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Foreword

This review of Hungary's Innovation Policy is part of a series of OECD country reviews of innovation policy.* The review was requested by the Hungarian authorities, represented by the National Office for Research and Technology (NKTH), and was carried out by the OECD Directorate for Science, Technology and Industry (DSTI) under the auspices of the Committee for Scientific and Technological Policy (CSTP).

The review draws on a background report commissioned by the Hungarian authorities**, and on the results of a series of interviews with major stakeholders of Hungary's innovation system. The review was drafted by Gernot Hutschenreiter, Michael Keenan (both of the Country Review Unit, DSTI, OECD) and Wolfgang Polt (consultant to the OECD), with contributions from and under the supervision of Jean Guinet (Head, Country Review Unit, DSTI, OECD).

This review owes much to Hungarian government officials, in particular Ilona Vass (Vice President, NKTH), who represented the Hungarian authorities, and József Imre (Deputy Head of Department, NKTH), who helped in providing background information, arranging the interviews in Hungary, and supporting the OECD team throughout the review process.

* See *www.oecd.org/sti/innovation/reviews*.

** The background report was prepared by a team of Hungarian experts and edited by Attila Havas and Lajos Nyiri on behalf of the National Office for Research and Technology (NKTH). The team's senior experts were Balázs Borsi, Annamária Inzelt and György Varga. Further contributions by Gábor Békés, Judit Mosoni-Fried, Tamás Polgár, Andrea Szalavetz and Judit Szilágyi are also acknowledged.

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OVERALL ASSESSMENT AND RECOMMENDATIONS

Achievements and challenges: An increased role for innovation in Hungary's economic development

Over the past two decades, Hungary has made very significant progress in building a market-oriented, competitive economy which is fully integrated into the European Union (EU) and the world economy at large. In the process of EU enlargement, Hungary has moved closer to the core of the European market. New specialisation patterns have emerged, as reflected by the fast-growing exports of manufactured goods, and their shift towards higher skills and quality. Investment by multinational enterprises (MNEs) that have located production plants in Hungary has been a key factor in the restructuring of the productive sector towards more technologically advanced activities.

For some time prior to the recent downturn, Hungary's economic growth was well above that of the more advanced countries, resulting in the convergence of its gross domestic product (GDP) per capita; it has reached USD 18 154 (2006 in purchasing power parity – PPP). However, it has a long way to go to catch up fully, since GDP per capita is still below 60% of the United States' level. This gap mainly reflects lagging labour productivity, while lower labour utilisation accounts for the much smaller remaining difference. In addition, the performance of comparable neighbouring countries indicates that Hungary does not fully realise its economic potential, owing to unstable macroeconomic conditions and structural factors. Among these, this review concentrates on factors that limit innovation capabilities.

Some forms of innovation have played an important role in explaining the robust growth of total factor productivity since the 1990s; these include the adoption of market institutions and related firm-level organisational change, as well as the importation, through foreign direct investment (FDI), of best production and marketing practices. However, at this stage, Hungary's ability to base a further rise in productivity on a new generation of sustained innovations appears limited, as its innovation performance is generally judged to have remained well below its potential. Many of the standard innovation performance indicators confirm that the overall level of innovation activity is low and innovation based on research and development (R&D) even weaker. Hungary exhibits some features of a "dual economy". On the one hand, it has large, often foreign-owned companies, which are well-integrated in international production, distribution and, in some cases, R&D

and innovation networks, but not always well connected to the rest of the Hungarian innovation system. On the other, there is a large sector of domestic firms, notably small and medium-sized enterprises (SMEs) characterised by low productivity and insufficient innovation capabilities, which typically operate in local markets with relatively unsophisticated demand. In spite of some encouraging developments (*e.g.* the emergence of sophisticated suppliers in the automotive industry and of some dynamic research-based firms), the quasi-absence of highly innovative medium-sized enterprises leaves a glaring gap.

The participation of knowledge institutions (mainly the universities and the Academy of Sciences, which plays a major role in the Hungarian research landscape) in innovation activities has improved but remains insufficient. Hungary has built a solid core of high-quality scientific research, produces quite good scientific output at costs well below the European average, and has some promising examples of co-operation between business firms and publicly funded public research organisations in some industries and regions (Budapest, but also locations such as Debrecen and Szeged). However, this relatively large sector of public research organisations could contribute more to innovation in terms of the formation of specialised human resources (notably science and engineering graduates) and of market-driven fundamental research. Fulfilling this task requires a research infrastructure of sufficiently high quality.

In summary, insufficient innovation capability is among the factors preventing Hungary from better adjusting to evolving competition, notably from emerging economies, and from seizing the opportunities arising from technological change and globalisation. OECD countries' experience shows that government policy can play a decisive role in improving innovative performance by establishing favourable framework conditions and adopting policy measures for overcoming specific market or systemic failures. In this context, Hungary should strive to make good use of the opportunities provided by the increased funds to be made available for investment in R&D and innovation by the European Union in the new planning period (to 2013). Efficient use of these resources will require a clear strategic orientation, well-functioning governance mechanisms in science, technology and innovation policy, a strong commitment, and the adoption of good practices in implementation.

Main strengths and weaknesses of the Hungarian innovation system

Hungary's history, geo-political situation, and cultural and institutional characteristics show some specific features which have to be taken into account in an assessment of the current state of its innovation system and in determining the feasibility of policy responses to new challenges and opportunities:

- Hungary has had a rich and at times difficult history, with phases of remarkable success and outbursts of creativity and entrepreneurship. In the recent past, it has re-invented itself as a market economy managed by democratic institutions.
- It is a small open economy with a population of slightly more than 10 million which needs to find an adaptive mode of specialisation to take advantage of the evolution of European and world markets.
- It has a relatively high level of political centralisation. It has a strong and thriving capital region around Budapest (central Hungary), and comparatively high levels of regional disparities, with some mismatch between the location of knowledge institutions and of industrial facilities.
- It has had difficulties in reconciling the political changes required for democracy with the need to secure the minimum degree of continuity necessary for forward-looking, efficient management of the economy. Science, technology and innovation policy is one of the areas in which evidence-based policy making can generate the consensus needed to safeguard long-term strategic investments from short-term policy turbulence.
- Hungary has a long tradition of excellence in science and has produced, notably in the 20th century, many world-class scientists who have made significant contributions to extending the world knowledge frontier in a number of areas. This has contributed to the social prestige of science and technology, but nevertheless additional government efforts are needed to mobilise the scientific community for economic goals.

