research organizations

One of the main global trends in the management of innovation in companies is the ever increasing interaction of the internal innovation process with diverse actors outside the company. An important type of external partner for a number of companies is represented by public research organizations or researcher workers from these organizations. The aim of the thematic areas of *commercialisation and collaboration with companies in public research organizations* is therefore to obtain credible information on:

1. What is the role of research organizations in the innovation process of companies?

   The subject of investigation is the variety of forms of collaboration. The various forms of collaboration reflect the different needs of companies and the objectives of research organizations. Emphasis is placed on the role of public research organizations. The method of investigation of this issue reflects the fact that the need for external collaboration with public RO in the field of innovation is heavily concentrated on technology companies with a certain level of innovation aspirations.

2. What are the barriers to collaboration and knowledge transfer between the academic and the commercial sectors?

   Examining barriers relates to the various forms of collaboration and commercialization of research results. Special attention is paid to the conditions under which actors with different missions and objectives find a common interest to collaborate.

Knowledge of the extent of the various forms of collaboration and their specific barriers is a prerequisite for establishing effective instruments to support collaboration in research, development and innovation. The public sector has a range of instruments for stimulate innovation through public ROs. These targeted instruments are therefore an integral part of the innovation policy of all developed economies.

Methodological approach

Sufficiently specific answers to the two questions above can only be obtained by combining qualitative and quantitative methods. The source of data of the qualitative analyses is field survey both in companies and research organizations. The qualitative analyses focused on knowing the problems and understanding their causes are embedded in a broader framework through a comparative analysis of the Czech Republic with selected OECD or EU countries. The following analyses were performed to obtain answers to these questions:

1. Comparative analysis of the extent of collaboration between companies and the academic sector in the Czech Republic

   The aim of this analysis is to understand the extent of external collaboration in the field of innovation, in particular where partner companies are public research organizations. The following four groups of indicators are used for the comparison based on data from the OECD MSTI Database, Innovation Union Scoreboard and Community Innovation Survey:

   (i) The share of small and medium-sized enterprises collaborating on innovation from all SMEs; the share of enterprises with external R&D capacity. This is used to compare the external

collaboration of companies in the field of innovation and also what part of this collaboration is attributable to R&D.

(ii) The share of companies collaborating on innovation with universities; the share of companies where universities are the most significant collaboration partners for innovation. These indicators are linked to those of the previous group and show the extent to which universities are external partners. This procedure indicates the extent and intensity (the most important partner) of collaboration with public ROs.

(iii) The share of expenditure on R&D in the higher education sector (HERD) funded by companies; the share of expenditure on R&D in the government sector (GOVERD) funded by enterprises. Another way to show the extent of collaboration of companies with public ROs in the field of R&D. At the same time it is possible to compare the importance of basic types of public ROs.

(iv) The number of scientific publications (with the authors from companies and academic institutions simultaneously) per million inhabitants. Collaboration in R&D has many forms and is routinely irregular in nature. This indicator can be used to compare countries based on the extent of such collaboration in R&D, which has a long-term nature and therefore the greatest potential for collaboration on new and unique knowledge or technologies.

2. Analysis of the forms of collaboration and commercialization of research results of public ROs

   The aim of this analysis is to explore in more detail the various forms of collaboration, identify the specific barriers to the various forms of collaboration and understand their causes. The relation between the motivation of individual participants and the forms of collaboration is also examined.

The obtained results provide valuable insight and develop knowledge obtained from the above-mentioned comparative analysis. The types of barriers related to various forms of motivation and types of partners provide an appropriate guide for setting targeted instruments for supporting collaboration in R&D.

