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An assessment of research system and policies

Hungary

Attila Havas

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Executive Summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs which aims to increase and improve investment in research and development, in particular in the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the performance of the national research system of Hungary and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

The main strengths and weaknesses are summarised below in a concise – table – format, organised by the four main domains and the related policy challenges. A generic feature, affecting all the four domains, is that a large number of apparently relevant policy schemes are in place – yet, Hungary's performance is lagging behind most EU countries, as it is reflected in the European Innovation Scoreboard [EIS] indicators. (EIS, 2008) One factor explaining this observation can be that policy-making structures and resource allocation mechanisms do not always operate as intended. Another major reason is that – as perceived by companies – demand is weak for innovative products and services.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	• Strong traditions in science and technology • Low level of GERD and especially BERD; a small share of innovative companies
	Securing long-term investment in research	• Multi- year RTDI support schemes • High share of foreign R&D funds in international comparison, esp. for firms • Policy-making structures and resource allocation mechanisms do not always operate as intended
	Dealing with barriers to private R&D investment	• Apparently appropriate incentives for companies to invest in RTDI • High concentration of RTDI activities (by firm size, ownership, and sectors) • Unfavourable framework conditions: not conducive to invest in research • Low level of available venture capital
	Providing qualified human resources	• Highly respected S&E education system • The level of qualified human resources for (future) RTDI activities is inadequate • Unfavourable conditions for human resources: research is not an attractive career, potential brain drain

Domain	Challenge	Assessment of strengths and weaknesses
Knowledge demand	Identifying the drivers of knowledge demand	• The first national technology foresight programme in a former planned economy was launched in Hungary (in 1997)
	Co-ordination and channelling knowledge demands	• No systematic efforts to co-ordinate knowledge demands since 2001
	Monitoring of demand fulfilment	• No mechanisms in place to monitor the fulfilment of knowledge demand
Knowledge production	Ensuring quality and excellence of knowledge production	• High quality of research in a number of scientific fields in international comparison • Relatively productive researchers at publicly financed R&D units
	Ensuring exploitability of knowledge	• Block funding is still the dominant source of funding in the public sector • Mismatch in the incentive structures among academic and business actors • Insufficient consideration of societal and industrial needs and economic aspects at publicly financed R&D units • Weak patenting activities in general
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	• A number of policy measures for fostering academia-industry co-operation; yet, low level of academia-industry co-operation (especially with PROs) • Low level of researcher mobility among R&D performing sectors
	Profiting from international knowledge	• Intense and successful participation in international RTD(I) projects • Several policy schemes in place to facilitate participation in international RTD(I) projects
	Enhancing absorptive capacity of knowledge users	• Several policy schemes in place to strengthen absorptive and innovation capacities of SMEs • Low absorptive capacity of firms, especially domestic SMEs

Several opportunities and policy-related risks have been also identified in the report, which are summarised below, presented by the four policy domains:

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Efficient use of the significant resources stemming from the Structural Funds • More emphasis on RTDI in the revised government structure • Implementation of the mid-term STI policy strategy, especially the strengthening of the STI governance system	• Lack of consensus, unpredictable policy environment • Resource mobilisation (especially BERD) is insufficient to meet Lisbon target • Poor implementation practices • Lack of adequate policy measures to tackle brain drain and attract researchers from abroad
Knowledge demand	• Application of relevant, up-to-date methods to identify, co-ordinate and channel demands for knowledge	• Fragmented support for RTDI activities, without a comprehensive understanding of knowledge dynamics • Not clear whether stipulations of the recent policy documents will be implemented

Domain	Main policy opportunities	Main policy-related risks
Knowledge production	• Refining existing policy mix for fostering industry-academia co-operation • The reform of the MTA and HE sector • Further strengthening the incentives of PROs and HEIs to make increased use of IPR and exploit research results	• The (potential) resistance of the MTA and HEI against fundamental reforms • Measures aimed at increasing the level of BERD and industry-academia co-operation could lead to one-off, insulated investments
Knowledge circulation	• Efforts and resources devoted to create a small number of internationally competitive research centres • Continued focus on improving absorption capacities, including measures to promote innovative clusters	• The existing measures promoting industry-academia co-operation continue to produce non-lasting and non-organic co-operations

Internationalisation of RTDI processes, and more recently the ERA initiatives have crucial bearings on the Hungarian research performers. Hungary has always been among the top three candidate countries/ new member states with respect to the number of project participation and the size of funds awarded by the various RTD Framework Programmes of the EU (since FP4). Active Hungarian participation can be observed in other programmes, too, such as EUREKA, COST and bilateral intergovernmental ones. These and other bilateral and multilateral R&D programmes are important vehicles for the Hungarian RTDI community to benefit from, and contribute to, knowledge circulation. Hungarian researchers also benefit from having access to large-scale pan-European research infrastructures, such as CERN.

There are several opportunities to further strengthen the ERA dimension. These include the potential impacts of the recent joint OTKA and NKTH, a scheme (entitled OTKA-H07) for promoting the development of human resources for basic research, with a strong international character, reflected in its all three funding lines. Co-operation with the European Technology Platforms can significantly improve the quality and efficiency of the operation of the recently established Hungarian national technology platforms. Exchange of experience among policy-makers could contribute to a better understanding for the need to apply up-to-date decision-preparatory (policy-making) tools in Hungary to co-ordinate and channel demands for knowledge, as well as monitor demand fulfilment.

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1- Introduction and overview of analytical framework

1.1 Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strength and weaknesses and policy-related opportunities and risks. A particular consideration in the analysis is given to elements of Europeanisation in the governance of national research systems in the framework of the European Research Area, re-launched with the ERA Green Paper of the Commission in April 2007. (EC 2007a)

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Figure 1: Domains and generic challenges of research systems

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
• Justifying resource provision • Long-term research investment • Barriers to private R&D funding • Qualified human resources	• Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment	• Quality and excellence of knowledge production • Exploitability of knowledge production	• Knowledge circulation between university, PRO and business sectors • International knowledge access • Absorptive capacity

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures. The way, in which a specific research system responds to these generic challenges, is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds in the following five steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges. The third step is to analyse recent changes in policy and governance in perspective of the results of the strengths and weaknesses part of the analysis. The fourth step focuses on an evidence-based assessment of policy-related risks and opportunities with respect to the analysis under 3) and in the light of Integrated Guideline 7; and finally the fifth step aims at a brief analysis of the role of the ERA dimension.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory[1] and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains five main subsections in correspondence with the five steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

[1] ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home. Other sources are explicitly referenced.

1.2 Overview of the structure of the national research system and its governance

Hungary, with its population of 10 million, is a medium-size country in EU-comparison, similarly to Portugal, the Netherlands, Sweden or Greece. In terms of economic development, the country has achieved significant real convergence with the EU, reaching 63.4% of the EU27 average in terms of PPS GDP per capita in 2007. It is expected to slow down, however, due to sluggish growth performance in 2008-2009.

The size of the research system decreased significantly in the early 1990s in the wake of the economic transition and restructuring, whereby the industrial research facilities were hit especially hard. Since the second half of the 1990s, the size of the research system (proxied by GERD/GDP) has been growing modestly, with occasional breaks in the general trend. The most recent Eurostat data[2] shows that gross R&D expenditures (GERD) stood at 1% of GDP in 2006, which is significantly lower than the EU27 average (1.84%), let alone the Lisbon-Barcelona objective of 3%.

In term of research performers, the business sector has recently become the largest performer in terms of its share of full-time-equivalent (FTE) scientists and engineers (35.6% in 2006), but the private sector still only performs 48.3% of the Hungarian GERD (way below the ratio of the business sector in the advanced countries). This means that the Barcelona target of a 2:1 ratio in favour of business R&D expenditures and the current EU average (63.8%) is still out of reach. Furthermore, large, foreign owned firms in a few sectors account for about 70% of BERD (see Section 2.1.3).

The government sector's share in performing R&D is significant: 25.4% of GERD (vs. 13.6% EU average) in 2006, while its weight in employing research personnel is even larger. The most important player in this sector is the Hungarian Academy of Sciences (MTA) with its extensive network of research institutes, and hence its substantial weight in the Hungarian research system. The MTA is a legal entity, a public body having self-governing rights. It has a high degree of autonomy in scientific, political and financial respects. Its main tasks are to develop, promote and represent science. The MTA gives its expert opinion to the Parliament or the Government upon request, supervises the ethical norms in science and publishes scientific journals. The Academy has the right to establish and operate research institutes, libraries, archives, information services, etc. It can also influence on STI policies, especially via its president as a Vice-Chair of the TTPK.

The largest number of research units is operated at higher education institutes (HEIs), but the average size of these units is rather small, just below 4 FTE researchers. HERD as a percentage of GERD was 24.4% in 2006, which is somewhat higher than the EU average (21.7%).

Private non-profit research institutes are not significant in Hungary, as they perform less than 1% of GERD.

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[2] Unless explicitly noted otherwise, data in this Analytical Report are the most recent available Eurostat indicators. (http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=Yearlies_new_science_technology&depth=3)

The science, technology and innovation (STI) governance system is in an almost permanent state of flux, including both the highest level policy-making bodies, as well as implementing agencies. In May 2008, yet another major government reshuffle took place, affecting the highest level STI policy-making structures, too. The new government structure entails a reorganisation of the responsibilities of various ministries. The (renamed) Ministry of National Development and Economy now has significantly increased decision-making competences in terms of regional development, but hands over its (former) STI related ones to a new minister without portfolio, responsible for research and development.[3] Furthermore, the STI policy action plan stipulated that the STI governance system should be overhauled. A government decree has been prepared, proposing a number of significant changes, but due to more urgent political issues (the government had to be reshuffled as the junior coalition partner left the government in May 2008), this has not been approved by the end of August 2008.

There are a number of bodies and mechanisms in place, which would, in principle, be suitable for co-ordinating STI policies. At the highest level, this task is to be performed by the Science and Technology Policy Council (STPC or TTPK). It is headed by the Prime Minister, and the Vice-Chairs are the Ministers responsible for Education and Culture, for Economy and Transport,[4] respectively, and the President of the Hungarian Academy of Sciences. Further members include ministers, and other permanent, invited members, representing various stakeholder groups. In practice, however, it cannot perform its intended role as it has not met since January 2006.

The Education and Science Committee and the Economic and Informatics Committee of the Parliament are the highest-level political bodies in the field of STI policy. Recognising the strategic importance and cross-sectoral nature of STI policies, a sub-committee of the Education and Science Committee of the Parliament, called "Science and Innovation Policy ad hoc Committee", was established in August 2007.

The most important ministries with responsibilities for various domains of STI policies are the Ministry of Education and Culture (OKM) and, until May 2008, the Ministry of Economy and Transport (GKM). The former has the main responsibility for overseeing the whole education system, whereas the latter operates complex economic development programmes as well as more direct technology and innovation policy measures. Between 2006 and May 2008 the Minister of Economy and Transport supervised the activities of the National Office for Research and Technology (NKTH), the government agency responsible for a set of STI policy measures. The ministry has also played a key role in setting the priorities of the Economic Development Operational Programme and drafting the Government's mid-term STI policy strategy. As of May 2008, the Ministry (renamed as Ministry of National Development and Economy) lost most of its responsibilities in terms of STI policies (handed over to the newly appointed Minister without portfolio, responsible for R&D). However, it will continue to influence innovation policies through its new regional development policy tools.

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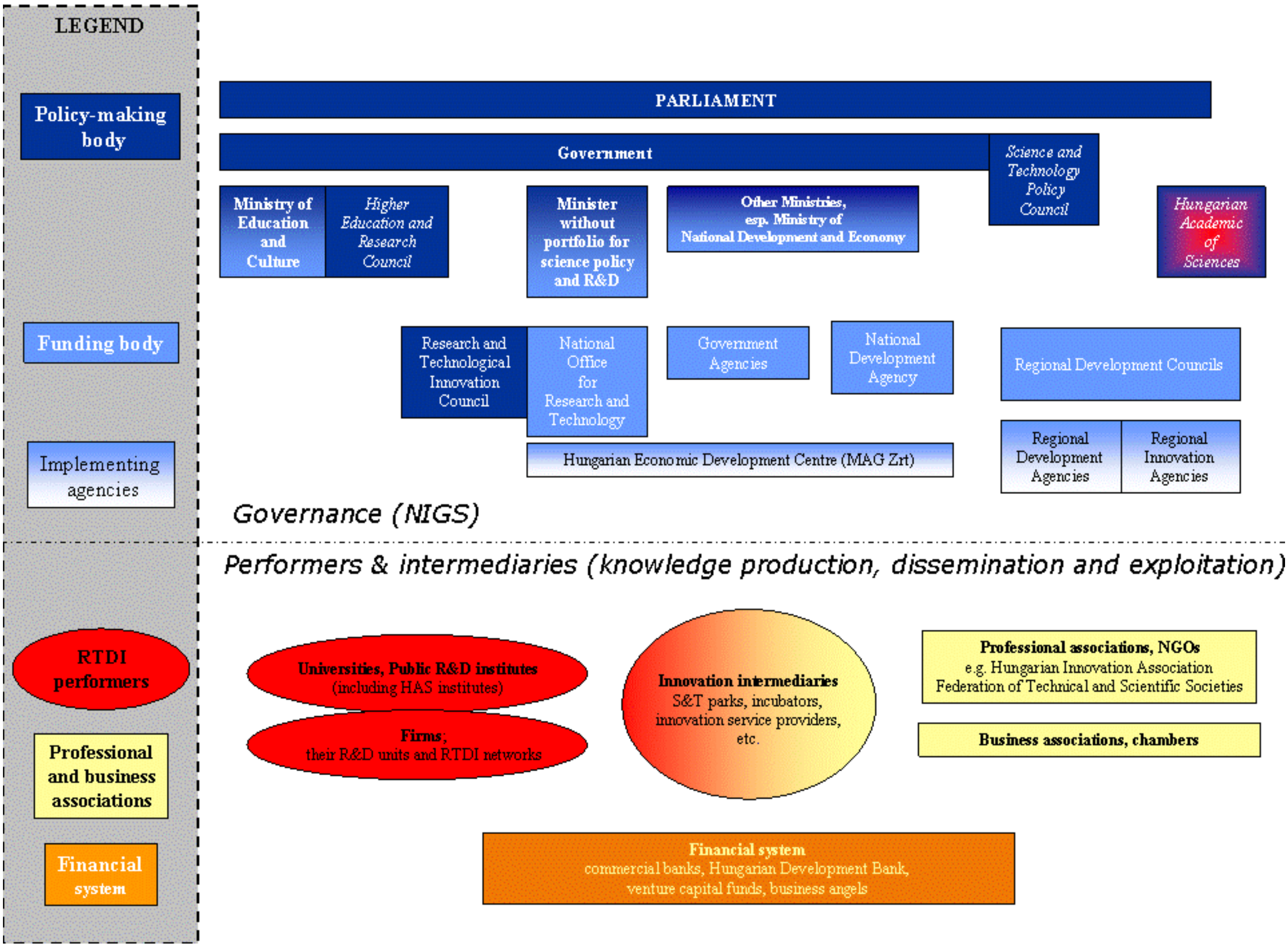
[3] The official name of this new position is "minister without portfolio, responsible for research and development". The relevant government resolution stipulates that the minister is responsible for: a) R&D and technological innovation; and b) co-ordination of science policy.