Main strengths

The main strengths of the Hungarian innovation system include:

- *The legacy of strong and sustained growth of output and productivity*. The overall efficiency of the economy has increased significantly over the last 15 years.
- *A high degree of openness of the economy*. Within a relatively short time, Hungary has become one of the world's most "internationalised" economies and has attracted a sizeable volume of FDI.
- *Improved framework conditions for innovation.* Institutions and framework conditions have evolved rapidly and in many respects now appear to be conducive to innovation. Competition policies, for example, have been adapted to comply with EU standards and made more rigorous. Yet efforts need to be continued to provide framework conditions that increase the incentives for firms to respond to market pressure through innovation, keeping in mind that good framework conditions are necessary but not always sufficient for strong innovation performance.
- *Good quality of research output in some areas*. Hungarian science shows comparatively good overall performance and strong results in some areas of fundamental or more applied research such as physics, mathematics, biology, chemistry, clinical medicine and engineering.
- *Comparatively high "research productivity"*. Publication output per researcher and quality of publications (measured by citation-related indicators) are closer to the EU average than the level of funding might suggest.
- *A solid legal basis for science, technology and innovation (STI) policy*. Hungary's STI policy today rests on a solid legal basis (laws on innovation, the innovation fund, higher education, etc.).
- Most other major institutions of an advanced innovation policy system have also been put in place at least formally, e.g. high-level policy co-ordination and advisory bodies.
- *Existence of a differentiated portfolio of funding schemes* for applied and basic research, managed by specialised funding institutions such as the Office for Research and Technology (NKTH) and the Hungarian Scientific Research Fund (OTKA).
- *Political acknowledgement of the importance of fostering science, technology and innovation*. Fostering innovation has been declared a

priority by the Hungarian government in major policy documents *(*the New National Development Plan, the Mid-term STI Strategy and the Economic Development Operational Plan – EDOP).

Main weaknesses

The main weaknesses of the Hungarian innovation system include:

- *Low level of activity and performance in R&D and innovation, especially in SMEs*, as reflected in many indicators:
  - *Low level of R&D intensity, an even lower level of business R&D spending and weak patent activity.* Moreover, R&D is heavily concentrated in relatively few large firms under foreign ownership, operating in a narrow range of industries. This implies poor capacity to sustain competition in research-based industries and limits spillovers as well as the capacity of the economy to absorb knowledge from abroad.
  - *High regional concentration of R&D activity.* R&D is heavily concentrated in central Hungary. This also holds true for science, technology and innovation governance capabilities.
  - *Relatively low non-R&D investment in innovation by international standards* (such as expenditure on machinery, equipment, licences and know-how for the introduction of new products and processes) although its share in total innovation expenditure is rather high.
  - *Lack of a strong segment of innovative SMEs.* Much of the SME sector records low productivity, lacks entrepreneurial and innovative capabilities, is oriented towards local markets and is insufficiently integrated in global value chains. Hungarian enterprises show a significantly lower propensity to innovate than businesses in most EU member countries.
- *Lack of mobility and co-operation between actors*. The level of co-operation between enterprises and of industry-science relationships, including the mobility of personnel between academia and industry, appears to be low.
- *Slow adaptation of public research organisations, including universities and the Academy of Sciences, to the requirements of a knowledge-based economy.* Only recently have these institutions undergone the profound changes (*e.g.* in steering and funding) that were implemented earlier in most other OECD countries.

- *Insufficient formation of human resources for science and technology*. Hungary turns out fewer graduates in science and engineering relative to the total number of new degrees than most OECD countries. More generally, tertiary-level educational attainment of the working age population is low. The shortage of skilled personnel is likely to become a major bottleneck should the overall level of innovative activity pick up in Hungary.

- *Shortcomings in STI policy*. Major achievements in the area of STI governance – such as the establishment of a solid legal basis for STI policy, other specialised institutions and funding schemes – do not bear full fruit, owing to the way STI policy is implemented in practice. The shortcomings in STI policy will be dealt with below.

Threats and opportunities

Major *threats* to Hungary's future development include:

- *A loss of dynamism with a marginalisation of Hungary as a location for internationally mobile investment and innovation.*

- *Failure to adapt to increasingly innovation-driven competition*, in particular from emerging economies, and to exploit new opportunities in the global economy.

- *Drying up of the pipeline for human resources for science and technology (HRST)*, in a context of growing global "competition for talent".

There are also very significant *opportunities* to be seized:

- *Achieving a high-performing and adaptive innovation system* so as to move towards a more knowledge-based economy.

- *Realising the potential of Hungary's public research organisations* and increasing their contribution to the overall performance of the national innovation system.

- *Making the best use of the substantial EU funds* available for the new planning period (2007-13).

- *Maximising the national benefits for innovation, economic growth and social welfare from the globalisation of R&D through accelerated development of international linkages.*

Shortcomings in science, technology and innovation policy

In spite of substantial efforts to correct weaknesses and build on strengths to seize new opportunities, Hungary's STI policy still exhibits a number of shortcomings. These need to be addressed to improve its contribution to sustainable growth.

Lack of political commitment

While important policy documents stipulate science, technology and innovation as a policy priority, the requisite public investment and constant high-level policy attention to issues related to innovation have too often not followed.

Instability

A lack of stability is epitomised in frequent changes in the status, mandates and operation of key innovation policy institutions (NKTH and its predecessors offer an important, but not the sole example). This has arguably had detrimental effects on the ability of agencies to implement measures consistently, thus blurring signals and creating a good deal of uncertainty among beneficiaries of the policy measures. Moreover, excessive instability is a serious obstacle to institutional learning and to the adoption of an evidence-based approach to STI policy making in Hungary.