8. Framework conditions for entrepreneurship and innovation

This analytical part is focused on an evaluation of the international position of the Czech Republic in terms of the quality of selected factors affecting the business environment. A favourable business environment is important for the implementation of innovation in existing companies, but especially for the implementation of innovation through the establishment of a new company. It affects not only the overall competitiveness of the economy but also innovation. This analytical part was included the same as for the issues of education because it is an integral part of the NIS. However, it is an issue whose detailed analysis should be subject to a separate project. The outputs of this thematic area therefore serve to warn and demonstrate the significant influences of framework conditions for entrepreneurship and innovation. Therefore, it is not a detailed analysis of this theme as such.

The analytical part addresses the following questions:

- What is the international position of the Czech Republic in terms of the ease of doing business?
- What are the main obstacles to doing business?

Methodological approach

The basis for answering the questions is an index for the ease of doing business, which assesses the quality of the various factors affecting the companies and helps identify the factors that represent the greatest disadvantage of the Czech Republic in an international comparison. The analysis also includes indicators of "fear of failure and confidence in one's own abilities" and "share of the population in the early and stabilized stages of doing business" using data from the Global Entrepreneurship Monitor (GEM).

3.3 Thematic areas of the analysis of innovation potential and their projection into the chapters of the methodology

Table 2 provides a summary of the links between thematic areas of the evaluation of the innovative potential of the Czech economy and the chapters of the three levels of analysis and their respective methodologies. Sufficiently information-rich answers to the analytical questions can only be obtained by connecting the sub-analyses across the themes and the three levels. The three levels and synthetic answers to the questions in the chapter "The main findings from the analyses" are connected in a summary form.

The description of the thematic areas of the detailed analysis of innovation potential describes the links between these areas and the sub-methods and analyses, which helped to answer the main analytical questions. It should be noted that the nature of these links has changed over time depending on the development of the global and national economies. This then changes the relationship between the evaluated economic structure and its impact on the company. ***Therefore, the initial step is to perform an in-depth analysis verifying the basis of the methodology and main relationships on which the individual methods are based.*** Any change in these assumptions could result in a modification of several of the analytical questions or a change in their weight, and thereby a shift in the emphasis on the sub-themes and relationships in the national innovation system when interpreting the results.

Table 2: Links between the chapters of the methodology and the thematic areas of the analysis of the innovation potential of the Czech economy

INKA Project		Thematic areas of the in-depth analysis of innovation potential							
		Economic performance	The position of the Czech Republic in the global economy	Economic structure of the national innovation system	Innovation and performance in companies	R&D capacity of companies	People and skills for innovation	Commercialization and collaboration with companies in public research organizations	Framework conditions for entrepreneurship and innovation
	Chapter (of the methodology and analysis)								
Macroanalysis	Development of the international economic position of the Czech Republic	■	■						■
	Context of the international position of the Czech Republic	■	■						
	Knowledge intensity and innovation of the Czech economy		■			■			
	Specialization of the Czech economy	■	■	■		■			
	Context of the specialization of the economy	■	■				■		
	Specific sectoral analysis			■					
	Innovation and outputs of innovation activity				■				
	Czech R&D capacity in an international comparison		■						
	Collaboration in R&DI				■			■	
	Further assumptions of the Czech Republic for the development of a knowledge-based economy		■				■		■
Microanalysis	Export performance – main product groups	■		■					
	Structure of the Czech manufacturing according to NACE classification		■			■			
	In-depth analysis of private expenditure in R&D					■			
	In-depth analysis of selected sectors			■	■	■			
	In-depth analysis of the outputs of public R&D capacity							■	
	Analysis of collaboration in the main areas of knowledge and main disciplines							■	
	Analysis of the links between knowledge intensity and company growth					■			
	Knowledge of the Czech economy in terms of HR					■	■		
	HR as a factor of technological advantage of Czech companies						■		
Field survey	Business aspirations and company objectives			■	■	■			
	Markets and clients			■	■				
	Sources of competitive advantage			■	■	■			
	Barriers to companies in the area of human resources				■	■	■		
	Technology position, capacities of R&D in firms, RTD collaboration				■	■		■	
	Public support of R&D in companies					■		■	

4 Analytical part: recommended use of the methodology as a whole

The proposed methodology for mapping the innovation potential of the Czech economy is based on a four-year analytical cycle, whereby an in-depth analysis of the NIS is conducted once every four years. This is connected to monitoring, targeted analysis and supplementary data collection on subjects of the NIS conducted in the intervening period (see Figure 2 below).