[4] As noted above, this ministry was renamed in May 2008.

Figure 2: The structure of the Hungarian National Innovation System (August 2008)



Source: Own compilation, assisted by Tamás Polgár

The Research and Technological Innovation Council (KuTIT) is responsible for overseeing the use of the Research and Technological Innovation Fund (the main source for funding national R&D and innovation policy schemes). The Council is a 15-strong body, with 6 members delegated by the relevant ministries (mostly state secretaries), 6 by various business associations and 3 other representatives of the RTDI community.

At the operational level, the National Office for Research and Technology (NKTH) devises R&D and innovation policy schemes, manages international R&D co-operation in bilateral and multilateral relations and supervises the network of Hungarian science and technology attaches. In brief, NKTH submits its strategic proposals to KuTIT, and implements the Council's decisions. As of May 2008, NKTH is supervised by the newly appointed minister without portfolio, responsible for R&D.

Hungary is a centralised country, where regions do not play a significant role in influencing STI policies. The Regional Development Agencies and the recently established Regional Innovation Agencies influence RTDI processes by devising regional innovation strategies, as well as through fund allocations and administering calls funded by the Research and Technological Innovation Fund[5] and the Regional Operational Programmes.

2 - Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

Four different challenges in the domain of resource mobilisation for research, which need to be addressed appropriately by the research system, can be distinguished:

- Justifying resource provision for research activities;
- Securing long-term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

2.1 Analysis of system characteristics

2.1.1 Justifying resource provision for research activities

As noted, the share of Hungarian GERD as a percentage of GDP was 1% in 2006, which is way below both the current EU27 average and the Lisbon-Barcelona target. Clearly, it would be unrealistic to reach the 3% target in the mid-term. The EU targets, however, are explicitly used by the Hungarian policy-makers as a rationale to urge for increasing R&D expenditures. It is also often emphasised that public R&D expenditures, measured by their share in the GDP, are not significantly lower than the EU average, implying that boosting private R&D is the major target.

The most important official strategic document is the Hungarian government's mid-term Science-, Technology and Innovation Policy Strategy (henceforth: STI policy strategy), approved in March 2007. It defines mid-term (2007-13) goals and targets, as well as longer term visions. In terms of resource provision for research activities, the general aim is the "dynamic increase in yearly R&D expenditure, above all as a result of growth in corporate expenditure", in line with the expectations of the EU Lisbon-Barcelona Strategy, as well as the National Reform Programmes (approved in 2005, updated in 2006 and 2007, respectively) serving to implement the Lisbon Strategy's initiatives. Explicitly referring to the Barcelona target, the STI policy strategy sets out the following mid-term goals: "Total R&D expenditure in the function of available budgetary sources should possibly reach **1.4% of GDP in 2010**, then

[5] It is stipulated that 25% of the Research and Technological Innovation Fund should be used to finance schemes fostering regional RTDI activities.

1.8% of GDP in 2013. In the interest of a more favourable R&D source structure it is a goal that every forint from the budget turned to R&D should attract at least one forint of corporate expenditure. **Corporate R&D expenditure** within total R&D expenditure should reach **45% in 2010**, and **50% in 2013**." (p. 10, emphasis in the original text)

In terms of public resources allocated to RTDI, there are two major sources which in principle are suitable to provide a stable and long-term financing framework. One of the stated rationales for setting up the Research and Technological Innovation Fund in 2004 was to create a stable and predictable financial source, which is 'protected' from the annual budget bargaining processes. In 2008, the NKTH is expected to allocate roughly €200m for national policy schemes using the Fund. The (previous) President of the NKTH has declared as one of his main priorities upon taking his position in August 2007 that the policy mix operated by the Office should be "streamlined" as well as made more predictable. In this spirit, the NKTH has approved a mid-term (2008-10) programme strategy, where major commitments as well as the general structure, announcements, rationales of the already operational or envisaged schemes are set out for a 3-year period. The second major source is EU funding, as the Structural Funds have become a very significant and stable source for financing RTDI activities. The most directly relevant programme is the Economic Development Operational Programme (EDOP), where the first so-called priority axis is exclusively dedicated to RTDI (including "pure" business innovation measures, innovation services, as well as support for applied research). Its share within the OP is rather significant, that is, 33%. In addition, the Social Infrastructure Operational Programme provides significant funding for research infrastructures primarily at HEIs. Taken these together, approximately €200m per annum is available for RTDI activities from the Structural Funds in 2007-13. These developments indicate that the Hungarian government is committed to increase RTDI spending, as defined by the EU Lisbon strategy – but taking into account the fiscal and other economic barriers.

GBAORD as a percentage of GDP was 0.36% in 2006,[6] that is, half of the EU27 average (0.75%, Eurostat estimate for 2006). The lack of data for other years prevents any analysis of its dynamics. As already discussed, RTDI goals have a prominent position within the Operational Programmes (using the Structural Funds) in Hungary. Since these resources are accounted for as part of the national budget in official statistics, the level of state contribution as a share of GDP is not considerably lower than the EU average. Reaching the Barcelona objective of 1% by 2010 is clearly not feasible, though. Thus, the official national target is 0.9% to be reached by 2013.

The role of RTDI in economic growth and overall socio-economic development is clearly not a central issue in mainstream political debate. Occasionally, certain questions, such as the reform plans of the Hungarian Academy of Sciences (especially the desirable level of state support for research without clear and immediate economic benefits) or some huge R&D-related investment projects (such as having the European Institute of Technology and/ or the European Spallation Source located in Hungary) have received increased attention. Clearly, interest groups and organisations are making endeavours to influence the longer term STI policy developments pursuing their individual interests. Regular dialogues between

[6] Own calculation, based on KSH data.

the major stakeholders with the aim of arriving at a consensus regarding major socio-economic objectives, and the appropriate strategies to achieve those goals (including STI strategies) are not visible.

2.1.2 Securing long-term investment in research

The share of GERD financed by public sources (that is, the state budget) ranged between 44.8-58.5% since 2000, reaching its lowest point in 2006 when the total amount was approximately €430m. The share of the government sector in performing R&D (GOVERD/GERD) is also about twice the EU average. These figures clearly indicate the large weight of the state in the overall research performance. The bulk of domestic public funding goes to R&D institutes (~€190m) and the higher education sector (~€179m). The decisive source of funding for these R&D performers, in turn, is the state budget (79%, and 77% of their total budget, respectively).

Though there is a growing emphasis on competitive allocation of resources, block funding is still the main form of financing in the public sector: both at the research institutes of the Hungarian Academy of Sciences and in the HE sector. In the latter case it has to be noted that – since there are no strict rules to separate funding for education and research activities and their use is not followed closely – the research budget can be used for financing education activities or covering general costs, such as heating and lighting.

Total public funding for R&D activities conducted by the higher education sector was around €179m in 2006 (i.e. around one-fifth of GERD), which is roughly 75% of HERD. Based on data provided by the HEIs themselves, there is a significantly growing share of non-core funding within their research budgets. In 2006, almost half of their research expenditures were covered by either domestic competitive grants (mainly through the National Scientific Research Fund [OTKA] and the Research and Technological Innovation Fund), from abroad (8%) or by businesses. The importance of funding from the industry (contract research) is gaining significance (see further details in Chapter 5.1.1), while national and international competitive grants are also becoming more important. Another mechanism for allocating funding based on competitive criteria is the Hungarian Academy of Sciences' (MTA) financial support to research groups located at universities. Here, a major reform has taken place in recent years, and resources have been focused to a significantly lower number of often cross-disciplinary research projects (79), where the selection and monitoring criteria are heavily based on scientific excellence, the quality of the researcher base and internationally recognised research results.

Several ministries (most notably the agricultural, health, economy, environment and defence) provide additional funding for R&D activities in various ways: running their own R&D institutes, offering a mix of core funding and competitive grants for them, or only providing competitive grants to R&D units, regardless of their owners. However, these are not really significant sources, as in total less than €24m was spent on R&D from these funds. These types of funds are negotiated every year as part of the annual budgeting process in Parliament.

The same parliamentary rules and processes are applied concerning the funds disbursed by the Academy of Sciences and the higher education system, including their research activities. However, the MTA enjoys a high degree of autonomy in terms of scientific affairs. The internal breakdown of funds among research institutes and themes, therefore, is decided upon by the organs of the Academy. Higher education, in contrast, is supervised by the Ministry of Education and Culture. Still, the HEIs have autonomy in terms of determining their own research profiles, but the size of block funding (as well as the normative support based on the number of registered students, falls within the jurisdiction of the Ministry, and ultimately the parliamentary majority. For these reasons, long-term budgetary conditions are not always predictable and can fall victim to restrictive fiscal policies. E.g. the National Scientific Research Fund (OTKA) has suffered declining annual budgets in recent years, even in absolute terms (~€23.4m in 2005, ~€22.4m in 2006 and ~€20.7m in 2007, respectively).

Besides block funding, the other important mechanism for securing long-term investment in research, by distributing national funds mainly on a competitive basis is the Research and Technological Innovation Fund, set up by a law passed in 2003. Its main rationale was precisely to create a stable environment for channelling resources into (mainly) privately undertaken RTDI activities, by removing these sources from the central budget, thus detaching it from the annual budget negotiations. The managing agency (the NKTH) is responsible for operating the Fund in a transparent way, as well as that the use of grants are properly monitored, and that they benefit the private sector, as stipulated in the legislation creating the Fund. The Fund is financed by two major sources: a levy paid in by firms (micro- and small firms are exempted), and automatic government funding: as the Law stipulates, the state budget shall commit the same amount of funding as was generated by the firms' levy two years earlier. (This requirement has not always been followed in recent years.) This way the Fund has helped increasing GERD. The Fund is aimed at increasing BERD, too: direct costs of in-house R&D activities, as well as expenditures on projects commissioned from public research units or from non-profit research organisations, financed by firms' own sources can be deducted from the contributions to be paid to the Fund.

In 2008, the National Office for Research and Technology (NKTH) is expected to allocate roughly €200m for national RTDI schemes using the Fund. It is defined in the mid-term strategy of the NKTH that the share of businesses as beneficiaries of the Fund shall be increased to 50% in 2008 and 60% in 2009. The vast majority of these resources are allocated via competitive calls.

The third crucial element of the funding system is the Community Support Framework, namely the Operational Programmes of the New Hungary Development Plan (2007-13). The Economic Development Operational Programme has a strong focus on RTDI, as noted above. In addition, the Social Infrastructure Operational Programme provides significant funding for research infrastructures primarily at HEIs. Taken these together, approximately €200m per year (2007-13) is available for RTDI from the Structural Funds, i.e. roughly the same as the volume of the Innovation Fund.

The latter two mechanisms can in principle be regarded as relatively predictable and stable sources of financing RTDI, which cannot be taken "hostage" by short-term fiscal considerations. However, even in these cases the current implementation practices (e.g. failing to comply with the matching fund rule or not reaching the desired share of supported private enterprises), as well as the possibility of a new government (or even a new minister or agency executive) can pose a serious threat to delivering some of the key commitments, as recent experience clearly shows. For instance, it is already apparent that several deadlines, including the ones for creating a more efficient STI governance structure set out in the Action Plan will not be met due to the simple fact that macroeconomic pressures, various political tensions, and the recent government reshuffle have overwritten the agenda of the government.

Similarly, there is no guarantee that a new government will not "relegate" the NKTH, currently a government agency, to being a division of one of the ministries, strip important bodies of their decision-making powers (as these happened in the late 1990s), or abandon other commitments, such as matching funds in the case of the Innovation Fund. Several studies have pointed out that the unpredictability of the STI governance system hinders transparent, evidence-based policy-making and implementation practices. (Veres and Krisztics, 2006; OECD, 2008)

2.1.3 Dealing with uncertain returns and other barriers to business R&D investment

The bulk of business R&D activities (as well as innovation activities) is conducted by a handful of large, foreign owned companies in a few sectors. The chemical industry (mainly related to pharmaceuticals) accounted for 60.4% of total R&D spending by manufacturing companies in 2006. The share of majority foreign-owned companies in BERD was 70%, while the figure for those employing more than 250 employees was 72% in 2006. (KSH 2007a) In brief, practically 5-6 large pharmaceuticals companies account for 35-40% of the entire Hungarian BERD.

Businesses themselves finance roughly three-quarters of their R&D expenditures, whereas the rest is divided between funds from abroad (16%) and the state budget (8%). These figures indicate the importance of FDI and large multinational firms in performing RTDI in Hungary. Based on the IRIS Scoreboard (IRIS 2006), the largest Hungarian private R&D performer is Gedeon Richter, a pharmaceuticals company located in Budapest: with its €50m R&D spending in 2005 it is ranked 218 in IRIS. The other two Hungarian firms included appearing among the top 1000 are: Egis Pharmaceuticals (€23m, ranked 356) and Graphisoft, an ICT company (€5.04m, ranked 802). These three companies account for more than one-fifth of total BERD in Hungary, clearly indicating the importance of the pharmaceuticals sector as well as the weight of large companies.

Overall, the level of BERD in Hungary is very low, though increasing significantly since 2004. BERD/GDP was a mere 0.45% in 2006 (35% of EU average), which is way below both the EU targets, and the 0.9% goal set in the mid-term STI policy strategy (to be achieved by 2013). It indicates that most companies, especially the small, domestic ones do not have the capacity to deal with uncertain returns and other barriers, mostly due to the lack of sufficient resources. The amount of available venture capital is very low indeed, and this has been identified as a key weakness of the research system, hindering R&D activities of firms. Moreover, most of these funds are invested in non-innovative activities: just as in many other CEE countries, most players of the private equity and venture capital industry are biased towards late(r) stage, commercially proven ventures. Some investors, however, have moved towards early stage investments in technology-based firms. This is a promising sign, although the number of investments is still small. A recent survey, conducted by the Hungarian Venture Capital and Private Equity Association, reveals that only 7.4% of the total private equity invested in 1989-2004 funded innovative firms.