Shortfalls in implementation

The difficulties encountered for optimal implementation of STI policy are partly related to the lack of commitment and stability. If the level of policy attention is low and organisations and institutions undergo frequent changes, implementation is likely to suffer. However, additional factors also limit the efficiency of the policy system:

- *Scarce capacity at both the national and regional levels to implement a rather large number of programmes.*
- *Delayed decisions and tardy provision of promised public funding* often make planning of projects by R&D performers, notably business enterprises, very difficult. In addition, in the face of budgetary constraints, the government has sacrificed innovation funding (*e.g.* the co-funding for the Fund for Research and Technological Innovation at one point).

Slow pace of reform

Despite frequent – and in some areas too frequent – changes in the institutional set-up for policy making and innovative policy design, change has been slow in some important parts of the Hungarian innovation system. Hungary has been rather slow to reform its Academy of Sciences. Failure to quickly adopt state-of-the-art evaluation practices to clarify and, where required, to separate the different roles played by the Academy (learned society, research performer, research funder, awarder of scientific degrees and titles, and science policy adviser), has constrained the ability of the Hungarian science system to adapt to the changing scientific research agenda (*e.g.* multidisciplinarity and the growing importance of application-oriented fundamental research) and to attract excellent young researchers.

A slow, insufficiently informed policy learning process

This has translated into a lack of systematic evaluation and broad-based consultation in the preparation of strategic decisions. Tools for strategic policy intelligence and policy learning, such as monitoring, evaluation and technology foresight, are used only occasionally, although it should be acknowledged that most of the programmes and institutions reviewed have not been in place long enough to assess their impact properly. So far, STI policy is "evidence-based" only to a small degree.

- *Lack of co-ordination and consultation*. Although high-level policy co-ordination and advisory bodies (the Science and Technology Policy Council, TTPK, chaired by the prime minister, and the Science, Technology Policy and Competitiveness Council, TTTT) exist, either they have not met in the past two to three years or were, in practice, insufficiently involved in major policy decisions.

- *Low level of stakeholder involvement (industry, the public research community, the financial sector, etc.)*, including in policy-making processes of high relevance, *e.g.* the formulation of the Mid-term STI Policy Strategy.

- *Unsystematic use of monitoring, evaluation* and other tools to inform policy making. Only a few public support programmes have been evaluated externally, and no attempt has yet been made to assess the current "policy mix" (direct support and tax incentives) comprehensively.

- *Lack of statistical information*. There has been, in some areas, a lack of data and difficulties in access to available data.

Strategic tasks and guiding principles

The overriding tasks of Hungary's innovation policy are to strengthen innovation as a driver of sustainable high growth, to achieve convergence with the more advanced OECD economies and to increase living standards for the Hungarian population. Increased innovative capabilities will raise Hungarian firms' competitiveness in more knowledge-based activities. From this perspective, the major tasks of the Hungarian government are to:

- *Raise the R&D and knowledge intensity of the Hungarian economy broadly*, by fostering innovative businesses in manufacturing and services, raising the innovative and absorptive capacities of SMEs, nurturing innovative clusters, and linking up to international sources of knowledge and markets for innovation.
- *Strengthen Hungary's knowledge infrastructures* and improve their capacity to contribute to a well-functioning national innovation system.

In accomplishing these tasks, the Hungarian government should subject its policy to some key guiding principles:

- *Predictable, evidence-based policy* has major advantages. Its implementation facilitates priority setting and customisation, and allows for improvements through learning. For the beneficiaries of policy measures, notably business firms, predictability tends to increase the power of incentives. A prerequisite for a predictable policy is political commitment at the highest executive levels of government.
- *Effective governance.* Political commitment should be reflected not only in adequate budgetary appropriations in support of STI activities, but also in the effective operation of a governance structure entrusted with the preparation of the S&T budget, the steering and funding of STI policy, and its co-ordination with relevant ministerial departments whose actions affect the performance of the STI system. A clearer separation of functions in the STI governance system should be achieved by drawing a clear distinction between policy formulation and policy implementation. Implementation should strive at using an effective mix of mechanisms: co-ordination, competition (*e.g.* competitive funding), co-operation (*e.g.* joint research projects) and performance-based steering mechanisms (*e.g.* performance contracts, well-defined funding criteria in project-based support schemes).

- *Evaluation and accountability.* Regular external evaluation of support programmes and institutions receiving public support should become the norm, with practical consequences for further rounds of support. However, a balance must be struck between the need for periodic adjustments to reflect the findings of evaluations and a certain stability of support to ensure a long-term impact on the behaviour of beneficiaries.

- *A comprehensive approach to fostering innovation* so as to enhance innovation capabilities throughout the economy, including in non-R&D-based activities. Innovation policy should avoid an exclusive or too narrow focus on "R&D" and "high technology". Non-technological or "soft" innovation – notably in the SME sector, which has particularly weak innovation capabilities in Hungary – provides considerable opportunities for boosting productivity and income growth. At the same time the R&D core of the innovation system also needs to be strengthened.

- *A participatory approach to priority setting*. Given limited resources and the economies of scale associated with some investments in R&D, there is a need to set priorities in science and technology. The allocation of resources via bottom-up mechanisms therefore needs to be complemented by some degree of top-down prioritisation in order to reach the necessary scale and critical mass. Market-compatible focusing devices include public-private partnerships for research and innovation. Innovation policy should be receptive to the evolving needs of the stakeholders of the innovation system. Building a vision that is shared by all private and public actors of what should be achieved is a prerequisite for the successful formulation and implementation of a government policy that attains the right balance between top-down and bottom-up initiatives.

- *Balanced policy mixes.* Policy mixes should be adapted to the policy priorities and reflect the need to achieve critical mass in support programmes. In the case of support to business R&D and innovation activities, the policy mix should strike a balance between direct support (*e.g.* matching funds), indirect support and sectoral support by taking account of the types of market or systemic failures these measures are meant to address. In the case of support to public research organisations, it should strike a balance between institutional and competitive funding while encouraging access to external resources.

- *Quality, relevance and critical mass in public research*. Reconciling these three objectives entails a rigorous selection among the research projects and teams applying for support, active involvement of research end users in defining research priorities, and some concentration of resources in selected areas.