Figure 3: Structure and course of the four-year analytical cycle of mapping the innovation potential of the Czech Republic

MAIN ACTIVITIES		*ACTIVITY*	*MAIN OUTPUTS*
YEAR 1	IN-DEPTH ANALYSIS OF NIS	Analysis of macroeconomic and aggregate data → Analysis of microeconomic and individual data → Collection and analysis of primary data (field survey)	In-depth analysis of NIS Monitoring of NIS Database of innovation profiles
YEAR 2	MONITORING OF NIS	Continuous updating of data on selected indicators (optional as needed) Updating data in the monitoring system, analysis and evaluation of changes to the NIS Partial thematic analysis (optional as needed)	Short update report Monitoring report Thematic analytical reports
	DATABASE OF COMPANIES	Updating data of exiting companies in the database (ongoing) Addition of companies to the database – supplementing the database (ongoing) Selection of samples for thematic analysis (as needed)	Updated database of companies
YEAR 3	MONI – TORING OF NIS	*Repetition of the activities of year 2* *taking into account the actual need for partial thematic analysis*	*Repetition of the outputs of year 2*
	DATABASE OF COMPANIES	*Repetition of the activities of year 2*	*Repetition of the outputs of year 2*
YEAR 4	MONITORING OF NIS	*Repetition of the activities of year 2* *taking into account the actual need for partial thematic analysis*	*Repetition of the outputs of year 2*
	DATABASE OF COMPANIES	*Repetition of the activities of year 2*	*Repetition of the outputs of year 2*
YEAR 5: NEW CYCLE	IN-DEPTH ANALYSIS OF NIS	Update of the task for the in-depth analysis on the basis of monitoring results → Analysis of macroeconomic and aggregate data → Analysis of microeconomic and individual data → Collection and analysis of primary data (field survey)	In-depth analysis of NIS Up-dated monitoring of NIS Up-dated database of innovation profiles

The length and structure of the analytical cycle was chosen to reflect substantial changes in the NIS, the functioning and structure of which are based on evolutionary development in relation to the global economy, but seldom change abruptly. Outputs of the in-depth analysis serve for the strategic management of national innovation policy or the individual instruments of the policy. At the same time, the analytical cycle includes activities carried out each year, whose purpose is to update the information needed for the operational management of innovation policy instruments. The four-year cycle of the analysis includes the activities described in the following sub-chapters:

4.1 In-depth analysis of the NIS

The purpose of the in-depth analysis is to provide detailed knowledge of the current state and dynamics of changes in the national innovation system of the Czech Republic. The outputs include strategic information prepared for use for the design of the innovation policy as a whole and the individual instruments, especially aimed at supporting research and development in companies and innovation. The outputs also include thorough knowledge of the individual characteristics of the main innovation actors. The in-depth analysis represents a knowledge base for subsequent analytical activities performed over the four-year analytical cycle.

The in-depth analysis is performed once every 4 years. The first in-depth analysis is part of the verification of the presented methodology and its structure and content are described in more detail in Chapter “3.2. Thematic areas of the in-depth analysis of innovation potential”.

4.2 Monitoring of the NIS.

The in-depth analysis is followed by monitoring of the development of the NIS. Its purpose is to apply the knowledge and conclusions of the in-depth analysis to monitor how the NIS and its sub-components develop, whether and how the described and analysed trends transform in the in-depth analysis, and whether there are sudden and unexpected changes that require ad hoc thematic analysis.

The monitoring is performed annually. It results in a ***monitoring report*** containing the analysis using a limited number of monitoring indicators describing the NIS across the main thematic areas of the analysis. The monitoring system can indicate the need for interim or short thematic **update reports** depending on the development of the indicator values. This is in response to a substantial acceleration/deceleration or change in trends of the monitoring indicators.