Direct funding of firms' RTDI activities has gained importance during the last ten years, especially since the launch of the two major funding mechanisms described in the previous sub-section (namely the Research and Technological Innovation Fund and the Operational Programmes allocating the resources of the Structural Funds). The schemes financed by these funds are meant to raise the quality of the research infrastructure, foster industry-academia co-operation, and support applied research projects in key technology areas. Still, as noted above, the share of BERD financed by public resources remains below 10%, i.e. these instruments are far from being the most decisive factor. According to the ERAWATCH R&D Specialisation Report (Erawatch, 2007, p.8), the only sectors with a share of public funding within BERD above 10 percent were “business activities & real estate”, and the “IT services” sectors in 2003. It is also telling that the annual R&D expenditures of the largest Hungarian pharmaceuticals company (Richter Gedeon, the first Hungarian company appearing in the IRIS Scoreboard) is roughly the same as the funds distributed via the Research and Technological Innovation Fund. Therefore it is unreasonable to expect that national R&D schemes by themselves can be sufficient to induce a considerable growth in BERD.

Other, indirect forms of support have also been utilised, such as the tax deduction for in-house R&D expenditures, or even larger exemptions if research is carried out by PROs, commissioned by private firms. The precise volume, let alone the impact of this fiscal incentive, is not known. Several measures have been launched in recent years to facilitate better access for businesses, especially SMEs, to risk capital in the forms of either (preferential) loans provided by the state-owned Hungarian Development Bank (and its affiliates, such as the Corvinus Group), or by providing equity guarantees (such as the START Equity Guarantee).

Finally, it should also be noted that the general business climate has not improved in recent years: macro-economic conditions have deteriorated significantly, administrative and financial burdens on businesses have increased, and the overall predictability and credibility of economic policies are seriously threatened by the lack of meaningful dialogues between the major political parties. These framework conditions clearly do not constitute a predictable, sufficiently ‘calm’ environment for RTDI activities.

2.1.4 Providing qualified human resources

Traditionally, the Hungarian education system, strongly influenced by the German model at all levels, has been seen as a key strength, even in an international comparison. The achievements of Hungarian scientists have been widely acknowledged, especially in the natural sciences. As for higher education, the most marked change since 1990 has been the explosion of the number of students. The number of full-time students in higher education has grown every year, and the threefold increase (coupled with the significant decline in the size of the corresponding age cohort) strongly indicates a shift from elite to mass higher education. The number of graduates has doubled between 1990 and 2006, while resources allocated to higher education have not kept pace.

There are other related tendencies that can also be interpreted as important challenges from the point of view of qualified human resources for research. First of all, with the drastic downsizing of the industrial R&D infrastructure in the early 1990s, the motivation for pursuing a research career was decreased, and this has been reflected in the sharp drop in S&E graduates, which is one of the main weaknesses of the system (currently a mere 40% of the EU average. (EIS, 2008) Also the low number of researchers per 1000 labour force (1990:4, 1995: 2.6, 2005: 3.8 vs EU25: 5.6 in 2004), especially in the private sphere, is a legacy of the economic restructuring in the early 1990s, still posing a challenge.

The relevance of the curricula has often been criticised, as too much based on mechanical memorisation of a large amount of information as opposed to more creative and practical skills, including language, communication, co-operation, and entrepreneurial/ innovation skills. These latter ones are crucial bottlenecks with regard to the exploitation of R&D results, another key weakness of the Hungarian research system. PISA reports have indicated that the once widely respected Hungarian education system is showing a deteriorating performance in basic reading skills as well as in mathematics, both of which are prerequisites of a sufficient human resource base for S&T. (http://www.pisa.oecd.org)

Though some universities have established co-operation with industry (e.g. involving PhD students in industrial research projects), and several recent measures have explicitly encouraged these types of co-operation, the general picture is a less promising one: qualitative evidence, such as a monitoring report on one of these scheme (Arnold *et al.*, 2007) supports the claim that business-academia linkages are weak primarily due to the mismatch in the incentive structures of these different types of players, as well as the insufficient understanding of the industry's needs in academic circles. Similarly, a report by the Ministry of Economy and Transport (GKM 2008, p. 43-44) points out that despite the relatively good performance of public research institutes (in terms of scientific output, in international comparison), there is a weak or no consideration for industrial needs in these units. Scientific excellence is still considered the first and foremost criterion for advancement in the university and public research sector, without any regard for economic relevance of research. Economic aspects are not considered in the management of such institutes, whereas knowledge transfer is impeded by an alarmingly low level of researcher mobility between research performing sectors.

A number of initiatives have aimed at directly or indirectly raising the level of S&E graduates (e.g. by changing the quotas for publicly financed enrolment), at facilitating the production of more economically relevant knowledge and human resources, or employing MSc and PhD students by providing tax incentives. Various scholarship schemes facilitate PhD studies as well as the pursuit of research careers for post-docs.

Researchers at PROs as well as HEIs fall under the generally strict but stable regulations of public employees, and are usually not well paid, unless involved in various external (especially international) projects. In fact, most HEIs are struggling with attracting talented young researchers due to the unfavourable work and financial conditions, and this can be seen in the growing average age of researchers in the sector. The MTA, on the other hand, has implemented a number of measures to attract or retain young researchers, which had a visible impact on the age composition of its institutes in recent years. Another closely related challenge is brain drain, for which we have scarce evidence. It is especially the most qualified and motivated researchers who are willing to move abroad to carry out research under much more favourable conditions. The Hungarian Academy of Sciences has recently conducted a non-representative survey (using the snowball method) for gauging the extent of the challenge in various professional groups and mapping the motives behind decisions to move abroad. (Csanády *et al*., 2008) Their results suggest that approximately 40% of the roughly 20,000 post-graduates leaving for longer or shorter periods of time have PhD or other scientific degrees, and the most worrisome aspect is that S&E graduates are clearly overrepresented among those opted for a career abroad. It is evident that younger persons are more motivated to take positions abroad. Only about 40% of the respondents plan to return to Hungary in the near or even the distant future. This issue needs to be addressed, but currently there are no appropriate policy initiatives or strategies to counter this tendency. It has to be pointed out that brain drain is deemed to have "reached a critical mass" by the authors of the above study. This assessment is indirectly confirmed by the SME Strategy of the Ministry of Economy and Transport explicitly conceding that "no solution is in place for the motivation and support to the repatriation of young researchers after employment abroad". (GKM, 2008, p. 44)

2.2 Assessment of strengths and weaknesses

Based on the above discussion, the main strengths and weaknesses of the system regarding resource mobilisation can be summarised as follows.

Main strengths	Main weaknesses
• Strong traditions in science and technology, with a highly respected S&E education system and relatively good performance by traditional indicators (publications and citations); • Apparently appropriate incentives (including multi-year RTDI support schemes) for companies to invest in research; • High share of foreign R&D funding in international comparison (esp. for firms).	• Low level of GERD and especially BERD; a small share of innovative companies; • High concentration of RTDI activities (by firm size, ownership, and sectors); • The level of qualified human resources for (future) RTDI activities is inadequate; • Unfavourable framework conditions, especially macroeconomic pressures: not conducive to investments in research; • Low level of available venture capital; • Unfavourable conditions for human resources: research is not an attractive career, potential brain drain; • Policy-making structures and resource allocation mechanisms do not always operate as intended.

Science and technology have strong traditions in Hungary, and thus S&E Hungarian degrees are usually respected in more advanced countries. Further, several university departments and institutes of the Hungarian Academy of Sciences show good performance measured by traditional performance indicators (such as publications and citations). Yet, the level of qualified human resources can be deemed inadequate. Research careers are not attractive, and hence only the minority of young talents opt for S&E studies. Moreover, graduates are tempted to move abroad. Despite the high number of apparently appropriate incentives (including multi-year RTDI support schemes), unfavourable framework conditions (especially macroeconomic pressures) are not conducive to investments in RTDI. Thus, the level of GERD, and especially BERD are low in comparison to the EU average, and the share of innovative companies is among the lowest in the EU. RTDI activities are concentrated to large, foreign-owned firms in a limited number of sectors, whose strategies are thus largely responsible for the dynamics of BERD.

2.3 Analysis of recent policy changes

There have been a number of policy changes since 2006, with regard to policy-making and implementing processes, as well as specific measures.

The most recent official document defining the goals of Hungarian STI policy is the government's Mid-Term Science and Technology Policy Strategy (2007-2013), and its action plan, approved in 2007. These documents set out the major challenges, the basic targets as well as the envisaged policy responses to STI policy challenges. In terms of resource mobilisation, GERD is expected to reach 1.8% of GDP, half of which is to be financed by the private sector, by 2013. With regard to human resources, one of the main objectives of the strategy is to promote "a respected, knowledge-based, creative and innovative workforce suited to the demands of society and the economy".

The Action Plan lists close to 100 specific actions to be taken by various organisations or bodies. The deadlines and the responsible organisations are clearly stated in the document and the source of funding is also given (where relevant) but without specifying the amount. Typically, the Action Plan sets out a deadline for devising of a conceptual document, and then another one for the submission or the implementation of a new regulation or other measure. The vast majority of the actions were due to be completed between December 2007 and December 2008. The implementation of the Action Plan is behind schedule.

Several important changes have taken place with regard to the use of the Research and Technological Innovation Fund. The president of NKTH (the government agency responsible for running this fund), appointed in August 2007,[7] has announced a number of changes in the policy mix and management practices, in order to address the challenge of unpredictability and lack of transparency with regard to the use of the Fund. These are set out in the so-called "Institutional Strategy 2007-10" document of the NKTH. (NKTH, 2007, pp. 20-27) Several similar or overlapping measures have been grouped under a small number of 'headlines', e.g. supporting competitive technological innovation, improving the knowledge base, enhancing international RTDI co-operation. As the strategy explicitly points out (ibid., p. 17) the aim is that the underlying strategic documents of the individual schemes, application guidelines, eligibility and other criteria shall be defined (and guaranteed) for 3 years in a transparent manner in order to enhance predictability. Calls and submission deadlines will be announced with regular intervals, that is, twice a year. Simplified eligibility criteria have been applied for a number of new or already running schemes. The introduction of a simplified, one-stop-shop system for both nationally and EU co-financed RTDI schemes is also planned.

To enhance the efficiency of public RTDI spending, stricter criteria will be applied, e.g. in the case of the National Technology Programme, the most important large-scale national scheme for funding primarily social demand-driven applied research in a handful of broadly defined areas. For instance, the applicants will be required to present the economic viability and competitiveness of the proposed projects to an expert committee, while the fulfilment of planned impacts will be regularly monitored in the implementation phase. Furthermore, a stronger emphasis will be put on the

[7] As a result of the government reshuffle and the appointment of a new minister without portfolio, the president left his position already in June 2008. As of August 2008, one of the vice-presidents is acting president.

capability of the applicant to draw in private investments to supplement the public support, as this will be a key evaluation criterion. For 2008, the size of resources allocated for this scheme is approximately €66m, which is roughly third of the total available amount.

The New Hungary Development Plan, allocating the resources of the Structural Funds, includes a number of schemes aimed at developing the research infrastructure. The most important ones within the first priority of the Economic Development Operational Programme for promoting RTDI are the “Development and strengthening of research and development centres”, “Support to innovation and technology parks”, “Complex technology development of enterprises”. Furthermore, the Social Infrastructure Operational Programme also includes an RTDI-related measure, namely “Infrastructural and ICT development for raising the quality of education and research activities of HEIs”.

There are a number of other recent relevant schemes run jointly by the National Scientific Research Fund and the National Office for Research and Technology to promote basic research underpinning innovation and to secure human resources for basic research, with the aim of attracting foreign researchers or bringing home Hungarian ones. Furthermore, the government has aimed at increasing the number of S&E students and graduates by raising the quota of publicly financed students enrolled at these faculties (at the expense of other fields) since the 2006/7 academic year. There has been a marked increase in the absolute number of students at S&T faculties since 2001, albeit with significant fluctuations, but the 2007 higher education enrolment statistics do not show any significant improvement in this respect when compared to 2006.

The next table summarises the most important trends in the governance system as well as policy responses to the four main challenges pertaining to resource mobilisation. As noted, several important strategic policy documents have identified these bottlenecks and set out envisaged policy responses. However, the slow implementation of the planned government’s measures has raised doubts as to the political ‘weight’ of STI policy, or in other words, as to the level of commitment. One should stress, though, that the planned measures themselves seem to be relevant to address the policy challenges identified.

With regard to the Hungarian performance, the European Commission summarised its general views as follows: “Overall, the 2007 Hungarian Implementation Report shows limited progress on implementing the revised National Reform Programme (NRP) over 2005-2007. Hungary is making strong efforts and the pace of progress has accelerated over the last year.” (EC 2007b, p. 2) While the most serious concerns were raised in relation to the uncertainties of macroeconomic stabilisation, progress made in terms of enhancing innovation performance is also assessed. It is acknowledged as a positive development that the government has approved and started implementing its mid-term STI policy strategy, which not only provides a general framework, defines priorities and related fields of intervention, but also measurable targets. However, it is noted that (i) commitments made as a response to the previous Annual Progress Report have only been partially achieved (“limited progress” is deemed to have been made); and (ii) the implementation of the STI strategy and the actual steps taken also raise uncertainties. Therefore, accelerated efforts are needed in important areas such as enhancing co-operation between public research institutes and the industry. From the point of view of resource mobilisation, concerns are also raised as to the stability of public funding (which should be redirected from direct state aid to companies towards more horizontal measures boosting competitiveness and reducing the administrative and financial burdens on businesses, e.g. improved access to financing for SMEs).

Challenges	**Main policy changes**
Justifying resource provision	The mid-term STI policy strategy of the government as well as the National Reform Programme defines as one of the key priorities to increase GERD and to integrate the Hungarian research system into the ERA.
Long-term research investment	Significant resources allocated to RTDI in the multi-year programming documents, such as the New Hungary Development Programme (2007-13) as well as the funding strategy of the Research and Technological Innovation Fund (2008-10), which are in principle disconnected from annual budgeting processes.
Barriers to private R&D funding	The reform of the STI governance system as well as more efficient policy-making and delivery practices are aimed at creating a more stable and favourable climate, facilitating private R&D investments. Equity guarantees and venture capital is also to be boosted by recent state interventions.
Qualified human resources	Increased number of state-funded S&E students, several tax incentives and support measures to facilitate the pursuit of a research career and the employment of (young) PhDs.