- *International openness*. International knowledge flows will remain critical for the development of the Hungarian innovation system. In a small, open economy, most of the knowledge needed to sustain innovation-driven growth must – in one way or another – be "imported" from abroad. Circulation of foreign and national researchers in and out of the country, R&D-related investment by international firms and research performed in Hungary by other organisations of foreign origin are essential. These channels need to be complemented by access to knowledge through markets for technology, outward investment in R&D and knowledge-based activities, and active participation in international innovation networks and research co-operation.

Recommendations

Framework conditions for innovation

The required framework conditions comprise macroeconomic stability, an innovation-friendly tax system and regulatory and intellectual property rights regimes, vigorous competition, openness to international trade and capital flows, and efficient information systems. As part of a continuous effort to pay more attention to their impact on innovation, the government should continuously screen these framework conditions with the following main objectives:

- *Restore and maintain sound macroeconomic conditions, including the sustainability of public finances,* one of the most important conditions for dynamic private and public investment in innovation.

- *Secure a pro-competition stance and other regulatory regimes conducive to innovation.*

- *Continue efforts to reduce the administrative burden* on businesses, including start-ups.

- *Ensure effective implementation of IPR legislation.*

- *Mobilise the financial sector to support innovation*. The government can initially stimulate the engagement of the financial sector through various programmes based on the principle of public-private risk sharing.

- *Identify and address other aspects of framework conditions which reduce the incentives or capabilities of SMEs to become more innovative.*

Strengthening the human resource base for science, technology and innovation

The Hungarian education system can still be considered in many respects a solid pillar of the national innovation system. However, it faces major challenges and must evolve if its positive contribution to achieving national socio-economic goals is to be maintained. A major issue is to maintain high standards despite the dramatic increase in the number of students (enrolments tripled and the number of graduates doubled between 1990 and 2006). Resources invested in the education system, though growing, have not kept pace. Second, over the longer term the share of science and engineering graduates has been in steep decline. This shift in the structure of enrolments and graduates by discipline can create a major bottleneck in the innovation system. The third challenge concerns the need to adapt curricula to the changing needs of the economy and society. Successful innovation requires, in addition to "hard" S&T skills, creative and practical "soft" skills, including the ability to communicate and to co-operate within teams. It also requires an entrepreneurial spirit and innovation management skills. The education system has been slow to make the necessary organisational changes. In fact, Hungarian higher education institutions were only partly successful in implementing new governance structures. Also, the criteria for institutional performance are not yet sufficiently tied to funding decisions. The government should:

- *Strengthen education in mathematics, technology and science in the primary and secondary schools* so that students entering higher education are more motivated and better prepared to take up S&E studies.

- *Consider further measures to increase the share of S&E graduates.*

- *Consider changing the funding criteria and apply stricter quality criteria when accrediting higher education institutions or certifying diplomas* in order to encourage universities to focus more on the quality of education and graduates.

- *Strengthen training at the enterprise level, including in MNEs*, as well as vocational training, while reinforcing the mechanisms through which industry can help adjust curricula to evolving needs.

Improving the governance of the innovation system

In the recent past, much effort has been made to put in place a modern legal and institutional framework for science, technology and innovation policy. At the same time, the system is young and more needs to be done in various areas to achieve arrangements that suit the country's current and future needs and to deliver policy efficiently. STI policy formulation and implementation have to be further improved so that funds are spent efficiently, as Hungary needs to increase investment in R&D and catch up in terms of R&D intensity.

The governance system for Hungary's innovation policy has undergone a number of changes in recent years, at the highest level of policy making and at the level of implementing ministries or agencies. These changes, though sometimes resulting in innovative solutions, such as the establishment of the Research and Technological Innovation Fund financed through a levy, resulted from *ad hoc* decisions due to changes in government rather than a thorough evaluation of institutions and instruments as part of a long-term strategy. While these changes failed to address certain key issues, *e.g.* the need to clarify the institutional positioning of NKTH; their frequency introduced uncertainty into the system and reduced the reliability, transparency and accountability of institutions of importance for Hungarian innovation policy, especially NKTH and the Research and Technological Innovation Fund.[1]

Current and envisaged reorganisations include a redistribution of some competences for innovation policy from the (current) Ministry of National Development and Economy to a new minister without portfolio. Further reforms seem to be imminent. The STI Policy Action Plan envisages a renewal of the institutions at the top of the innovation governance system, notably the restructuring of the Science and Technology Policy Council and the Science, Technology Policy and Competitiveness Advisory Board. It is hoped that this new wave of reforms will remedy, effectively and in a lasting way, the main deficiencies in governance which have for some time impaired the efficiency of Hungarian innovation policy. This would entail addressing the following issues:

1. Both NKTH and the Innovation Fund have again undergone recent changes, *e.g.* the merger of NKTH with the Agency for Research Fund Management and Research Exploitation (KPI) in early 2008, and the redistribution of management competences between NKTH and the Hungarian Economy Development Center (MAG).

Overall governance

- *Maintain the priorities and long-term strategic goals of STI policy* and safeguard public funding for science, technology and innovation against "crowding out" by short-term demands.
- *Permanently upgrade the representation of STI policy to the highest level* of government in order to secure policy attention and commitment. The nomination of a minister for R&D, Technology Development and Innovation might be a step in the right direction.
- *Reconsider the distribution of competences and ensure effective co-ordination of government actors* in order to integrate STI policy better into overall policy making.
- *Maintain funding levels for STI even in times of fiscal consolidation*. In this context, it is important to refrain from substituting funds from national sources allocated to R&D and innovation by (increasing) funds from the EU. At the same time, the money should be better allocated and spent, *e.g.* by streamlining the portfolio of funding instruments in order to ensure lean management and critical mass.
- *Ensure a minimum degree of stability* in bodies involved in shaping and implementing science, technology and innovation programmes and instruments, in terms both of organisational arrangements and funding. This is a precondition for predictable and continuous provision of support, because, as already underlined above:
  - Excessive instability (including the lack of regular calls in support programmes) blurs the signals sent by policy measures and diminishes incentives for actors in the innovation system to respond.
  - A higher degree of stability increases the transparency of STI policy and its delivery, and raises the net benefits for its target groups.
  - A minimum degree of stability of organisations, institutions, programmes and instruments is necessary for evidence-based policy making and learning.
- *Improve the institutional positioning of NKTH by applying the principle of clear separation between policy decision making and implementation.* In this context the transformation of the NKTH into an operationally autonomous agency owned by the ministry in charge of R&D and innovation might be considered.