The monitoring also includes a ***targeted thematic analysis***, whose aim is defined by the main analyst or project manager in relation to the results of the monitoring or based on the interest of the user of the methodology in certain new themes or a more detailed insight into an existing theme. This analysis, unlike the short/update reports or outputs, does not only use data of the monitoring system of the NIS but more detailed data are collected on an ad hoc basis, based on the choice of the relevant themes.

The thematic analysis cannot be predicted or planned in advance.

Maintenance, updating and supplementing the database of companies is part of the monitoring of the NIS and is carried out continuously during period between the in-depth analyses. The database includes the main actors of the NIS and dynamically growing technology SMEs that are becoming

major players in the NIS. The database serves as a source of factographic data for operative management of instruments of the innovation policy. At the same time, it is a resource for the selection of subjects for performing the field survey in the framework of the subsequent in-depth analysis. The database can also serve the management of the contracting authority as a tool for communication with the main actors of the NIS. This communication is also a source for the continuous updating of information about the companies in the database.

The first version of the database is the output of the verification of the methodology for the collection of primary data; it currently contains 174 entities of the innovation system with companies and research organizations being in an approximate ratio of 4:1. The database will be further expanded in Phase 2 of the INKA 2014+project, which is currently ongoing.

The database created at the end of Phase 1 of the project is unavoidably limited due to the number of interviews conducted but it is a good basis for further additions that are currently being made in Phase 2 and will lead to the database of entities representing over 50 % of the volume of the business R&D capacity.

Updating the database means adding information on entities that are already in the database. ***Supplementing the database*** means adding other newly emerging and verified entities to the database. ***Database management*** means its maintenance, access control, data protection, creation of partial results and ad hoc analytical information etc.

4.3 Database of companies and its supplementing

The previous chapter describes the purpose of the database of the main actors of the NIS and dynamically growing technology SMEs. This section adds some relevant information concerning its content and management.

It is stated above that the inclusion of companies into the database should only be done on the basis of thorough knowledge of the company. This means either knowledge gathered through in-depth interviews or repeated personal meetings between the database administrator and the management of the given company. The inclusion of the company on the basis of numerical values (secondary data) is not recommended. The sizeable number of interviews conducted to-date has shown that even subjects reporting high R&D expenditure may not be suitable representatives for obtaining the necessary primary data. Examples may include shared IT service centres of multinational corporations and some private companies focused on providing R&D services whose economy is built on a considerable volume of subsidies for R&D, without which the company would collapse economically.

We recommend that the database includes only companies that not only have technological capacities but also the ability to defend or expand their position on global markets. The inclusion of companies with internal R&D but without adequate market competence would lead to a distortion of the required information obtained during the in-depth and thematic analysis and information gathering, which does not correspond to the actual situation on the markets and in companies that are an integral part of the global economy and have such aspirations (e.g. start-ups).

The database is supplemented in two steps:

- In a first step a company is identified from the sources listed below, which is a potentially interesting subject of the innovation system. Mainly basic quantitative data is collected and the company is included in the list of companies.
- In the second step, if further (usually unpublished) quantitative data has been collected and ***particularly qualitative data has been gathered***, it is possible to include the company into the database and work with it.

The extent of data that must be obtained before the company can be included the database must include at least the information about target markets and the position of the company on them, the position in GPN and the character of the product. It is better if you also obtain (even indirectly) information on the ambitions, objectives and aspirations of the owners.