2.4 Assessment of policy opportunities and risks

The main opportunities and risks arising from recent policy responses to the resource mobilisation related challenges are summarised in the table below. The main opportunities can be attributed to the implementation of the STI policy strategy and the NRP, which identify and aim to address the most important governance and resource mobilisation related bottlenecks. In line with the current performance, the official targets (GERD/GDP 1.8%, BERD/GERD 50% by 2013) are more modest than the Lisbon-Barcelona targets, but still rather ambitious goals. The challenge of securing the sufficient level of human resources is also acknowledged. Present efforts have not brought about the necessary major improvements yet. There are significant amounts of resources available from national and EU Structural Fund (SF) sources, which span longer time periods. However, risks arise mainly as a result of weak governance and implementation practices. (OECD, 2008)

As noted in Section 2.1.2, even important mechanisms, meant to secure long term resource mobilisation can fall victim to short-term budgetary considerations, changes in the governance structure, or personal changes (in case of major positions). These types of threats pertain to the poor implementation practices of the STI governance system, a key aspect which has been clearly emphasised by a recent OECD study. (OECD 2008, p. 185) Furthermore, there is a lack of sufficient co-ordination with major economic policies (in the absence of an overarching socio-economic development strategy), with a wide range of ‘isolated’ STI policy measures, which therefore might not be sufficient to mobilise resources for R&D (especially BERD) in order to meet the Lisbon target. The efficient use of the significant resources stemming from the Structural Funds, aiming to tackle a wide range of challenges and bottlenecks of the Hungarian research system by a complex approach might be considered as a policy opportunity, especially if the stated stronger emphasis on RTDI (in the revised government structure) is realised, and the stipulations of the mid-term STI policy strategy are put into practice.

Main policy opportunities	Main policy-related risks
• Efficient use of the significant resources stemming from the Structural Funds to tackle bottlenecks of the Hungarian NIS; • More emphasis on RTDI in the revised government structure; • Implementation of the mid-term STI policy strategy, especially the strengthening of the STI governance system.	• Lack of an overall consensus on the desired objectives and instruments (leading to an unpredictable policy environment in case the responsible officials are replaced); • The current practice of ‘isolated’ STI policy measures – lack of co-ordination with major economic policies – might not be sufficient to mobilise resources for R&D (especially BERD) to meet the Lisbon target; • Poor implementation practices and lack of systematic evaluation jeopardise to achieve the government’s own objectives • Lack of adequate policy measures to tackle brain drain and attract researchers from abroad

2.5 Summary of the role of the ERA dimension

In recent years policy-makers have devoted particular attention to strengthening international RTDI co-operation. Membership in various international organisations such as COST, EUREKA, and CERN has been significant for the Hungarian research community. EUREKA offered opportunities for academia-industry collaborations, including co-operation with international industrial partners. The large number of bilateral intergovernmental S&T agreements has also accelerated the internationalisation of Hungarian RTDI activities.

A major field for orchestrating national efforts with the ERA dimension is the development of research infrastructures. One of the initiatives of the STI Policy Action Plan is to devise a national road map for the development of the national research infrastructures in line with the European Research Area.

Two funding agencies, OTKA and NKTH have recently launched a joint scheme (OTKA-H07) for promoting the development of human resources for basic research. The measure has a strong international character, reflected in its three funding lines: (1) supporting the inflow of researchers working abroad (indirectly promoting the return of Hungarian researchers staying long abroad); (2) funding research activities of young scientists with PhD either at prominent Hungarian or foreign laboratories; and (3) supporting the access of large research facilities abroad (like ESA, CERN, ESRF, EMBL, etc.) for PhD students or young scientists with PhD. The allocated amount of funding is €4m.

3 - Knowledge demand

The purpose of this chapter is to analyse and assess how research-related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand;
- Co-ordinating and channelling knowledge demands; and
- Monitoring demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted in Integrated Guideline no. 7 (IG7) of the Lisbon Strategy.

3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

A major driver of knowledge demand is the economic structure itself. The services sector has become the predominant one in many economies, and that is the case for Hungary, too. Agriculture accounted for 4.2% of the Hungarian GDP in 2006, manufacturing for 22.6%, construction for 4.8%, while services for 65.6%. (KSH, 2007b) As for services, the most important sectors are wholesale and retail (11.5%), transport, storage and communications (7.6%), financial intermediation (4.5%), real estate and business activities (17.9%), while public services account for 18.5%.

Until recently, however, data collection and analyses on RTDI processes have been concerned mainly with manufacturing industries, and the same applies for STI policy measures in most countries, including Hungary.

Hungary is a small open economy, with a very high trade integration rate of 57.6% in 2005 (in terms of goods – Eurostat). Trade is, therefore, of primary importance to economic performance. The bulk of exports is performed by manufacturing industries (88.7% in 2007, own calculation based on KSH, 2007b). The composition of Hungarian exports, in turn, is highly skewed by size of firms and sectors. Large firms accounted for 77.3% of total exports in 2003, while the share of SMEs was 22.7%, with a very low proportion of micro-firms (1.1%) and a modest contribution of medium-sized enterprises (13.9%). The weight of two sectors, manufacture of electrical and optical equipment and automotive industry was almost excessively high, namely 58.6%. Combining these two aspects (size and sector), the share of large firms from the latter sectors was 54.6% in the total Hungarian exports. In comparison with the EU, Hungarian large firms have much higher, while the micro-firms a much lower share in total exports. (KSH, 2006)

The above figures might suggest that the dominant Hungarian manufacturing industries are R&D-intensive ones – at least the widely held assumption is that electronics industry is a so-called high-tech one (characterised by a high proportion of R&D expenditures relative to sales or value-added), while automotive industry is a “medium-high tech” one (characterised by a somewhat lower R&D intensity, but given its weight in the EU economy, it is among the top five sectors in terms of R&D expenditures in absolute terms). These assumptions, however, are not held in Hungary.

Data on the distribution of business R&D spending clearly show that manufacturing industries account for 34% of GERD, and the biggest R&D spender in that branch is the chemicals industry [NACE code 24]: just above 60% of BERD. This high amount is due to 5-6 large pharmaceuticals firms. Automotive and electronics industries (subsumed in sectors 29 and 31), in contrast, devote negligible resources to R&D activities. R&D service providers (sector 73) also have a sizeable slice of the cake (HUF57.4 bn). (Table 1)

Overall – as already pointed out – both GERD and BERD are low in Hungary.

Table 1: **Composition of R&D expenditures by industries in Hungary (2006, %)**

Code	Industries, branch	Expenditure	Current expenditure	Capital expenditure
A+B	Agriculture, hunting and forestry, fishing	0.8%	0.8%	0.6%
D	Manufacturing	34.2%	28.9%	62.4%
15	manufacture of food products and beverages	0.6%	0.6%	0.4%
24	manufacture of chemicals and chemical products	20.6%	15.2%	48.0%
29	manufacture of machinery and equipment	1.7%	1.6%	2.5%
31	manufacture of electrical machinery and apparatus	2.0%	1.6%	4.3%
33	manufacture of medical, precision and optical instruments, watches and clocks	0.7%	0.7%	0.8%
E	Electricity, gas and water supply	0.1%	0.1%	0.4%
F	Construction	0.2%	0.2%	0.3%
G	Wholesale and retail trade, repair of motor vehicles, and household goods	5.5%	6.2%	2.9%
I	Transport, storage and communication	0.3%	0.3%	0.2%
K	Real estate renting and business activities	26.7%	30.1%	14.1%
73	research and development	24.1%	27.4%	11.9%
L	Public administration and defence, compulsory social security	1.6%	1.8%	1.0%
M	Education	24.5%	27.0%	15.7%
N	Health and social work	1.8%	1.9%	1.7%
O	Other community, social and personal service activities	2.2%	2.6%	0.5%
	Cannot be classified by industries	2.0%	-	-

Source: Research and Development, 2006, KSH

Broadening this simple statistical exercise to innovation activities, internationally comparable data clearly suggest that Hungarian enterprises innovate to a significantly lesser degree than businesses in most EU member states. (CIS3 and CIS4) Only about every fifth Hungarian enterprise (with more than 10 employees) reports some kind of innovation activity: 23.3% vs. 44% in the EU15 in 1999-2001, and 20.9% in 2002-2004 (CIS4).[8] This figure puts Hungary to the last but one among the EU25 countries.

The majority of companies (59%) did not innovate due to the lack of demand for new products and services. Similarly to the other countries, Hungarian enterprises mentioned “innovation costs too high” and “lack of own resources” as the two main obstacles hindering innovation activities (CIS4).

Product and process innovations require different types of knowledge, but some elements of those types of knowledge are also interrelated. A majority of innovative Hungarian enterprises only introduced product innovations without process innovations in 1999-2001 – in contrast to businesses in the EU15. Data from the Fourth Community Innovation Survey (CIS4) show a modest improvement in this regard: a relative majority (38.1%) of firms combine these two basic types of innovations, but the Hungarian rate is still lagging behind the practice of advanced countries.[9]

With regard to innovation expenditures (including R&D spending as well as expenditures on machinery, equipment, licences and know-how for the introduction of new products and processes), innovative Hungarian manufacturing companies spent only slightly less in relative terms (as a percentage of turnover), than the leading countries (Belgium, Great Britain, Greece, Germany and Slovakia) in 2000.[10] According to the most recent data (2004), Hungary fell back to the bottom third of the ‘league’ with 3.1%. Innovative Hungarian firms spent almost three-quarters of their innovation expenditures on obtaining external knowledge embodied in machinery and equipment. Thus, spending on both in-house and external R&D activities was significantly lower (13% and 7%, respectively), just as in the less developed countries of the EU.

In sum, demand for either R&D or other types of knowledge is rather low in Hungary, given the low level of knowledge-intensive activities. In other words, most Hungarian manufacturing firms perform relatively simple assembly activities, but the products of these activities can be still exported inside big international groups or global production networks. From a different angle, the OECD classification of sectors by their R&D intensity can be rather misleading from a policy point of view, given the significant deviation between the weight of ‘high-tech’ sectors in the economic structure and their actual knowledge-intensity.[11]

[8] There was practically no difference between the share of innovative firms in manufacturing industries and that of in services in 2002-2004. (CIS4)

[9] Both theoretical considerations and empirical analyses suggest that combining product and process innovations (a) reduce the chance of failed innovation efforts; and (b) increase the economic impacts of innovation. (Cefis and Marsalis, 2005, Mohnen *et al*., 2006, Tang, 2006)

[10] The Hungarian Central Statistical Office has had severe concerns as to the reliability of these data, due to the very low response rate for CIS3. Thus, these data are only available at the Eurostat website.

[11] The Hungarian case is not an ‘exotic’ exception, on the contrary, these features characterise many other countries. (Srholec, 2006) The Hungarian data simply confirm a more general observation: to analyse a link between economic structures and the level of demand for knowledge one should take into account the actual activities performed in a given economy, and especially the knowledge content of these activities. This more demanding task cannot be spared by simply applying the widely used OECD classification of sectors. Firms belonging to the same statistical sector might possess quite different capabilities, e.g. innovation, production, management, marketing and financial ones. Further, they are unlikely to produce identical goods, e.g. in terms of skills and investment requirement, quality, market and profit opportunities. Finally, they perform different activities, especially in their knowledge-

3.1.2 Co-ordinating and channelling knowledge demands

Technology foresight is obviously a prime tool for co-ordination and channelling the knowledge demand. The first national foresight programme in a former centrally planned economy was launched in Hungary in 1997, called Technology Foresight Programme (TEP). Given the legacy of central planning, it was decided to launch a 'bottom-up', expert-driven professional programme rather than a 'top-down', centralised, politically laden one. TEP relied on panel activities, and a large-scale Delphi survey, and was conducted in three stages: pre-foresight (July 1997 – March 1998), main foresight (April 1998 – May 2000), and dissemination and implementation (June 2000 onwards). The Steering Group (SG) and seven thematic panels assessed the current situation, outlined different visions for the future, and devised policy proposals. The thematic panels analysed the key aspects of the following areas: human resources; health and life sciences; information technology, telecommunications and the media; natural and built environments; manufacturing and business processes; agribusiness and the food industry; transport. Their main concern was to identify tools to improve the quality of life and enhance international competitiveness, and thus they emphasised the significance of both knowledge generation and exploitation.[12]

With the benefits of hindsight, TEP can be seen as a mixed case. It is considered a success from a methodological point of view by experts, confirmed also by an independent, external evaluation conducted by an international panel. Furthermore, practitioners and policy-makers in CEE countries and other emerging economies are still interested in the Hungarian experience, and lessons learnt. However, TEP has not had a substantial, immediate policy impact; and its results and recommendations have been implemented with some delay, in several cases in an indirect way.[13] According to the evaluation by the International Panel:

"A careful analysis indicates an impact both on the climate of thought in many policy areas and a series of indirect but significant effects on policy in several domains. It seems that TEP created a reservoir of knowledge that entered the policy system in a non-linear fashion, either through personal networks of participants or simply by having cogent text available when policies were being drafted. (…) The reasons for lack of direct implementation lie, we believe, in the implementation environment in which the programme was situated. Its origins within the OMFB may initially have given it a welcome degree of freedom but with the radical change in nature of that organisation and a change of government, there was no natural channel, nor an obvious champion in government able to act upon the results. Even if OMFB had been unchanged, it was itself at a distance from some of the political decisions implied in the recommendations. (…) The added value of TEP came from being able to take a holistic view of sectors which a purely sectoral exercise could not have achieved. While greater engagement by some ministries would have been beneficial,

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intensity. These dissimilarities are likely to be even more pronounced when we analyse sectors, firms, products and activities across different national systems of innovation and production. In brief, one should make a clear distinction between high-tech sectors and knowledge-intensive activities. (Havas, 2006)

[12] For further methodological and practical details, see Havas (2003).

[13] The futures outlined in the first National Development Plan (2004-2006), as well as the overall vision of the new STI policy strategy, approved by the government in March 2007, heavily rely on the so-called macro visions published in the Steering Group report of TEP.

reporting to them directly could have constrained thinking and lost the benefit of multidisciplinarity within panels and learning generated through interaction between them." (Georghiou, L. et al., 2004, p. 6)

It is a sobering fact that although the final reports of TEP were published in 2001, and thus a new round of foresight would be clearly needed, it is not on the agenda. However, the new STI policy strategy makes explicit reference to the most desirable 'future' developed by TEP, and stresses that modern decision-preparatory tools, including foresight, should be used by the government.

The National Office for Research and Technology launched series of public debates, entitled "Innovation Spring 2005", later renamed as "Innovation Forum". The aim of these events was to identify 'windows of opportunities for leapfrogging', i.e. specific technologies or segments of sectors, which would be capable not only of fast growth, but also of generating similar growth in other sectors. It would be practically impossible to assess the impact of these events on co-ordinating and channelling knowledge demands. It is noticeable, however, that several dedicated measures were launched in that period to support specific technologies (e.g. mobile telecommunications, nanotechnology, and biotechnology).[14]

3.1.3 Monitoring demand fulfilment

There are no signs that demand fulfilment is being monitored in Hungary.

In general, monitoring of the implementation of STI policy measures had not been a widely used practice in Hungary, as no indicators had been set in advance, against which projects and programmes could have been monitored. A visible impact of joining the EU can be detected, however, in the documents of the new policy schemes operated since May 2004: in most cases, indicators are specified *ex ante* for the measurement of their results/ impacts. A monitoring strategy has recently been devised: NKTH commissioned a report by a group of international experts (Arnold *et al*. 2007) for programme monitoring and a pilot monitoring exercise of two policy tools. The new monitoring system should be implemented based on the following underlying principles: policy-relevant programmes and projects – e.g. those schemes and projects where a considerable amount of money is spent, or those pursuing essential policy goals – would be thoroughly monitored, while those with less significant funding – e.g. small grants for international project preparation – would be checked only by financial and administrative criteria. In sum, this new monitoring strategy serves different objectives (not monitoring of demand fulfilment).