- *Foster evidence-based policy making* by systematically applying advanced monitoring and evaluation practices and other state-of-the-art management tools. For this purpose:
  - Build up competences in the institutions implementing STI policy at the national and regional level, not least to deal with the expanded allocation of EU funds over the coming years. This goal should not be sacrificed for short-term savings on personnel, even in periods of budgetary constraint.
  - Establish monitoring procedures to allow a state-of-the-art evaluation of programmes in two to three years. In the meantime, build up and make better use of related capacities at two levels: programme administration and the community of innovation policy scientists and experts.
  - Increase the participation of international experts in evaluations. The involvement of experts from abroad has become international good practice, but is not yet regularly practised in Hungary.

Policy mix

About 40 policy schemes to support innovation are currently in place in Hungary, of which 20 seek to promote business R&D and innovation. A large number of supporting mechanisms also target networking and co-operation (17 in all, of which six aim at international co-operation). Four relatively new schemes address regional aspects of innovation policy, a subject that is attracting increasing attention.[2] Taken together, these instruments address all areas in which there is a strong rationale for government intervention in innovation processes. In certain cases (such as the Co-operative Research Centers, KKK and the Regional Knowledge Centers, RKC) they have been modelled after successful examples in other OECD countries; in others, Hungary has experimented with new designs (*e.g.* the Research and Technological Innovation Fund or the Innocsekk initiative). The availability of EU funding has facilitated quite rapid development of a rather complete set of policy instruments.

In the STI policy mix, the following issues will require careful consideration: avoidance of overlaps between existing measures, the mix of generic and sector-specific measures, the mix of funding for applied and

2. In the second half of the 1990s the National Committee for Technological Development (OMFB) launched special funding schemes for promoting regional innovation. These schemes were operated by the local Chambers of Commerce. They were later discontinued.

basic research, the articulation between national, regional and EU funding, and the mix of direct and indirect support.

- *Avoid the proliferation of instruments*. A major challenge will be to take advantage of increasing EU funding to raise the overall efficiency of the policy mix. Avoiding diminishing returns to additional public investment will require in particular resisting the fragmentation of a toolkit that is already quite differentiated.

- *Thoroughly evaluate the policy mix*, *e.g.* the balance between fiscal incentives for R&D and direct support instruments, the impact of innovation policy on the orientation of public research, and the balance of support for different types of firms, including new firms. However, such an overall evaluation will not be possible as long as a central institution such as the Research and Technological Innovation Fund has not itself been carefully evaluated.

- *Continue strengthening the regional dimension of STI policy*. A major goal of regional innovation policy should be to better align and connect industrial capacities and the regional education and public R&D infrastructure. This should be achieved through a combination of bottom-up measures, *e.g.* cluster-based policies, and top-down measures, *e.g.* strengthening local infrastructures. Regional innovation policy should play a prominent role in pursuing the priority objective of better "embedding" MNEs into the innovation system.

- *Strike a better balance between supply-side and demand-side measures.* The new technology platforms should be used to better articulate demand with Hungarian innovation capabilities. More generally, the government should review some aspects of its procurement policy with a view to ensuring that it is conducive to innovation, following the best international practices in this field.

- *Raise the goals for e-government.* Current initiatives are commendable but are not yet at the level of the best international practices.

Promoting innovation in the business sector

Increasing the level of R&D and innovation activities in Hungarian enterprises, especially SMEs, has been rightly identified as a priority task of innovation policy in various policy documents (notably the current action plan). In addition to the improvement of framework conditions (see above), this requires continuing financial support for R&D and innovation in enterprises to correct market failures that lead to underinvestment by the private sector.

This kind of support to enterprises has increased in the past years, especially since the launch of the Research and Technological Innovation Fund in 2004; but it may still be insufficient to induce the growth in business R&D that is necessary to achieve a target of total R&D intensity of 1.8%. Hungary will have the opportunity to leverage national resources devoted to support for R&D and innovation owing to new funds made available by the EU, notably Structural Funds, which may be of the same order of magnitude as national funding (approximately EUR 200 million). In addition, Hungarian researchers will continue to be successful in attracting funds from the European Framework Programmes. In this area, it is necessary to:

- *Ensure that EU funding does not crowd out national funding.* Given the needs of the Hungarian business sector and the importance of customising support measures accordingly, it is important to fully seize this new opportunity, while avoiding the risk of external funding substituting for national funding. Maintaining the level of national budgetary effort for R&D and innovation will only be justified if all the conditions for efficient use of such funding are met.

- *Put more emphasis on measures to reinforce the innovation capabilities of SMEs*, taking into account their specific and varied needs.[3]

- *Place strong emphasis on stimulating SMEs to innovate and to collaborate* with other enterprises and with public research institutions (*e.g.* in regional clusters).

- *Ensure that measures to support R&D and innovation do not discriminate* de facto *against innovative start-ups*.

- *Consider additional measures to encourage R&D and innovation in the services sector.*

- *Facilitate the diffusion of new technologies,* including ICT, which will continue to play a key role in boosting productivity growth. The most powerful means of achieving rapid uptake of technologies are good framework conditions – international openness, competitive markets and innovation-friendly regulation – but more specific tools can also be used. A combination of specific incentives and customised services is needed. Their delivery would involve the mobilisation of

3. For example, the Bay Zoltán Institutes, which offer applied R&D and innovation-oriented services to enterprises (mostly to SMEs, on a 100% contract research basis), have experienced rapid growth in recent years and expect to grow at a similar rate in the near future. This indicates that there exists a "demand for innovation" from these enterprises.

actors such as government support agencies, business associations and public research organisations. The regional dimension of technology diffusion processes should be stressed.