5 The main findings of the analyses

5.1 The international position of the Czech Republic and the importance of foreign direct investment

The economic performance of the Czech Republic is decreasing. This is primarily based on high employment rather than higher productivity. According to the OECD classification the Czech Republic is a middle-income country (based on GDP per capita measured in purchasing power parity). In a European framework we belong among the top performers in this class (85 % of the average EU-28) but we are lagging far behind the most developed countries (e.g. Austria, Belgium, Germany). In recent years (since 2008) our pace of catching up has slowed significantly and escalated until we have gradually lost position. Many less developed economies (e.g. Slovakia, Estonia, Chile), however, have accelerated in catching up with the Czech Republic. Our position is relatively worse in terms of GDP created by employed persons in the economy, which shows that our current economic performance is due more to the employment rate (one of the highest in Europe) than labour productivity (65 % of the average EU-28, below the values of Portugal and Slovakia).

In foreign trade we currently compete internationally mainly due to "partnerships" with foreign direct investors. Our strong economic performance is conditioned by exports (in the Czech Republic value added from exports represents 35 % of GDP). This is comparable with close competitors (Hungary, Slovakia, Slovenia) and slightly higher than in developed countries (Germany, Austria), suggesting the lower importance of challenging demands on the domestic market and the competitiveness of our outputs on external markets. The export performance of the Czech economy is mainly due to a combination of a skilled labour force located in the imaginary centre of the European market, on the edge of a large cost differential (the cost of skilled hours in Germany and further west vs. the price of skilled hours in the Czech Republic and further east). This strategic advantage has helped us enter into partnerships with foreign companies that provide capital and technology, but also access markets and build relationships with customers. Several endogenous companies have managed to assert themselves on demanding international markets; however, there is not a substantial number in the framework of the whole economy. These companies are often focused on supplying other manufacturers not end markets, even if a number of exceptions can be found. In order to be ranked among high-income countries (according to the OECD categorization)

we would require further substantial strengthening of the segment of companies that are able to assert themselves on the global markets without the aforementioned "partnerships" with foreign companies with established markets and access to customers.

In the overall assessment of the conditions for competitiveness we are significantly losing (a drop from 32nd to 46th place in the GCI over the last five years). Over the last five years, we have been surpassed in the GCI by Turkey, Malta, Poland, Kuwait, Bahrain, Azerbaijan, Indonesia, Thailand, Oman, Brunei, Mauritius, Panama and Puerto Rico. In contrast, Germany has strengthened its position, so now the Czech Republic borders the 4th most competitive economy in the world. Economic development in Germany also significantly affects the development of the Czech economy. We are doing the worst in the quality of institutions, labour market efficiency, and the ability to attract and retain talent. The slight improvement seen in the current WEF rankings cannot be evaluated as changing trend[12]. From the reference countries New Zealand worked the hardest during the monitoring period on conditions for competitiveness. The economies of the Czech Republic and New Zealand in terms of the motivation to create framework conditions for entrepreneurship, competitiveness and knowledge activities, should be compared in the context of the existence (CZ) or absence (NZ) of a large cost-attractive market (with a notable difference in the price of inputs and outputs) on the boundaries of the given economy.

The economic slowdown can mainly be explained by the fact that we have exhausted the possibilities of growth based on employing more people in "manufacturing for Europe". In the period 2000-2007 there was an increase in the share of employment in manufacturing at the expense of the service sector. Even in 2012, our share of employment in manufacturing was the highest in Europe (25 %). Our workforce, especially those qualified in fields important for our economy, is aging and we are creating fewer jobs for foreigners. According to the index of aging we are among the countries with a demographic risk. Therefore, we have a higher rate of employment in general compared to the EU and high employment in industry which pulls our economy, draws foreign investment, and creates the positive contribution of foreign trade to GDP. Technological and market trends like the ongoing industrial automation and the gradual "return" of production to developed countries (though industry-selective) will further intensify the pressure to optimize processes and a large part of innovation will lead to a reduction in the number of jobs. To maintain long-term growth of the Czech economy it will be increasingly important, in addition to manufacturing for Europe, to strengthen segments of the economy which develop, manufacture and market throughout the world.