Evaluation of STI policy measures is not a widely used practice, either, especially in the case of nationally financed schemes. However, a few potentially important steps have been taken recently.

The National Office for Research and Technology has commissioned a review of the National System of Innovation, to be carried out by the OECD and its international experts. As the first stage of the process, a team of Hungarian experts prepared a Background Report. (Havas and Nyiri (eds), 2008) As a final output, an overarching

[14] Until then, so-called horizontal policy measures had been the main tools, supporting e.g. academia-industry co-operation, modernisation of the physical infrastructure of R&D units, applied R&D, start-up firms, international RTDI co-operation, etc. In short, these, previously predominant measures have not had any technology-specific goals.

study, discussing the current structure and performance of the Hungarian NIS will be produced by October 2008, including a number of operational recommendations by the OECD for improving the prospects of innovation performance in Hungary.

As for the evaluation of individual support measures, one of the basic principles of the Law on Research and Technological Innovation was that publicly financed STI policy measures shall regularly be evaluated by independent experts. Based on the Law, the Government Decree no. 198/2005 specifies the precise range of measures to be evaluated ex-post. As a general rule, one-off schemes above 1 bn HUF (€4m) are to be evaluated within 3 years following the closure of the scheme, whereas continuous programmes (with a cumulated funding over 1 bn HUF) within 2 years of the closure of the given programme cycle. For continuous programmes, irrespective of the volume, ex-post evaluation is compulsory within 4 years of the launch of its first call. Despite these stipulations, only two external evaluations took place in recent years. Based on the prioritisation of the so-called evaluation strategy of the KuTIT[15] setting out the measures to be evaluated in 2007,[16] two further evaluations are currently in progress.

Evaluation of schemes co-funded by the EU, on the other hand, is compulsory. Accordingly, ex-ante and mid-term evaluations of the policy measures launched in January 2004 as part of the Community Support Framework – of which six are directly relevant for RTDI and a further two are of indirect relevance – have been carried out, while the ex-post evaluations will take place in the near future (as these schemes are phasing out).

3.2 Assessment of strengths and weaknesses

The first national technology foresight programme in a former planned economy was launched in Hungary in 1997. It is still referred to, e.g. in the recent STI policy strategy of the government. However, no systematic efforts can be observed to co-ordinate knowledge demand in recent years. Knowledge demand is thus neither appraised, nor channelled in a structured manner, and therefore no mechanisms exist for monitoring the fulfilment of these targets.

Main strengths	Main weaknesses
• The first national Technology Foresight Programme launched in Central and Eastern Europe (completed in 2001)	• No systematic efforts to co-ordinate knowledge demands since 2001 • No mechanisms in place to monitor the fulfilment of knowledge demand

3.3 Analysis of recent policy changes

A new measure was launched in October 2007, called "National Technology Platforms", aimed at supporting the establishment of technology platforms in order to identify areas of breakthrough potential. These platforms should bring together the stakeholders within key technology areas and provide strategic intelligence in order to identify avenues of demand-driven research. The platforms shall define their own

[15] This resolution of 24.10.2007 can be accessed athttp://www.nkth.gov.hu/main.php?folderID=2644
[16] It has to be added, however, that these very same three measures were already mentioned in the 2006 Annual Report of the NKTH (p. 11) as those that are to be evaluated in 2006.

organisational forms, area of operation, and the partners to be involved. Platforms are also expected to maintain contact with representatives of the respective policy areas. The platforms shall provide a situation analysis, and a review of trends, challenges and scenarios [futures] in their respective fields. As a result of their 2-year operation, the strategic goals within the area of RTDI shall be devised in the form of Strategic Research Plans, and related action plans. Eleven such platforms have been established so far (including bio- and nanotechnology, pharmaceutics, humanities, fisheries, food- and automotive technologies etc.), with a total public support of €1.6m (100% public funding in the form of grants).

A new round of the same scheme is underway in order to broaden the scope of technologies covered.

Challenges	Main policy changes
Identification of knowledge demand drivers	A new scheme, called National Technology Platforms was launched in October 2007 to assist companies and publicly financed R&D organisations to identify new technological opportunities, and co-ordinate knowledge demands. These platforms, in principle, can also monitor demand fulfilment.
Co-ordination of knowledge demands	
Monitoring of demand fulfilment	

3.4 Assessment of policy opportunities and risks

The main policy opportunity concerning the identification, co-ordination and channelling of demands for knowledge would be the application of relevant, up-to-date methods, most notably technology foresight. It would be also crucial to monitor demand fulfilment. These types of changes have been recommended also by a recent OECD Report (OECD, 2008, p. 184) Recent significant documents, as well as reorganisations of the STI governance system have had the explicit intention of putting more emphasis on these issues. In this sense, recent policy developments, such as the stipulations of the government's STI policy action plan, might be regarded as a policy opportunity. Furthermore, the creation of a new position of a minister without portfolio for R&D, with the intention of clearer responsibilities and better co-ordination of policies, might open new policy opportunities. However, these commitments might prove to be unfulfilled hopes, i.e. remain at the level of official statements. In addition, the staff of the new minister without portfolio is not appointed yet (as of the end of August 2008), and thus no major steps have been taken. It is not clear, either, whether the new division of labour within the revised government structure will significantly improve the situation, as intended.

Main policy opportunities	Main policy-related risks
• Application of relevant, up-to-date methods, most notably technology foresight, to identify, co-ordinate and channel demands for knowledge	• Fragmented support for RTDI activities, without a comprehensive understanding of knowledge dynamics (drivers for the emergence of new knowledge, demand for knowledge) • Not clear whether stipulations of the recent policy documents will be implemented

3.5 Summary of the role of the ERA dimension

Co-operation with the European Technology Platforms can significantly improve the quality and efficiency of the operation of the recently established Hungarian national technology platforms. Further, exchange of experience among policy-makers – e.g. in the form of dedicated workshops, Open Method of Co-ordination (OMC) tools, "sandwich programmes" – could contribute to a better understanding for the need to apply up-to-date decision-preparatory (policy-making) tools in Hungary to co-ordinate and channel demands for knowledge, as well as monitor demand fulfilment.

4 - Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities, which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge, which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable for economic knowledge producers, as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

4.1 Analysis of system characteristics

4.1.1 Improving quality and excellence of knowledge production

Hungarian researchers are fairly productive in terms of scientific output, especially if their low number and the low level of research expenditures (compared to the EU averages) are taken into account. Output per researcher is close to the EU15 average (85%), while funding is much lower: 40% of EU15 R&D spending per researcher and 47% funding per publications. The quality of publications, as suggested by the citation-related indicators, is also much closer to the EU average than the level of funding. (Havas and Nyiri (eds), 2008)

According to the publication, impact factor and citation data of the Web of Science database, Hungarian researchers have shown outstanding performance in 3 scientific fields in terms of *the number of publications*, namely chemistry, clinical medicine and physics, while no field of science has been labelled as moderate in this respect. Only a single field has achieved an outstanding performance in terms of *citation rate,* namely space science, whereas none in terms of *impact factor*. As for citation rate, only 3 fields have shown a fair position: physics, engineering, computer science, while 12 fields achieved a moderate position. As for impact factor, 4 fields have achieved a fair performance, namely physics, engineering, materials science, and pharmacology and toxicology, while 9 fields only a moderate performance. Combining these two criteria, researchers working in the fields of physics and engineering have reached a fair ranking.[17]

The strengths of the research community are also indicated by the Framework Programme (FP) statistics of the European Union. (See Section 5)

The share of basic research has been fluctuating in recent years, and stood at 26% of GERD in 2006. As for the government sector, the corresponding ratio is around 50%. In terms of scientific fields, Hungary shows high specialisations in natural sciences (especially mathematics, physics and chemistry), as well as in neurosciences, pharmacology, agriculture and computer sciences, according to bibliometrics data. (ERAWATCH, 2007, Figures 9 and 10)

As for the composition of research efforts, a steep reduction in the share of natural sciences took place by 2003, to a level of 37.3%, while the shares of humanities and social sciences in GOVERD increased considerably, that is, to over 10%. (ERAWATCH, 2007 Report)

Concerning the R&D performing sectors, the government sector, mainly comprising the institutes of the Hungarian Academy of Sciences, accounts for a far larger share of GERD than the EU average. The highest number of research units (with very low average number of researchers) can be found in the HE sector. Businesses became the most significant players in Hungary only in recent years – in terms of both research personnel as well as expenditures.

In terms of the number of (FTE) scientists and engineers, the government sector's share was 29.8% of the national total in 2006. This figure reflects a high weight of PROs in the Hungarian NIS compared to the EU27 average (13.6% in 2005; OECD MSTI 2007). According to the ERAWATCH Specialisation Report (ERAWATCH, 2007, Figure 5), the share of natural sciences within GOVERD has decreased from almost 60% in 1993 to below 40% in 2003, but is still the scientific field which receives by far the highest public funding.

The most important player is the *Hungarian Academy of Sciences (MTA)* with its extensive network of research institutes. As of 2007, the MTA had 39 research institutes and 171 research units associated with universities. The MTA has a substantial weight in the Hungarian research system: its share was 16.7% in the total number of researchers (FTE), and 14.3% of the expenditures of all Hungarian R&D units in 2006. Its role is particularly decisive in the field of natural sciences: almost 60% in terms of total expenditures in those disciplines. In terms of "output", 26.1% of books, book chapters and 27.1% of articles published in scientific journals by Hungarian authors abroad in 2006 have been written by MTA researchers. (KSH 2007a)

The MTA has self-governing rights and a high degree of autonomy, and this it bears the principal responsibility for devising and employing mechanisms for ensuring excellence at its institutes. More recently, stricter evaluation criteria have been introduced for the assessment of the scientific performance of the institutes. These

[17] For further details, see Havas and Nyiri (eds) [2008].

are mainly based on the usual indicators of excellence, though there have been initiatives to introduce international peer review and also economic criteria into these appraisals. An overarching reform of the MTA, probably entailing a strengthening of these approaches is on the agenda, and the new law regulating the status of the MTA is expected to be approved in 2008-9.

The President of the Academy has to report on the MTA's activities and on the general conditions of science in Hungary to the government (every year) and to the Parliament (every other year). Funding is mainly provided by the annual budget allocated to the MTA by the Parliament. Besides, the MTA institutes can also apply for additional funds using a number of national (e.g. the National Scientific Research Fund) and EU co-funded schemes by submitting project proposals; that is, competing with other research performers. The MTA institutes participated in 186 FP6 projects, with a total contracted support of €30.6m. (preliminary data; Vizi, 2008, p. 568)

The largest number of research units is operated at higher education organisations, but the average size of these units is rather small, just below 4 FTE researchers. HERD as a percentage of GDP was 0.24% in 2005, which is just over half of the EU average. According to the ERAWATCH R&D Specialisation Report (ERAWATCH, 2007, Figure 4), the distribution of funds in the HE sector is balanced between the various scientific fields with natural sciences, engineering and humanities receiving relatively larger shares of total funding. Here, scientific excellence is still clearly the dominant criterion. As discussed earlier, most of the funding is still based on the normative support and block funding in principle earmarked for research purposes. HEIs are also eligible to a number of competitive funding schemes, both domestic and international ones.

Businesses became the largest employer of (FTE) researchers in 2006 (35.6%), and firms have the biggest share in performing GERD (43.2%), too (KSH, 2007a). Yet, the share of businesses in the total national R&D activities (either in terms of employing researchers or performing GERD) is still rather low in Hungary, compared to advanced countries: one of the most worrisome performance indicators of the Hungarian NIS is the low level of business expenditures on R&D in international comparison, measured either as a percentage of GDP, or that of GERD. The Hungarian BERD/GDP ratio was 44% of the EU27 average (0.48% vs. 1.09%) in 2006, (OECD, 2007, p. 29). As noted above, companies themselves finance their own research endeavours to an extent of over 75%, whereas state support is relatively minor. The two most important sources are the Science and Technological Innovation Fund and the Economic Development Operational Programme. Grants provided by these measures are competitive and project-based. It is the official intention, set out in various documents such as the mid-term funding strategy of the National Office for Research and Technology, to involve international experts on a more regular basis in the usually two- or even three-round selection processes in order to appraise the relevance of the research projects in terms of scientific, societal and economic criteria.

4.1.2 Improving exploitability of knowledge production

Hungarian researchers are far less successful in terms of producing directly exploitable knowledge; in fact, this particular aspect has been often identified as one of the major weaknesses of the research system. The number of patents (EPO, USPTO or Triad[18]), community designs and trademarks per million population are a mere 5-20% of the corresponding EU averages, and these indicators even show a decreasing tendency. However, several arguments can be put forward, why these are not adequate metric for assessing the performance of a less developed (catching up) economy and its national innovation system (NIS). First, at this stage of development, it might not be considered a meaningful (or feasible) target at all of the national economy and its firms to produce as many patentable products as possible. It is more appropriate to concentrate on exploiting knowledge, partly produced elsewhere (to a large extent abroad), by other players. That requires enhancing learning capabilities for more efficient absorption of new technologies, as well as non-technological innovations. These activities, contrary to widely held beliefs, still require fairly developed R&D and innovation skills, in order to identify the most suitable pieces and types of knowledge to be acquired (often imported), and 'assemble' those in an appropriate way, suited to the new context.[19]

Second, a wide array of other means are utilised by firms to protect intellectual property, many of which are not captured by measurable or readily available indicators. Thus, a low level of patenting activity does not necessarily mean that single organisations, or players of an innovation ecosystem as a whole, are not capable of producing exploitable knowledge.

A wide range of interconnected factors explains this particular weakness of the Hungarian innovation system. Firstly, there is weak co-operation between publicly financed research units (including HEIs) and industry. A recent monitoring report by an international expert group (Arnold *et al*. 2007), including a pilot assessment of two major schemes, namely the Asboth and the Regional Knowledge Centres at Universities (RET) [Pázmány Péter] Programmes, confirms the pertinence of this challenge. To a large extent, similar diagnoses are observed for both measures, e.g. that industrial exploitation of university research results are weak; universities lack experience to address industrial needs; there are few incentives for universities to perform industrially relevant research; university regulations and management are not compatible with the needs of businesses and vice versa; commercialisation activities at universities are at an inadequate level, etc. The report concludes that Pazmany Regional Knowledge Centres at Universities have not fully achieved their goals of strengthening organic and long-term co-operations. Similarly, the mid-term SME Strategy devised by the Ministry of Economy and Transport points out that there is weak or no consideration for industrial needs in publicly financed research units due to diverse incentive structures, i.e. economic aspects are not considered in the management of such institutes, whereas knowledge transfer is impeded by an alarmingly low level of researcher mobility between sectors and fields of research. (GKM 2008, p. 43-44)

The ERAWATCH R&D Specialisation Report (ERAWATCH, 2007) has found no correlation between economic or BERD specialisation and patenting activity, which can probably be attributed to the very low occurrence of patents. However, the report documents a very high patent specialisation in the chemical, pharmaceuticals and

[18] A patent is a triad patent if, and only if, it is filed at the European Patent Office (EPO), the Japanese Patent Office (JPO) and is granted by the US Patent & Trademark Office (USPTO).