Strengthening the links in the innovation system

The Hungarian government recognises that weak connectivity within the innovation system is limiting its performance. Since the mid-1990s measures have been adopted to strengthen collaboration and networking, notably between industry and academia. Since the late 1990s, cluster-oriented policies have been evolving as a tool of innovation policy. The government should intensify its efforts along these lines while drawing lessons from experience in improving some of the instruments used to promote collaborative innovation.

- *Foster stronger ties between foreign-owned companies and local suppliers or customers and research institutions* and encourage links between Hungarian companies and foreign (and Hungarian) research organisations. There is a case for supporting the attraction and maintenance of MNEs' R&D units in order to provide opportunities for learning in both industry and the academic sector.
- *Ensure that the programmes aimed at fostering industry-science relations (ISR) correspond to the real needs of industry*. In current practice, many, if not most, of the research topics and output of ISR-oriented projects are university-initiated and university-driven. This may be – at least partly – a reflection of distorted incentives in current funding schemes, including some aspects of the design of the innovation levy.[4]
- Strengthen the basis for improved industry-science links through additional measures that strengthen the absorptive capacity of business firms, especially SMEs. The government should consider whether the voucher scheme Innocsekk could be better used for this purpose.
- *Assess the effectiveness of technology transfer organisations* at universities against international good practice.

4. For example, strategic behaviour may lead public research organisations to submit projects to NKTH that are actually basic research in disguise. Analogously, "collaborative" projects between public research organisations and enterprises in reality often seem to take place without significant participation or contribution from enterprises. These appear to be a funding vehicle for public research institutions rather than a way for enterprises to reinforce their research capabilities.

Fostering critical mass, excellence and relevance in public research

The current public research funding system sends mixed and sometimes inconsistent signals to the relevant actors. Public research organisations (mainly the universities and the Academy of Sciences) receive large amounts of block grant funding or were granted ownership of important assets (including real estate). This institutional funding is generally insufficiently tied to strict criteria regarding research quality and, in the case of universities, the contribution of research to education. Better linking funding to performance would help ensure critical mass in research activities and strengthen centres of excellence with international visibility.

Much more competitive funding is officially earmarked for applied research than for basic research. This imbalance is likely to become more pronounced with the new funds from the European Union in the period to 2013.

- *Take measures to increase the contribution of public research organisations*, including universities and the Academy of Sciences, to the overall performance of the Hungarian innovation system. The reform of these organisations should be accelerated, and they should have more performance-based incentives, in order to make fuller use of their strong capabilities in achieving priority socio-economic objectives.
- *Continue the reform of the governance structures of the Academy of Sciences* to allow for a more strategic approach to managing its portfolio of institutes, to increase its responsiveness to new research opportunities, and to increase its attractiveness for excellent young researchers. The multiple functions of the Academy should be more clearly separated to minimise conflicts of interest and improve the management of individual functions. The question of whether all functions should remain under the Academy or some should be spun out, *e.g.* its research funding function, should be considered.
- *Increase competitive funding for basic research*. In order to increase transparency (and to align incentives with stated objectives), the competitive funding for basic research through OTKA ought to be stepped up considerably.
- *At the same time, improve the selection process for funding research projects,* including with greater involvement of international peer reviewers.

Maximising benefits from the internationalisation of R&D

Hungarian research is well connected internationally, but needs continued support to participate effectively in fast-growing global networks.

- *Support internationalisation in science, technology and innovation across all areas.* Support that gives Hungarian researchers access to international networks (especially the EU Framework Programmes, in which Hungarian researchers perform quite well) and to international research infrastructure should continue.

- To complement the policy of attracting foreign direct investment, *support an active outward strategy in Hungarian firms*, beyond export promotion (*e.g.* a presence in innovation hot spots in advanced and emerging economies).

- *Participate more actively in the initiatives of the EU's Open Method of Co-ordination* with a view to enhancing systematic policy learning (*e.g.* through participation in ERAnet, in international benchmarking exercises, etc.).

- *Take a global approach to international co-operation*. Intensive participation in EU programmes and initiatives should be complemented by intensified Hungarian efforts to develop linkages with leading and emerging S&T powers outside the EU.

Summary table: Hungary's strengths, weaknesses, opportunities and threats (SWOT)

Strengths	Opportunities
• Robust medium-term growth of total factor productivity and GDP per capita resulting in convergence with more advanced countries • Strong growth of the manufacturing base • High degree of international openness • Generally well-skilled labour force • Good framework conditions for innovation in many respects • Solid legal basis for STI policy • Areas of strengths in industrial innovation and of excellence in scientific research • High participation in European research programmes	• Innovation as a pillar of the catch-up strategy • Stronger economic performance by fostering innovation capabilities and the knowledge infrastructure • Sustained high investment to boost technology acquisition and development, learning and absorptive capacities • Attraction of foreign direct investment in R&D-related activities • Better alignment of public research capacities to business sector requirements to raise the performance of the innovation system • Industry-academia interactions to be used as "focusing devices" for developing the knowledge infrastructure • More competitiveness in knowledge- and innovation-intensive manufacturing and services industries • Formation of dynamic, innovative clusters • Effective use of increased EU funds allocated to STI
Weaknesses	**Threats**
• Low investment in R&D and innovation • High concentration of R&D in some large firms, sector and regions • Insufficient entrepreneurial and technological skills in the SME sector ("dual economy") • Weak linkages among actors in the innovation system • Lack of R&D management capabilities in public research institutions • Shortfall in the formation of human resources for science and technology • Slow uptake of ICT applications • Instability of the innovation policy governance system • Weak evaluation culture • Low degree of stakeholder involvement, weak innovation policy community • Weaknesses in the implementation of innovation policy	• Failure to realise the growth potential, stalling catch-up process • Decline of competitiveness, notably *vis-à-vis* emerging economies • Loss of the highly qualified human resources needed for innovation • Marginalisation as a location for R&D

EVALUATION D’ENSEMBLE ET RECOMMANDATIONS

Succès et défis : Un rôle accru pour l’innovation dans le développement économique de la Hongrie

Ces vingt dernières années, la Hongrie a enregistré de très notables progrès sur la voie d’une économie de marché concurrentielle, pleinement intégrée à l’Union européenne (UE) et à l’économie mondiale dans son ensemble. Avec la poursuite de l’élargissement de l’UE, la Hongrie a acquis une place plus centrale dans le marché européen. De nouveaux profils de spécialisation se sont dessinés, comme en témoignent la rapide progression des exportations de biens manufacturés et, plus généralement, le redéploiement vers des activités exigeant une plus haute qualification de la main d’œuvre et qualité. L’investissement d’entreprises multinationales (EMN) ayant implanté des sites de production en Hongrie a joué un rôle prépondérant dans la restructuration du secteur productif vers des activités plus avancées technologiquement.