5.2 Knowledge intensity of the Czech economy

Knowledge intensity of the Czech Republic (R&D expenditure/GDP) is **below average** and corresponds to our position in economic performance. Although our share of public expenditure on R&D on GDP even outpaces some of the innovation leaders (Canada, United Kingdom, Japan), in private expenditure on R&D we have substantial reserves. In addition, private expenditure on R&D in the Czech Republic (16 % - the highest of any OECD county) mainly comes from money redistributed

[12] Improvement in GCI is primarily due to improvements in the pillars of institutions, the macroeconomic environment and financial markets, in which there are indicators in which the Czech Republic has moved up approximately 50 places in the rankings. This improvement is probably associated with government austerity measures taken in recent years; the legal environment is better evaluated.

by the public sector. Various indices measuring innovation performance place us slightly below average in terms of the monitored countries of Europe (SII) and the world (a new composite indicator of outputs of innovation activities) with slightly below-average growth. We have European primacy in the share of employees in high-tech and medium-tech industries in total employment, which may look good, but the classification of technological demands of the sector does not reflect innovation activity and the contribution to economic performance and growth (see the importance of sectors classified as low-tech for example in the economy of New Zealand). If activity in high-tech sectors often focuses largely or solely on the production - assembly of imported components (production of computers, consumer electronics, etc.) – then we can hardly talk about knowledge intensity, even through the companies are formally counted among high-tech sectors.

5.3 Structure and specialization of the Czech economy

We specialize in mobility, electrical and mechanical engineering. The detailed analysis of foreign trade identified seven export items in which the Czech Republic has a significant share of global exports, and this proportion is strengthening. These are: Other stationery products; Machine tools; Microscopes; Telecommunication equipment; Wool and fine or coarse animal hair; Electrical equipment for internal combustion engines; Motor vehicles for the transport of persons. For a total of 14 NACE groups their share of the value added of industry in the Czech Republic is more than 0.5 times higher than the comparable value for the EU-28. The Czech Republic shows the greatest degree of specialization in the production of rail vehicles - within the Czech industry this group has 4.5 times greater importance than in the context of EU-28. Other important areas of specialization for the Czech Republic include manufacture of components for the automotive industry (3.3 times greater importance), the rubber industry (3 times greater importance), manufacture of refractory products (2.7 times greater significance), and manufacture of steam boilers (2.7 times greater significance).

Specialized division of roles along value chains in Europe. This specialization is not chosen voluntary but is the result of partnerships with foreign investors and depends on how our transformational opportunities are utilized. We manufacture for Europe, while elsewhere they sell, manage and design. We innovate the production process, while elsewhere they innovate relationships with customers. The distance of our core disciplines from the final customer is quite large and we do not significantly close the gap. To a certain extent, we have beaten competition from Western Europe in terms of where it is possible to produce efficiently, but now we compete in production activities with China and others. We do not compete so much with developed countries on demanding markets in terms of how we are able to sell (our analysis shows that Czech companies are far away from the end customer and have little control or contact with open markets) but we compete with emerging countries in how we can produce. Compared to China, we offer specialized “small scale production” quality - if it is important for the given brand it will be produced in our country (e.g. LEGO). Many companies more or less differ from this image. These differences are concentrated to heavily innovation-oriented companies with developed market competencies. From a macroeconomic perspective there is still a very small number of companies of this type in the whole economy, even if it seems that the growing number of differing companies could be promising for future development.

We do not invest into R&D in strong sectors like in developed countries. Sectors of the manufacturing industry, which are important in terms of their contribution to value added,

employment and the share of exports (and are theoretically also relatively knowledge-intensive) include (our supporting sectoral specialization):

- 25 Manufacture of fabricated metal products, except machinery and equipment
- 26 Manufacture of computer, electronic and optical equipment
- 27 Manufacture of electrical equipment
- 28 Manufacture of machinery and equipment n.e.c.
- 29 Manufacture of motor vehicles (except motorcycles), trailers and semi-trailers

From the service sector a significant sector based on the mentioned indicators is