[19] In other words, adoption always requires adaptation, too, and thus it is gross simplification to speak of 'imported' innovations (assuming that no local RTDI efforts and knowledge are needed by those firms introducing these types of innovations).

food sectors, whereas the other important sector accounting for a relatively large share of Hungarian patents, namely electronics, does not show a high level of specialisation in an EU15 comparison.

In recent years, increasing emphasis is placed on aspects of exploitability when allocating public resources for RTDI. In the case of most measures funded by the Research and Technological Innovation Fund or the Operational Programmes, the project selection criteria include economic and/or societal relevance and sustainability. Further, ex-ante indicators should be defined, such as the expected or desired growth of the profits or revenues, the number of new products, patents, and the like. As for the new National Technology Programme, the applicants are required to justify the socio-economic relevance and economic viability of their planned projects to an expert committee, as an integral and obligatory part of the selection process.

As discussed in the next sub-section, attempts are being made to create a more favourable regulatory environment and incentives for PROs to accelerate their IPR activities and produce exploitable knowledge.

4.2 Assessment of strengths and weaknesses

Based on the above discussion, the main strengths and weaknesses of the system with regard to knowledge production (and exploitability) can be summarised as follows. The Hungarian innovation system shows a relatively good performance in traditional research indicators such as publications and citations, especially at PROs in a number of disciplines (particularly if their relatively low budgets are taken into account). A few R&D-intensive sectors, most notably the pharmaceuticals industry, show relatively good patenting performance. Hungary as whole, however, is way below the EU average on IPR indicators. (EIS, 2008) The main weaknesses pertain to the overall weak consideration of societal and economic aspects (including industrial needs) at publicly financed research institutes, due to the mismatch in the academic and business incentive structures (e.g. scientific excellence and core funding vs. competitive public funds based on economic exploitability; see Arnold *et al*., 2007), low levels of researcher mobility among R&D performing sectors (GKM, 2008, p. 43-44), as well as weak demand for innovative products and services (CIS3 and CIS4). This results in a generally weak exploitation of the available research results.

Main strengths	**Main weaknesses**
• High quality of research in a number of scientific fields in international comparison; • Relatively productive researchers at publicly financed R&D units; • Relatively good patenting activities in a few R&D intensive sectors.	• Mismatch in the incentive structures among academic and business actors; • Poor consideration of industry's needs; not conducive to industry-academia co-operation and exploitation of research; • Block funding is still the dominant source of funding in the public sector; • Low level of researcher mobility among R&D performing sectors; • Weak demand for innovative products and services; • Insufficient consideration of societal and industrial needs and economic aspects at publicly financed R&D units; • Low level of patenting activities in general.

4.3 Analysis of recent policy changes

Societal concerns have not been addressed in the practice of STI policies until recently, but with the approval of the mid-term STI policy strategy of the Hungarian government they have become part of the policy agenda. The production and exploitation of knowledge and ensuring that research is tightly connected to societal concerns has a prominent position in this recent policy document. One of its objectives is to "Strengthen knowledge supporting the competitiveness of society" by „ensuring conditions for scientific research on the basis of excellence criteria. The main factor is quality in societal-economic challenges, research in national values and heritage, as well as in public-interest research not belonging to direct interest in the corporate sphere. The requirements related to research directly utilized in the economy are defined by the corporate sector." (Government, 2007 p. 11) Furthermore, the second priority of the Strategy envisages a "Quality, performance and utilization driven efficient national innovation system", detailing the main objectives and tasks of the government in order to promote the creation of internationally competitive research centres, infrastructures, strengthening regional RTDI capabilities (involving development poles and an emphasis on clusters), promoting flexible co-operation and researcher mobility between the various research performing sectors for more efficient exploitation of knowledge.

As noted in the precious section, it has been decided that more thorough scrutiny of large-scale research projects has to be applied in a number of cases, including both traditional criteria of excellence (mainly at the institutes of the MTA), but more recently also societal relevance and economic viability (e.g. the new National Technology Programme). Similarly, in the case of research units located at HEIs, financed by the MTA, proven excellence, international recognition and economic aspects are to be given more emphasis when allocating extra (competitive resources) to these research projects. Furthermore, international expertise is planned to be utilised more widely, e.g. as part of the peer-reviews for selecting projects for public RTDI funding, or internationally competed director positions at the institutes of the MTA.

Some progress has been made by targeted changes in the regulatory environment, facilitating more active exploitation of research results. The Law on Research and Technological Innovation (Act CXXXIV/2004, effective as of 2005) has introduced the notion of spin-offs into the regulatory framework. Since 2006, every publicly financed research institute is obliged to devise an IPR management strategy. Furthermore, in order to be eligible for funding, beneficiaries of the Research and Technological Innovation Fund are obliged to submit the applicable IPR rules (regarding IPR utilisation and procedures, researcher motivation, licensing) to the funding agency. In many cases, technology transfer offices have been established at publicly financed research organisations to deal with these obligations. In order to facilitate the establishment of spin-offs, the Parliament modified the Law on Higher Education in June 2007. From September 1, 2007 higher education institutes can establish business entities for commercialising their intellectual assets without any formal consent of government authorities. The Act CVI. of 2007 (25 September) on State Property amends the Law on Research and Technological Innovation: it stipulates that, as opposed to the general regulations of the Act, publicly financed research units shall be the owners of acquired IPR and be entitled to a share of the spin-off firm emanating from it. IPR regulation has become more favourable for the exploitation of R&D results by giving property rights to the publicly financed research units and by allowing the establishment of business entities (spin-offs) for the commercialisation of HE intellectual assets.

Since the approval of the Law on Research and Technological Innovation, the number of spin-offs has risen significantly. Though no precise figure is available, the Hungarian Association of Spin-offs estimates that the number of officially recognised spin-offs (i.e. as defined by the Law) is around 40, while that of quasi spin-off (university affiliated) firms is 100-120. Their yearly turnover is estimated to be around €40m. These figures suggest that there is still room and potential for significant improvement in the utilisation of research results.

A recently launched measure, called "National Technology Platforms" aims at supporting the establishment of technology platforms in order to identify areas of breakthrough potential. These platforms should bring together the stakeholders within key technology areas and provide strategic intelligence in order to identify avenues of demand-driven research.

Although the Co-operative Research Centres (KKK) and the Regional Knowledge Centres at Universities (RET or Pazmany Programme) have been key elements of the Hungarian policy mix for a number of years, these can still be deemed as the most relevant ones of facilitating technology transfer and the exploitation of knowledge created at PROs and HEIs. Due to their primary objectives, these are discussed in more detail in Chapter 5. What is important to note here is that according to the new funding strategy of the National Office for Research and Technology, emphasis in the coming years will be shifted towards the creation of a few, large-scale, internationally competitive knowledge centres in a few selected technology areas/ sectors, such as biotechnology, info-communications and automotive industry. The selected so-called "national knowledge- and innovation centres", involving consortia of knowledge producers and users from the main sectors will receive increased funding for a number of years until they become self-sustaining. Their economic and scientific performance will be monitored and assessed on a regular basis.

In the Economic Development and the Regional Development Operational Programmes of the New Hungary Development Plan, there is a strong focus on the so-called "accredited innovation clusters in pole cities": internationally competitive clusters of firms, research institutes, HEIs, municipalities, accredited by the Pole Accreditation Office. The programme is a complex set of measures spanning seven years. The development of the poles is connected to the so-called pole towns and key technology areas, which have been identified in the mid-term STI policy strategy and used consequently in regional development strategies and policies, such as the New Hungary Development Plan. The measures of the complex programme are aimed at the various stages of innovation pole development. A set of schemes promotes the identification and establishment of 150-200 potentially successful clusters. (The first of these measures are to be launched in the second half of 2008.) Following an accreditation process (where the most profitable and internationally competitive clusters are identified), the selected cluster will be eligible for support explicitly targeted at them. Finally, large-scale state support will be available for the most competitive few (approximately 5-15 by 2013) in order to establish complex infrastructural background. It is expected that the direct state funding through the operational programmes, together with the stimulated private investments will add up to a significant €2-3b in the period 2008-13 within the framework of innovation cluster development.

The table below summarises the most important trends in the governance system as well as policy responses to the two main challenges associated with the production and exploitation of knowledge. As elaborated in Section 2.3, the main strategic policy documents have identified major challenges, but current policy-making and implementation practices raise concerns as to whether the envisaged policy responses will yield the desired results. The European Commission's Annual Progress Report on the NRP acknowledges the "limited progress" that has been achieved, but calls for more effective action.

Challenges	Main policy changes
Quality and excellence of knowledge production	• A more focused approach to knowledge centres schemes, with the aim of creating a small number of large-scale, internationally recognised national centres within a selected few scientific fields • The new National Technology Platforms scheme aims at identifying technology areas and research avenues with breakthrough potentials • Growing importance of proven scientific excellence, international recognition and societal relevance when awarding competitive funds • Growing importance is to be given to international expertise, e.g. international peer-reviews in the selection process of publicly funded RTDI projects, or international competition for director positions at MTA institutes
Exploitability of knowledge production	• Recent legislation introduces a number of favourable conditions for retaining IPR, establishing spin-offs, etc. for publicly financed research units • Strategic policy documents as well as the New Hungary Development plan places strong emphasis on exploitation of knowledge, with several measures in place, and an emerging importance of "innovative clusters"

4.4 Assessment of policy opportunities and risks

In relation to policy responses addressing the production and exploitability of knowledge, the following main policy opportunities and risks can be identified. There are a number of apparently relevant initiatives to accelerate knowledge production and to put more emphasis on both scientific excellence and economic/societal relevance at publicly financed research units, through increased importance of competitive funding and more effective scrutiny. Notably, the on-going reforms of the Hungarian Academy of Sciences (MTA) and HE sector, with increased role of a new set of performance indicators, stressing socio-economic relevance of research in funding (selection and evaluation) decisions can be regarded as a key opportunity. These, coupled with policy measures and regulatory incentives to facilitate IPR protection and foster industry-academia co-operation, and the planned strong emphasis on large-scale, internationally competitive centres of excellence and innovation clusters might lead to enhanced exploitation of knowledge. An effective implementation of these steps – taking into account the possible synergies, too – could lead to socially more relevant and exploitable knowledge.

Risks can be attributed to the resistance of vested interests in publicly funded research units and to the challenge of embedding public R&D investments into the broader innovation system. Arguably, the resistance of the MTA and HEIs against fundamental reforms entailing the growing weight of non-traditional selection/ evaluation criteria (e.g. economic considerations as a basis of competitive allocation of public funds) can be an important risk factor. Further, measures aimed at increasing the level of BERD and industry-academia co-operation could lead to one-off, insulated investments, which would not be sustained after public funding has phased out and/or would also leave the other parts of the system untouched, partly as a result of continuing weak demand for innovative products.

Main policy opportunities	**Main policy-related risks**
• Refining existing policy mix for fostering industry-academia co-operation • The reform of the MTA and HE sector, stressing socio-economic relevance of research in funding decisions • Further strengthening the incentives of PROs and HEIs to make increased use of IPR and exploit research results	• The (potential) resistance of the MTA and HEI against fundamental reforms • Measures aimed at increasing the level of BERD and industry-academia co-operation could lead to one-off, insulated investments

4.5 Summary of the role of the ERA dimension

The European Research Area context plays some role in ensuring excellence via the Bologna process as research conducted at universities has to be assessed. One should bear in mind, however, that HE institutes perform only around one quarters of the Hungarian GERD.

5 - Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of the knowledge produced. This is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors to overcome institutional barriers;
- Profiting from access to international knowledge by reducing barriers and increasing openness; and
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

Effective knowledge sharing is one of the main axes of the ERA green paper (EC 2007a) and significant elements of Integrated Guideline no. 7 (IG7) relate to knowledge circulation. To be effectively addressed, these require a good knowledge of the system responses to these challenges.

5.1 *Analysis of system characteristics*

5.1.1 Facilitating knowledge circulation between university, PRO and business sectors

One of the main weaknesses of the Hungarian innovation system is the insufficient level of co-operation between the sectors involved in producing and using knowledge.[20] Researcher mobility is very low between the private and the various types of publicly financed research organisations, which can seriously hinder the dissemination of tacit knowledge. (IS 2007, Havas and Nyiri (eds), 2008)

There are some mechanisms in place to facilitate the institutionalisation of research co-operations. Contract research is one of the main channels which have been gaining importance in recent years. Actually, the 13% share of HERD financed by industry in 2006 was one of the highest in the EU, and an even higher percentage characterises PROs, that is, 14.3% (OECD MSTI 2007).[21] This latter figure is also way above the EU average (which was 8.4% in 2005), and showed a rapid increase in recent years.[22]

These high ratios of business funding might be attributed to the low level of the Hungarian HERD and GOVERD in absolute terms (HERD: approx €300-400m per year; GOVERD is slightly higher). Thus, a few projects commissioned by firms, amounting to relatively small funds by international standards, can lead to a high weight of business funding in HERD. The large yearly variations in terms of GOVERD financed by industry hint to a more general hypothesis: incentives provided by various policy tools are just one element of a bigger, more complex system influencing innovation behaviour of the major actors.

Innovative Hungarian firms conduct at least as intense co-operation activities as the EU27 average. Among the potential innovation co-operation partners, suppliers are at the top (26.2% vs. 16.5% [EU]), followed by clients and customers (19.6% vs. 13.9%). Universities are in third place (13.7% vs. 8.8%). It should also be added, however, that a mere 4.7% of innovative Hungarian firms mentioned universities as highly important source of information. (Community Innovation Survey, CIS4)

While Hungarian firms over-perform the EU27 in almost all partner categories in terms of the frequency of innovation collaborations, the exception is a very significant one, namely co-operation with public research organisations (PROs): (5.0% vs. 5.7% [EU]). (CIS4) It is aggravated by the poor ranking of PROs as a source of important information for innovation. These findings call for major efforts by all interested parties, including policy-makers, given the high importance of the MTA institutes, and the potential associated with the more efficient utilisation of knowledge produced by them.

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[20] To avoid a potential misunderstanding, it should be stressed at the outset that the business sector is engaged both in producing and using knowledge, i.e. the traditional use of the notion of technology transfer – denoting a one-way ‘traffic' from various types of publicly financed research organisations to firms – is grossly misleading.