Avant le fléchissement récent, la croissance économique de la Hongrie a, pendant un certain temps, été nettement supérieure à celle des pays les plus avancés, ce qui a permis un certain rattrapage de son produit intérieur brut (PIB) par habitant, lequel a atteint USD 18 154 (2006 en parités de pouvoir d’achat – PPA). Il lui reste toutefois beaucoup de chemin à faire, puisque le PIB par habitant est encore inférieur à 60 % du niveau des États-Unis. Cet écart s’explique par la relative faiblesse de la productivité du travail, ainsi que, dans une bien moindre mesure, de l’utilisation de la main d’œuvre. En outre, au regard des performances des pays voisins comparables, la Hongrie ne semble pas réaliser tout son potentiel économique, et ce en raison de circonstances macroéconomiques instables et de facteurs structurels. Cette étude examine les facteurs qui limitent les capacités d’innovation de la Hongrie.

Certaines innovations ont joué un rôle majeur dans la forte croissance de la productivité totale des facteurs observée depuis les années 90 ; parmi elles, l’adoption d’institutions de marché et les changements organisationnels intervenus par contrecoup au sein des entreprises, ainsi que l’importation, par l’intermédiaire de l’investissement direct étranger (IDE), de bonnes pratiques en matière de production et de commercialisation. Aujourd’hui, la capacité de la Hongrie à accroître encore sa productivité par le flux continu d’une nouvelle génération d’innovations apparaît toutefois limitée, car sa performance d’innovation semble nettement en dessous de son potentiel. Un grand nombre d’indicateurs standards de la performance d’innovation confirment que le niveau global de l’activité d’innovation est faible et que celui de l’innovation reposant sur la recherche-développement (R&D) l’est encore plus. La Hongrie présente un certain nombre de caractéristiques d’une « économie duale ». D’un côté, on y trouve de grandes entreprises contrôlées par des capitaux étrangers, qui sont bien intégrées dans les réseaux mondiaux de production et de distribution et, parfois de R&D et d’innovation, mais pas toujours bien reliées au reste du système d’innovation hongrois. D’autre part, il existe un important secteur d’entreprises nationales, notamment de petites et moyennes entreprises (PME) caractérisées par une faible productivité et des capacités d’innovation insuffisantes, qui opèrent le plus souvent sur les marchés locaux en répondant à une demande relativement peu sophistiquée. En dépit de quelques signes encourageants (notamment l’émergence de sous-traitants modernes dans l’industrie automobile et d’une poignée d’entreprises dynamiques axées sur la recherche), la quasi absence d’entreprises moyennes innovantes est une faiblesse criante de l’économie hongroise.

La participation des institutions de savoir (essentiellement les universités et l’Académie des sciences, qui joue un rôle prépondérant dans le système de recherche hongrois) dans les activités d’innovation s’est améliorée mais reste insuffisante. La Hongrie s’est dotée d’une base solide de recherche scientifique de grande qualité, sa production scientifique est de bon niveau, et ses coûts sont nettement inférieurs à la moyenne européenne, et on observe quelques exemples prometteurs de coopération entre des entreprises commerciales et des organisations de recherche financées sur fonds publics dans certains secteurs et dans certaines régions (principalement à Budapest, mais aussi dans des villes telles que Debrecen et Szeged). Toutefois, ce secteur relativement grand d’organisations publiques de recherche pourrait apporter une contribution plus importante à l’innovation en termes de formation de ressources humaines spécialisées (notamment des diplômés en science et en ingénierie) et de recherche fondamentale répondant aux besoins du marché. Pour ce faire, il devra pouvoir s’appuyer sur des infrastructures de recherche de grande qualité.

En résumé, la faiblesse de la capacité d’innovation est l’un des facteurs qui empêchent la Hongrie de mieux s’adapter à l’évolution de la concurrence, notamment en provenance des économies émergentes, et de saisir les opportunités créées par l’évolution des technologies et la mondialisation. L’expérience des pays de l’OCDE montre que les politiques gouvernementales peuvent jouer un rôle décisif pour améliorer les performances d’innovation d’un pays, en établissant des conditions cadres favorables et en adoptant des mesures permettant de remédier à des déficiences systémiques ou du marché. De ce point de vue, la Hongrie devrait s'efforcer de tirer le meilleur parti des opportunités offertes par l'augmentation des financements de l'Union européenne destinés aux investissements de R&D et à l'innovation dans la nouvelle période de planification (qui va jusqu'en 2013). Pour que ces ressources soient utilisées de manière efficiente, il faudra une orientation stratégique claire, de bons mécanismes de gouvernance pour la politique scientifique, technologique et de l'innovation, une volonté politique forte et l'adoption de bonnes pratiques de mise en œuvre.

Principales forces et faiblesses du système d'innovation hongrois

La Hongrie présente des particularités historiques, géopolitiques, culturelles et institutionnelles qui doivent être prises en compte dans l'évaluation de l'état actuel de son système d'innovation et dans la détermination de la faisabilité des mesures d'action publiques pour relever les défis et exploiter les opportunités nouvelles :

- Un héritage historique riche, marqué par des périodes difficiles mais aussi par des phases brillantes et des périodes d'effervescence créatrice et entrepreneuriale. Depuis peu, le pays se réinvente avec succès comme une démocratie à économie de marché.
- Avec un peu plus de 10 millions d'habitants, la Hongrie est une économie ouverte de taille modeste, et doit trouver un mode adaptatif de spécialisation afin de profiter des marchés européens et mondiaux.
- Un niveau relativement élevé de centralisation politique. La région capitale, autour de Budapest, est forte et dynamique, mais des disparités régionales assez importantes existent, avec une certaine inadéquation entre la localisation géographique des institutions de savoir et celle des activités industrielles.
- Le pays a eu des difficultés à concilier le changement politique nécessaire pour instaurer la démocratie avec le minimum de continuité indispensable à un pilotage efficace et tourné vers l'avenir de l'économie. La politique scientifique, technologique et de l'innovation est l'un des domaines dans lesquels un mode de décision « fondée sur des faits » est le meilleur moyen de générer le consensus nécessaire pour préserver les investissements stratégiques de long terme des conséquences négatives des turbulences de plus court terme.