- 62 Activities in the field of information technology

Although the microanalysis showed the strongest concentration of private expenditure on R&D in the most important sectors, the contribution of BERD to GVA in these fields to the average contribution of BERD to GVA in the whole economy - i.e. the degree of sectoral concentration of knowledge intensity - reached a value lower than 1, both for Czech and for foreign companies. In the advanced reference economies it is not uncommon that these fields are three to four times more knowledge intensive than the average knowledge intensity of the given economy. Furthermore, according to the microanalysis in most of the strongest sectors the share of domestic and foreign companies in investment in R&D is more or less balanced, but the difference in their contribution to GVA is greatly in favour of companies controlled elsewhere. This further confirms the previously mentioned geographical distribution of roles within the value chains connected to these sectors. Management, marketing, sales, research and development are carried out in developed countries, whereas manufacturing is performed in the Czech Republic.

Nevertheless, it is possible to find companies differing from this image. These include several foreign companies that are increasing their development activities in the Czech Republic and in some cases even their research activities. Although this trend is positive, in many cases the development of R&D activities is driven by the aforementioned cost differential not unique knowledge and the overall picture is still not significant. Furthermore, according to the detailed analysis of microeconomic data, we know that the majority of private expenditure on R&D in strong NACE-2 or NACE-3 is from only a few individual companies (a 60 to 95 % share of the total expenditure in the given NACE-3 is no exception). The microanalysis also showed that foreign companies can cut R&D spending faster than domestic ones. A bibliometric analysis again revealed a mismatch i.e. we have intense publishing activity in fields that are not directly related to the main sectors of the economy[13]. This is a logical consequence (or proof of the existence) of cooperative arrangements where expensive activities with more demands on inputs in the form of knowledge are found in economies with the necessary infrastructure and decision-making powers of multinational corporations, whereas labour intensive activities are found in economies that are more efficient in the utilization of these resources.

[13] “We have good foundations but the house stands somewhere else.” (quote from a company visit).

5.4 Collaboration in research and development, creation and use of new knowledge

Our companies collaborate in R&D on an average level, they collaborate more with external workers than with universities; our companies mainly collaborate with staff at universities informally, probably because it is more productive and also, as shown by the field survey, they prefer short-term projects that quickly lead to results and they are unwilling (or unable) to enter into long-term projects.

We have a low level of patent activity and it is mainly domestic. An international comparison of the Czech Republic based on PCT patent applications per unit of GDP shows that the Czech Republic reaches only half the values compared with the values for the entire EU and ranks among the economies with the lowest values in Europe. In addition, according to the IS R&DI microeconomic data only 1 in 4 patents has protection elsewhere other than at the patent office of the Czech Republic. These figures do not reflect the great potential of Czech inventions to assert themselves on international markets. On the other hand, several inventions fully or partially originating in the Czech Republic are patented by the headquarters or foreign parts of corporations operating in the Czech Republic. There are several reasons for the limited patent activity: we can assume the existence of artificially induced patent activity, the aforementioned industrial-knowledge lock-in and brain drain, the affect of the character of the field in which new ideas arise or the low motivation of creators who do not have access to a functioning ecosystem, investors or entrepreneurs who are ready and able to commercialize patented intellectual property. Finally, there is the cost of enforcing rights violations on foreign markets. Representatives of SMEs in the interviews repeatedly stated that the acquisition of patents itself is a small part of the total investment required for the protection of industrial property rights. The costs and experiences related to the recovery of industrial property rights constitute a motive for many SMEs to find other forms of protection.