[21] Just to give an indication, the amount of contract research fees for the institutes of the MTA reached €16m in 2007.

[22] The most successful HEIs to receive non-core funding were the Budapest University of Technology and Economics (raising approximately €24m in 2006 from national R&D grants, international R&D grants and contract research), University of Debrecen (€17m) and the University of Szeged (€12m). (Inzelt *et al*., forthcoming, cited in Havas and Nyiri (eds), 2008, p. 73)

A recent study on 12 Hungarian universities has found that 73% of total publications have been co-publications with other actors outside the university of the lead author. The vast majority of co-authors are either from other universities (57%) or from public research organisations (29%), and only 4% from businesses. There are, however, significant differences across scientific fields. The proportion of business co-authors is the highest at the Semmelweis University (in life and medical sciences) and at the Budapest University of Technology and Economics (mostly in engineering). (Inzelt *et al*., forthcoming)

A number of tax incentives are aimed at both recruiting research personnel already during the training phase (e.g. employing MSc and PhD students), or carrying out research in co-operation with PROs, namely at public research laboratories.

5.1.2 Profiting from access to international knowledge

The Hungarian research community has been relatively successful at participating in various international research initiatives. Hungary has always been among the top three candidate countries/ new member states with respect to the number of the EU Framework Programme for Research and Technological Development (EU RTD FP) project participation and the size of funds awarded. FP4 provided €15.6m to Hungarian project participants. This amount grew to €64.2m in FP5, and €141.5m in FP6. This €141.5m represents 0.89% of FP6 total budget and Hungary has the 16th position out of the 25 member states (only Poland has better position than Hungary in the group of the new members states). The number of projects with Hungarian participants has also grown significantly.

There has also been considerable improvement in terms of Hungarian participation in the FPs. In FP6 there were 755 projects with at least one participant from Hungary and 96 projects were co-ordinated by Hungarian project leaders. Hungarians participated in 1 out of 10 FP6 projects. This share was the highest in the “Citizens”, “Food” and “Euratom” specific programmes. Hungarian researchers were most successful in terms of financial support obtained and the number of participants in the specific programme on Information Society Technologies (IST). A large number of Hungarian teams participated in the specific programmes of Mobility; Sustainable development; Food; Nanotechnologies; and Life sciences as well. The Framework Programmes are much more popular for the academic community in Hungary. Firms’ participation is limited: they represent 17.6% of the total Hungarian project participants. In FP6 relatively high business interests could be seen in the support of Specific International Scientific Cooperation Activities (INCO) (firms accounting for 43% of all HU participants), in aeronautics & space (36%), in nanotechnologies (30%), in food (21%) and in life sciences (20%). In IST the share of business participation is at the level of the Hungarian average (18%). (Data provided by the NKTH)

The institutes of the MTA proved particularly successful in FP project participation: according to preliminary data, MTA institutes participated in 186 FP6 projects, with a total contracted support of €30.6m. FP6 was a success story for Hungarian higher education institutes. In terms of financial support from the EU, the most successful individual applicant in the group of all new member states was the Budapest University of Technology and Economics. There are 7 universities in the top ten Hungarian beneficiaries.

Active Hungarian participation can be observed in other programmes, too, such as EUREKA, COST and bilateral intergovernmental ones. Further, Hungarian researchers also benefit from having access to large-scale pan-European research infrastructures, such as CERN. These and other bilateral and multilateral R&D programmes are crucial for Hungarian project participants. They are important vehicles for the Hungarian RTDI community to gain access to international networks of knowledge creation, as well as to additional sources of funding.

Most Hungarian STI policy schemes are open to foreign researchers, too.[23] Hence it can be another major source to profit from access to international knowledge. Yet, it is still unusual to have foreign partners in these projects. Further, Hungary has participated in a small number of ERA-Net projects, too, which, in principle might lead to co-operation between the participants of nationally or jointly funded projects and thus enhanced knowledge exchange at the level of research performers. In practice, however, no such impacts can be observed so far. As stressed above, the relevant channels are still the more 'traditional' bilateral and multilateral R&D programmes.

It can be seen as an indication of international orientation of Hungarian researchers that 41 percent of all scientific publications in 2006 have been produced in international co-operation. (MTA, 2007, p. 5)

Another major way to access international knowledge is via foreign-owned firms operating in Hungary, and perhaps even more importantly, their parent companies. These firms play a dominant role both as producers of knowledge (through their overwhelming weight in BERD) and by constituting demand for domestic knowledge (mainly in the form of qualified research personnel). Their knowledge is also diffused among their Hungarian partners, most notably suppliers. About 16 percent of BERD was financed by foreign sources in 2006 (KSH, 2007a).

5.1.3 Absorptive capacity of knowledge users

The capacity of domestic firms, especially SMEs, to absorb (scientific and technological) knowledge can be deemed low in general, as indicated by several indicators used in the European Innovation Scoreboard. (EIS, 2008) A single figure tells volumes: only one in five enterprises are innovative. (CIS4) Poor performance in indicators reflecting the absorption capabilities of firms, such as participation in life-long-learning (LLL), tertiary education or broadband penetration suggests that a fast improvement cannot be expected. It is also a worrisome fact that only around 700 SMEs (out of several hundred thousand ones) conduct R&D activities. The dynamics in this respect is more promising: the number of research units operated by these types of firms has more than doubled between 2000 and 2006 (albeit from a very low level). The various nationally and EU co-funded schemes to foster RTDI activities of SMEs are likely to have contributed to this increase.

As discussed in Section 2.1.4, the low number of S&E graduates and research personnel also clearly hinders an intense knowledge circulation and exploitation.[24] Further, firms identify the lack of sufficient financial resources, as well as a low level

[23] As a general rule, foreign researchers can join a consortium submitting a project proposal, but in most cases without being eligible for Hungarian funding.
[24] For further details, consult the annual ProInno TrendChart Reports on Hungary; available at http://www.proinno-europe.eu/index.cfm?fuseaction=country.showCountry&topicID=263&parentID=52&ID=20

of demand for innovative products and services as major barriers to innovation. (CIS4)

One way of assessing the absorptive capacity of firms would be to analyse their participation and success rate in schemes promoting RTDI. Unfortunately, only scattered information is available, mainly drawn from monitoring data from the first National Development Plan. These clearly show that companies were very active in submitting proposals. The mid-term evaluation of the Economic Competitiveness Operational Programme (2004-2006) carried out in early 2006 gave an overall positive assessment on the absorptive capacities. The budget allocated for the RTDI priority was committed by the end of 2005, and the demand exceeded the available resources by 80%. The success rate was around 50% in terms of both the number of applications and by financial means, but in some schemes it was over 70%. A large number of applications (over 1,500) were submitted by enterprises and about 1,000 projects led by firms have been granted. Thirty-three applications were submitted by companies to improve their RTD infrastructure and 24 were granted. The 14 Co-operative Research Centres granted also had many companies among their consortia members from the targeted technology area and/or sector, but their number is not published.

5.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the system with regard to the circulation of knowledge both within the national system as well as internationally can be summarised as follows. Research institutes are rather actively participating in European research co-operations, and there are a number of support measures and incentives in place to facilitate these, as well as industry-academia co-operation. Yet, the occurrence of organic and lasting co-operations, which would enable a systematic circulation of knowledge, remains insufficient. In particular, the knowledge base of PROs is clearly under-utilised, as the level of academia-industry co-operation (especially with PROs) remains low due to the mismatch in the incentive structures, the poor consideration of industrial needs, and the weak mobility of researchers between sectors. (Arnold *et al*., 2007; OECD, 2008) In brief, the isolated efforts are not conducive to the exploitation of research. These complex challenges clearly call for more effective policy responses. Furthermore, firms' – particularly domestic SMEs' – capabilities of absorbing increasingly complex (technological) knowledge are rather weak.

Main strengths	**Main weaknesses**
• A number of policy measures in place for fostering academia-industry co-operation (as a primary or a secondary objective), and participation in international RTDI projects; • Intense and successful participation in international RTD(I) projects • Several policy schemes in place to strengthen absorptive and innovation capacities of SMEs	• Low level of academia-industry co-operation (especially with PROs) • Weak mobility of researchers between sectors • Low absorptive capacity of firms, especially domestic SMEs

5.3 Analysis of recent policy changes

Fostering co-operation among the producers and users of knowledge has been among the first objectives of Hungarian STI policy since the late 1990s. (Inzelt, 2004) These measures have had more significant impacts than the more recent ones, and thus it is worth briefly recalling them. One of the first major such schemes, following successful foreign examples, was aimed at establishing Co-operative Research Centres with the participation of firms and publicly financed research organisations (PROs and HEIs). The success of this scheme is underlined by several facts, identified by an independent, ex-post evaluation. (Netwin Kft and Laser Consult Kft, 2005) The final report found that the scheme basically attained its goal in strengthening research co-operation, creating jobs and products with higher knowledge content. Based on the recommendations of the evaluation, the scheme has been continued partly as a new, EU co-funded measure (providing funding for newly established centres) and as a purely national one (for the continued financial support of centres set up as a result of the original scheme). The fact that currently 19 such centres are operated in various parts of the country in a wide range of scientific and technologic fields shows the popularity of the initiative. Furthermore, a similar scheme, with more emphasis on the regional aspect as well as the knowledge production role of universities, has been launched in 2005, entitled Regional Knowledge Centres at Universities (RET, or Pazmany Programme).

It has also been noted that there are apparent overlaps between these programmes without clear differentiation of either the main objectives or the target groups. (Veres and Krisztics, 2006) Also, the number of supported centres (19+19) is probably too high for such a small research system to be economically efficient. Therefore, in order to attain a “critical mass”, the recent strategy document of the National Office for Research and Technology envisages a much more focused approach to funding the centres, and will provide larger amounts of support to a radically reduced number of so-called national research centres. The intention is to create large-scale but internationally competitive centres in a small number of selected technology areas, by avoiding the fragmentation of the available resources. (NKTH, 2007, p. 21)

As described in Chapter 4, the strong focus of the Operational Programmes of the New Hungary Development Plan are expected to have knowledge and technology spill-over effects on firms actively participating in the clusters (e.g. as suppliers). It is also envisaged that the regional environment of the clusters will reap benefits from the overall increase in the knowledge base, thus raising the level of absorptive capacities.

The government coalition, in office between 2002 and 2008, defined as one of its key priorities to raise the level of IT skills and broadband penetration rates, which yielded relatively significant results, albeit from a very low base (e.g. broadband penetration increasing from 29% of the EU average to 45% in the period 2004-6). Furthermore, as discussed in relation to resource mobilisation (providing sufficient human resources), attempts have been made to provide direct and indirect incentives for the pursuit of research careers (e.g. by raising the quota of publicly funded S&E students). Another major concern for the (former) Ministry of Economy and Transport was to address the low level of entrepreneurial skills of businesses in general, but also of those aiming to exploit research results. For instance, a recent scheme (called Fostering Start-up Entrepreneurial Activities) operated by the Ministry and the Hungarian Economic Development Centre (MAG Zrt.) targets start-up companies, and as one of its key target groups, technology-intensive spin-offs emanating from HEIs, public research institutes and carrying out RTDI activities. It aims to disseminate knowledge pertaining to entrepreneurial culture, management skills, business planning, application systems, and market-oriented ICT skills. To this end, the scheme supports the development of curricula and consultancy services to disseminate the vital skills and good practices.

Several measures have been in place for a number of years to facilitate participation in international networks, co-operation, FP projects, conferences, etc. Hungarian participation in FP6 and dedicated measures fostering participation are due to be evaluated in 2008. However, popularity and the active participation of Hungarian researchers and institutes in these programmes indicate that these had been at least partly successful, and thus similar measures were launched in 2007 to support Hungarian participation in FP7 projects.

Also, as discussed in Section 4.3, it is planned to rely on international expertise more intensely; e.g. international peer-review is to be used more widely when awarding public funding; and foreigners can also apply to become directors of MTA institutes. However, attracting foreign researchers is remains a bottleneck not adequately addressed.

The table below summarises the most important trends in the governance system as well as policy responses to the two main challenges associated with the production and exploitation of knowledge. As pointed out in Section 2.3, the main strategic policy documents have identified major challenges, but current policy-making and implementation practices raise concerns as to whether the envisaged policy responses will yield the desired results. The European Commission's Annual Progress Report on the NRP acknowledges the "limited progress" that has been achieved, but calls for more effective action. (EC, 2007b)

Challenges	**Main policy changes**
Knowledge circulation between university, PRO and business sectors	• Recent re-focusing of long-standing measures fostering industry-academia co-operation (i.e. the intention to create a few large-scale, internationally competitive national centres of excellence)
International knowledge access	• Intention to rely more frequently and intensely on foreign expertise when awarding RTDI grants • Sustained support for Hungarian participation in international research projects
Absorptive capacity	• Focus on improving IT-skills, raising the level of human resources with S&E competences and promoting entrepreneurial skills • Significant resources earmarked for the development of innovative clusters with potential spill-over effects and potentially improved absorptive capacities of firms participating in the clusters

5.4 Assessment of policy opportunities and risks

Regarding policy responses addressing the circulation of knowledge, the following main policy opportunities and risks can be identified. There are a number of policy measures in place addressing the need to enhance co-operation among the main producers and users of knowledge. Some of the most relevant measures have been running for years, with some tangible impacts. (Netwin Kft and Laser Consult Kft, 2005) A recent monitoring report (Arnold *et al.*, 2007) and qualitative evidence, however, seem to suggest that several bottlenecks in the design and implementation of these schemes hinder the emergence of lasting and organic co-operations (especially with PROs), which would facilitate the systematic circulation and exploitation of knowledge. NKTH, the government agency responsible for these measures has recently declared its intention to concentrate the available resources in order to create a smaller number of internationally competitive research centres. (NKTH, 2007)

Noteworthy developments have taken place in recent years with regard to some aspects of boosting enterprises' absorption capacities, such as improvements in ICT indicators. The still existing gap in this field provides ample room and opportunities for a continued focus of policies aimed at the dynamic enhancement of these skills. Furthermore, the recent emphasis on innovation clusters (especially with regard to the use of the Structural Funds) might provide a new policy framework for an overall increase in the absorptive capacities among small and medium-sized cluster members and even beyond, due to – intended and unintended - diffusion processes.

Main policy opportunities	Main policy-related risks
• Efforts and resources devoted to create a small number of internationally competitive research centres • Continued focus on improving absorption capacities, including measures to promote innovative clusters	• The existing measures promoting industry-academia co-operation continue to produce non-lasting and non-organic co-operations, which do not facilitate a systematic circulation and exploitation of knowledge

5.5 Summary of the role of the ERA dimension

As already pointed out, Hungarian researchers have been relatively successful at participating in various international research initiatives. Hungary has always been among the top three candidate countries/ new member states with respect to the number of project participation and the size of funds awarded by the various RTD Framework Programmes of the EU (since FP4). Active Hungarian participation can be observed in other programmes, too, such as EUREKA, COST and bilateral intergovernmental ones. These and other bilateral and multilateral R&D programmes are important vehicles for the Hungarian RTDI community to benefit from, and contribute to, knowledge circulation. Hungarian researchers also benefit from having access to large-scale pan-European research infrastructures, such as CERN.