Our economic performance continues to be based on increasing efficiency and not on greater use of new knowledge for innovation. Employment in research and the development of employment of specialists in general are increasing, and mostly in strong sectors. A simple analysis of knowledge intensity and economic performance data from the last seven years, however, did not produce any statistically significant conclusions. This is due to the fact that for a considerable number of companies in the economy growth is based on increasing efficiency rather than on the creation and implementation of new unique knowledge (especially knowledge with a significant impact on market share growth or the creation of new markets) into practice. From the perspective of many companies increasing efficiency is an important innovation (e.g. the purchase of a new production line). In terms of the competitive position of companies on the market, there is an acceptance of foreign innovation. Innovation in this regard is not in itself a source of market advantage. The above findings also corresponds strongly to the perceived lack of scientific researchers felt by companies (up to half of the companies surveyed consider this to be the greatest barrier to the development of R&D in spite of the objective absolute increase in the employment of specialists). We believe that this is related to the international nature of the labour market for the “class of experts”. While wages for workers have managed to maintain the cost differential (the difference between the average salary in the Czech Republic vs. Germany and Western Europe), for the relatively more mobile class of experts this is more difficult. This is confirmed by evaluation of GCI, where over the last five years in the characteristic of brain drain (the ability to retain talent) we have fallen to 109th place and in brain

gain (the ability to attract talent) to 87th place (the average fall of the Czech Republic was only to 46th place) [14].

The outlook for the future without fundamental changes is unfortunately not optimistic. In comparison to competing countries the proportion of the young population with a tertiary education is very low[15]. The field survey indicates the dissatisfaction of companies with the quality of graduates. We pay low wages to our teachers and we are losing out position in mathematical literacy and other key skills. According to the World Bank it is difficult to do business in the Czech Republic and our position in this index has worsened the most of the monitored counties in recent years (a drop of more than 30 places in the last 7 years). In actual business activity the Czech population is rather passive and in terms of long-term sustainability of the enterprise it is not overly successful.

5.5 Conclusion

The current situation and the basis of the methodology are heavily dependent on past development. Because of this, our specialization is locked in manufacturing, which under certain circumstances may pose a potential for the future. But we are far away from our customers, so our innovations do not respond to the demands of the end markets, but the intermediaries. This limits the possibility of larger nationwide economic utilization of the industrial potential of the local economy. Due to the continuing favourable conditions of production factors (cost differential associated with attractiveness for foreign investors) there is not enough pressure on building a high-quality and competitive environment in the Czech Republic for either business or innovation. Private investment in R&D will not substantially grow if there is no increase in the number and size of companies finding new ways of communicating directly with end customers in the growth markets of the world. The motivational lever that such investment would trigger can only come from there. The transfer of knowledge from developed countries to the Czech Republic based on low labour costs will continue, but this does not represent a structural change that could significantly shift the Czech economy towards the most developed countries of the world. Without an effective policy for strengthening the position of Czech companies within the value chain it will be difficult to implement an effective policy for the support of innovation.

Only a coherent analysis of long-term and intelligently collected primary data, on which should work all the institutions of the innovation system (i.e. Ministry of Industry and Trade, CzechInvest, CzechTrade, Ministry of Education, TAČR), can show how to effectively support the above-mentioned aim of key companies in the Czech economy and so increase the chances of a significant qualitative shift in the competitiveness of the Czech Republic. Without government priorities forming a truly competitive institutional environment for business TAČR cannot effectively implement a policy for the support of innovation. The structural changes that need to take place in the Czech economy will be long-lasting, they will be difficult to manage and coordinate and there is not room for departmental rivalries or wasting of public funds.

[14] The latest GCI data indicate that concerning brain drain the position of the Czech Republic has increase by 29 places, while the brain gain it has worsened by 6 places. Nevertheless, in these characteristics we lag behind the average position of the Czech Republic in the general index of GCI.

[15] Despite the high proportion of the population entering tertiary education, according to Eurostat, the proportion of people aged between 30 and 34 years who have completed tertiary education is slightly more than a quarter and the Czech Republic is among the bottom third of EU countries.

The public sector must enter into partnerships with 500 – 1,000 key Czech companies (i.e. controlled from the Czech Republic, regardless of ownership nationality) and help them to make technological and innovative upgrades that will lead to them consolidating their position (and a shift towards end customers = global demand) in global value chains. TAČR plays an important, but not primary, collaborating role in this process.