Further, foreign researchers in principle can join consortia submitting project proposals seeking financial support from Hungarian STI policy schemes (as a general rule, without being eligible for Hungarian funding). Yet, it is still unusual to have foreign partners in these projects, and thus it has not become a major source to profit from access to international knowledge so far. Hungary has also participated in a small number of ERA-Net projects, which eventually could lead to enhanced knowledge exchange among research performers. In practice, however, no such impacts can be observed so far. In sum, the relevant channels are still the more 'traditional' bilateral and multilateral R&D programmes.

6 - Overall assessment and conclusions

This section brings together the main results of the foregoing analysis: (i) the strengths and weaknesses of the Hungarian national innovation system; (ii) the main policy opportunities and policy-related risks; and finally (iii) the actual and potential impacts of the ERA on the

6.1 Strengths and weaknesses of research system and governance

The report has identified several strengths and weaknesses of the Hungarian national innovation system. These are summarised below, organised by the four main domains and the related policy challenges. A generic feature, affecting all the four domains, is that a large number of apparently relevant policy schemes are in place – yet, Hungary's performance is lagging behind most EU countries.[25] One factor explaining this observation can be that policy-making structures and resource allocation mechanisms do not always operate as intended. Another major reason is that – as companies perceive – demand is weak for innovative products and services. (CIS4)

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	• Strong traditions in science and technology • Low level of GERD and especially BERD; a small share of innovative companies
	Securing long-term investment in research	• Multi- year RTDI support schemes • High share of foreign R&D funds in international comparison, esp. for firms • Policy-making structures and resource allocation mechanisms do not always operate as intended
	Dealing with barriers to private R&D investment	• Apparently appropriate incentives for companies to invest in RTDI • High concentration of RTDI activities (by firm size, ownership, and sectors) • Unfavourable framework conditions: not conducive to invest in research • Low level of available venture capital
	Providing qualified human resources	• Highly respected S&E education system • The level of qualified human resources for (future) RTDI activities is inadequate • Unfavourable conditions for human resources: research is not an attractive career, potential brain drain
Knowledge demand	Identifying the drivers of knowledge demand	• The first national technology foresight programme in a former planned economy was launched in Hungary (in 1997)
	Co-ordination and channelling knowledge demands	• No systematic efforts to co-ordinate knowledge demands since 2001
	Monitoring of demand fulfilment	• No mechanisms in place to monitor the fulfilment of knowledge demand

[25] It is clearly reflected in the EIS indicators (EIS, 2007), and have been noted by earlier reports; see, e.g., the annual country reports for the TrendChart project, or the country report for the "Policy Mix Project" (Veres and Krisztics, 2006).

Domain	Challenge	Assessment of strengths and weaknesses
Knowledge production	Ensuring quality and excellence of knowledge production	• High quality of research in a number of scientific fields in international comparison • Relatively productive researchers at publicly financed R&D units
	Ensuring exploitability of knowledge	• Block funding is still the dominant source of funding in the public sector • Mismatch in the incentive structures among academic and business actors • Insufficient consideration of societal and industrial needs and economic aspects at publicly financed R&D units • Weak patenting activities in general
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	• A number of policy measures for fostering academia-industry co-operation; yet, low level of academia-industry co-operation (especially with PROs) • Low level of researcher mobility among R&D performing sectors
	Profiting from international knowledge	• Intense and successful participation in international RTD(I) projects • Several policy schemes in place to facilitate participation in international RTD(I) projects
	Enhancing absorptive capacity of knowledge users	• Several policy schemes in place to strengthen absorptive and innovation capacities of SMEs • Low absorptive capacity of firms, especially domestic SMEs

6.2 Policy dynamics, opportunities and risks

Several opportunities and risks can be identified in the four policy domains analysed in this report. With regard to resource mobilisation, the implementation of the government's own policy initiatives and commitments, presented in recent major policy documents, such as the strengthening of the STI governance system is the main opportunity. It could be underpinned by an efficient use of the significant resources stemming from the Structural Funds, in order to tackle a wide range of challenges and bottlenecks of the Hungarian research system, following a complex, systemic approach. Given the previous poor implementation practices and the lack of systematic evaluation of policy measures, it is uncertain if the government can achieve its declared objectives. A related risk can be attributed to the lack of an overall, strong consensus among stakeholders and policy-makers on the desired objectives and instruments, and thus the policy environment is unpredictable (e.g., goals and commitments can be easily abandoned in case the responsible officials are replaced). Despite a wide range of potentially adequate policy measures and incentives, BERD and GERD are way below the levels set by the Lisbon-Barcelona targets. In terms of securing resource mobilisation from the human resources side, the lack of adequate policy measures for countering brain-drain and for attracting foreign researchers is an important risk.

The government's recent STI policy action plan stipulate that it is an important task to apply relevant, up-to-date methods – notably technology foresight, technology assessment and technology watch – to identify, co-ordinate and channel demands for knowledge. However, the prevailing practice is one of fragmented support for RTDI activities, without a comprehensive understanding of knowledge dynamics (drivers for the emergence of new knowledge, and demand for knowledge).

Refining the existing policy mix for fostering academia-industry co-operation, the reform of the MTA and HE sector, with increased role of a new set of performance indicators, stressing socio-economic relevance of research in funding (selection and evaluation) decisions, as well as further strengthening the incentives of PROs and HEIs to make increased use of IPR and exploit research results are envisaged in recent strategic documents and policy initiatives. A conscious combination of these steps could lead to socially more relevant and exploitable knowledge. However, the potential resistance of the MTA and HEIs against fundamental reforms – entailing the increasing weight of non-traditional selection/ evaluation criteria – might hinder the implementation of the initiated changes. Measures aimed at increasing the level of BERD and industry-academia co-operation could lead to one-off, insulated investments, which would not be sustained after public funding has phased out and/or would also leave the other parts of the system untouched, partly as a result of continuing weak demand for innovative products.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Efficient use of the significant resources stemming from the Structural Funds • More emphasis on RTDI in the revised government structure • Implementation of the mid-term STI policy strategy, especially the strengthening of the STI governance system	• Lack of consensus, unpredictable policy environment • Resource mobilisation (especially BERD) is insufficient to meet Lisbon target • Poor implementation practices • Lack of adequate policy measures to tackle brain drain and attract researchers from abroad
Knowledge demand	• Application of relevant, up-to-date methods to identify, co-ordinate and channel demands for knowledge	• Fragmented support for RTDI activities, without a comprehensive understanding of knowledge dynamics • Not clear whether stipulations of the recent policy documents will be implemented
Knowledge production	• Refining existing policy mix for fostering industry-academia co-operation • The reform of the MTA and HE sector • Further strengthening the incentives of PROs and HEIs to make increased use of IPR and exploit research results	• The (potential) resistance of the MTA and HEI against fundamental reforms • Measures aimed at increasing the level of BERD and industry-academia co-operation could lead to one-off, insulated investments
Knowledge circulation	• Efforts and resources devoted to create a small number of internationally competitive research centres • Continued focus on improving absorption capacities, including measures to promote innovative clusters	• The existing measures promoting industry-academia co-operation continue to produce non-lasting and non-organic co-operations

Recently announced initiatives signal the intention to create a small number of internationally competitive research centres. The concentration of resources devoted to this objective might result in a more efficient use of public funds for promoting industry-academia co-operation, a cornerstone of knowledge circulation. These intentions are planned to be backed by a continued focus on improving absorption capacities (especially that of domestic SMEs), including measures to promote innovative clusters. These objectives have a central position in the various Operational Programmes of the New Hungary Development Plan (co-financed by the EU Structural Funds). However, the experience so far has been that the existing measures promoting industry-academia co-operation tend to produce non-lasting and non-organic co-operations, which do not facilitate a systematic circulation and exploitation of knowledge.

6.3 System and policy dynamics from the perspective of the ERA

In recent years Hungarian policy-makers have devoted particular attention to strengthening international RTDI co-operation. Membership in various international organisations such as COST, EUREKA, and CERN has been significant for the Hungarian research community. EUREKA offered opportunities for academia-industry collaborations, including co-operation with international industrial partners. The large number of bilateral intergovernmental S&T agreements has also accelerated the internationalisation of Hungarian RTDI activities.

As for resource mobilisation, two recent policy actions are worth mentioning. Two funding agencies, OTKA and NKTH have launched a joint scheme (entitled OTKA-H07) for promoting the development of human resources for basic research. The measure has a strong international character, reflected in its three funding lines: (1) supporting the inflow of researchers working abroad (indirectly promoting the return of Hungarian researchers working abroad); (2) funding research activities of young scientists with PhD either at prominent Hungarian or foreign laboratories; and (3) supporting the access of large research facilities abroad (like CERN, EMBL, ESA, ESRF, etc.) for PhD students or young scientists with PhD.

Further, a roadmap for the development of the national research infrastructure is to be devised, taking into account the ERA dimension.

As for policies related to knowledge demand, two major opportunities can be highlighted from the point of view of the ERA. First, co-operation with the European Technology Platforms can significantly improve the quality and efficiency of the operation of the recently established Hungarian national technology platforms. Second, exchange of experience among policy-makers – e.g. in the form of dedicated workshops, OMC tools, “sandwich programmes” – could contribute to a better understanding for the need to apply up-to-date decision-preparatory (policy-making) tools in Hungary to co-ordinate and channel demands for knowledge, as well as monitor demand fulfilment.

As for knowledge production, the European Research Area context plays some role in ensuring excellence via the Bologna process as research conducted at universities has to be assessed. One should bear in mind, however, that HE institutes conduct only around one quarters of the Hungarian GERD.

Knowledge circulation has been significantly fostered by EU schemes and initiatives. Hungary has always been among the top three candidate countries/ new member states with respect to the number of project participation and the size of funds awarded by the various RTD Framework Programmes of the EU (since FP4). Active Hungarian participation can be observed in other programmes, too, such as EUREKA, COST and bilateral intergovernmental ones. These and other bilateral and multilateral R&D programmes are important vehicles for the Hungarian RTDI community to benefit from, and contribute to, knowledge circulation. Hungarian researchers also benefit from having access to large-scale pan-European research infrastructures, such as CERN.

In principle, consortia seeking financial support from Hungarian STI policy schemes can have foreign researchers, too, as partners. (As a general rule, however, foreign partners are not eligible for Hungarian financial support.) So far it has not become a major channel to exploit international knowledge, given the fact that foreign partners seldom join these projects. Hungary has also been involved in a few ERA-Net projects. These co-operations could lead to international R&D projects, and thus a knowledge exchange can be facilitated among the participating researchers. So far these potential advantages have not materialised. The more ‘traditional’ bilateral and multilateral R&D programmes can still be regarded as the most significant channels to access the international knowledge pool.

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List of Abbreviations

ÁSZ	State Audit Office (in Hungarian: Állami Számvevőszék)
BERD	Expenditure on R&D in the Business Enterprise Sector
CERN	European Organisation for Nuclear Research
COST	European Cooperation in the field of Scientific and Technical Research
CIS	Community Innovation Survey
EDOP	Economic Development Operational Programme (of the New Hungarian Development Plan of 2007-2013) (in Hungarian: Gazdaságfejlesztési Operatív Program - GOP)
EIS	European Innovation Scoreboard
EMBL	European Molecular Biology Laboratory
EPO	European Patent Office
ESA	European Space Agency
ESRF	European Synchrotron Radiation Facility
ERA	European Research Area
EU RTD FP	EU Framework Programme for Research and Technological Development
FDI	Foreign direct investment
FTE	full-time equivalent
GDP	Gross Domestic Product
GERD	Gross expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GKM	Ministry of Economy and Transport (in Hungarian: Gazdasági és Közlekedési Minisztérium)
HEI	Higher Education Institute
HERD	Expenditure on R&D in the Higher Education Sector
IG	Integrated Guideline
INCO	Specific International Scientific Cooperation Activities
IPR	Intellectual Property Rights
IRIS	Industrial Research Investment Scoreboard
IST	Information Society Technologies
JPO	Japanese Patent Office
KSH	Central Statistical Office of Hungary, HCSO (in Hungarian: Központi Statisztikai Hivatal)
KuTIT	Research and Technological Innovation Council (in Hungarian: Kutatási és Technológiai Innovációs Tanács)
LLL	Life-Long Learning
MAG Zrt	Hungarian Economy Development Centre (in Hungarian: Magyar Gazdaságfejlesztési Központ Zrt)
MFB	Hungarian Development Bank (in Hungarian: Magyar Fejlesztési Bank)

MISZ	Hungarian Innovation Association (in Hungarian: Magyar Innovációs Szövetség)
MSZH	Hungarian Patent Office (in Hungarian: Magyar Szabadalmi Hivatal)
MTA	Hungarian Academy of Sciences (in Hungarian: Magyar Tudományos Akadémia)
MTESZ	Hungarian Federation of Technical and Scientific Societies (in Hungarian:
NFÜ	National Development Agency (in Hungarian: Nemzeti Fejlesztési Ügynökség)
NKTH	National Office for Research & Technology (in Hungarian: Nemzeti Kutatási és Technológiai Hivatal)
NRP	National Reform Programme
OECD	Organisation for Economic Co-Operation and Development
OMC	Open Method of Co-ordination
OMFB	Országos Műszaki Fejlesztési Bizottság (National Committee for Technological Development, predecessor of NKTH)
OKM	Ministry of Education and Culture
OTKA	Hungarian Scientific Research Fund (Országos Tudományos Kutatási Alapprogramok)
PISA	The Programme for International Student Assessment
PRO	Publicly Research Organisation
RTDI	Research, Technology Development & Innovation
SF	Structural Funds
SG	Steering Group
SVSZ	Hungarian Association of Spin-off Companies (in Hungarian: Spin-off Vállalkozások Szövetsége)
STI	Science, Technology & Innovation
TEP	Hungarian Technology Foresight Programme (in Hungarian: Technológiai Előretekintési Program)
TTPK	Science & Technology Policy Council (in Hungarian: Tudomány- és Technológia-Politikai Kollégium)
USPTO	US Patent & Trademark Office

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Abstract

The main objective of ERAWATCH country reports 2008 is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports are produced for each EU Member State to support the mutual learning process and the monitoring of Member States' efforts by DG Research in the context of the Lisbon Strategy and the European Research Area. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The reports are based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.
This report encompasses an analysis of the research system and policies in Hungary.

The mission of the Joint Research Centre is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of European Union policies. As a service of the European Commission, the Joint Research Centre functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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