- La Hongrie possède une longue tradition d'excellence scientifique et a produit, notamment au 20e siècle, de nombreux scientifiques de renommée mondiale qui ont apporté des contributions importantes au savoir universel dans un certain nombre de domaines. La science et la technologie jouit en conséquence d'un prestige social certain, qui ne dispense toutefois pas les pouvoirs publics d'en faire davantage pour mobiliser la communauté scientifique au service d'objectifs économiques.

Principaux points forts

Le système d'innovation hongrois n'est pas dénué d'atouts :

- *L'héritage d'une croissance de la production et de la productivité forte et soutenue*. L'efficacité globale de l'économie a fortement augmenté ces quinze dernières années.
- *Une économie très ouverte*. Dans un laps de temps assez court, la Hongrie est devenue l'une des économies les plus « internationalisées » du monde, attirant un fort volume d'IDE.
- *Des conditions-cadres* améliorées *pour l'innovation.* Les institutions et les conditions cadres ont connu une évolution rapide et à de nombreux égards semblent désormais propices pour susciter l'innovation. La politique de la concurrence, par exemple, adaptée pour être mise en conformité avec les normes de l'UE, est désormais plus rigoureuse. Il reste toutefois des efforts à faire pour que les conditions cadres incitent encore davantage les entreprises à apporter des réponses innovantes aux pressions du marché, étant entendu que de bonnes conditions cadres sont nécessaires mais pas toujours suffisantes pour une forte performance d'innovation.
- *Dans certains domaines, une bonne qualité des résultats de la recherche.* La recherche hongroise présente globalement de bonnes performances et des résultats enviables dans certains domaines de la recherche fondamentale, ou plus appliquée, tels que la physique, les mathématiques, la biologie, la chimie, la médecine clinique et l'ingénierie.
- *Une « productivité de la recherche » comparativement élevée.* Le nombre de publications par chercheur et la qualité des publications (mesurée par les indicateurs de citations) sont plus proches de la moyenne UE que ne le laisserait penser le niveau de financement.
- *Une base juridique solide* pour *la politique scientifique, technologique et d'innovation (STI).* La politique STI de la Hongrie repose

maintenant sur une base juridique solide (lois sur l'innovation, fonds pour l'innovation, enseignement supérieur, etc.)

- *La plupart des autres grandes institutions nécessaires à un système avancé de politique de l'innovation ont également été mises en place, du moins formellement* (notamment une coordination des politiques à haut niveau et des organes consultatifs).

- *Existence d'une palette différentiée de dispositifs de financement* pour la recherche appliquée et la recherche fondamentale, gérée par des institutions de financement spécialisées telles que l'Office pour la recherche et la technologie (NKTH) et le Fonds hongrois pour la recherche scientifique (OTKA).

- *La classe politique reconnaît l'importance du soutien à la science, à la technologie et à l'innovation.* L'innovation a été déclarée priorité nationale par le gouvernement hongrois, comme en témoignent d'importants documents de politique (le nouveau Plan de développement national, la Stratégie STI à moyen terme, et le Plan opérationnel de développement économique - EDOP).

Principales faiblesses

Mais le système d'innovation hongrois souffre également de certaines faiblesses, parmi lesquelles :

- *De faibles niveaux d'activité et de performance dans la R&D et l'innovation,* en particulier chez les PME, comme l'illustrent de nombreux indicateurs :

  – *Une faible intensité de R&D, des dépenses de R&D des entreprises encore plus parcimonieuses et une activité de brevetage quelque peu atone.* En outre, la R&D est fortement concentrée dans un petit nombre de grandes entreprises à capitaux étrangers et dans un petit nombre d'activités. Cela se traduit par une insuffisante capacité à soutenir la concurrence dans les secteurs axés sur la recherche, une étroitesse du champ des retombées de la R&D des entreprises installées en Hongrie et une aptitude réduite et à absorber des connaissances de l'étranger.

  – *Une forte concentration régionale de l'activité de R&D.* La R&D est fortement concentrée dans le centre de la Hongrie. Cela est aussi vrai des capacités de gouvernance dans les domaines de la science, de la technologie et de l'innovation.

  – *Un niveau d'investissements dans l'innovation autres qu'en R&D relativement faible au regard des standards internationaux* (notamment les dépenses en machines, équipements, licences et savoir-faire pour l'introduction de produits et de procédés nouveaux) même si leur part de la dépense totale d'innovation est relativement élevée.

  – *Le manque de PME innovantes.* La plupart des PME montrent une faible productivité, possèdent peu de capacités entrepreneuriales et d'innovation, sont tournées vers les marchés locaux et ne sont pas suffisamment intégrées aux chaînes de valeur mondiales. Les entreprises hongroises ont une propension à innover plus faible que leurs homologues de la plupart des autres pays membres de l'UE.

- *Un déficit de mobilité et de coopération entre les acteurs*. Le niveau de coopération entre entreprises et les liens entre industrie et science, notamment la mobilité du personnel entre l'université et l'entreprise, semblent insuffisants.

- *Une adaptation lente des organisations publiques de recherche – notamment les universités et l'Académie des sciences – aux besoins d'une économie fondée sur le savoir.* Ces institutions n'ont fait l'objet que récemment des profondes réformes (au niveau de leur pilotage et financement) mises en œuvre depuis longtemps dans la plupart des pays de l'OCDE.

- *Une formation insuffisante de ressources humaines en science et de technologie.* La Hongrie produit moins de diplômés en sciences et en ingénierie en proportion du nombre total de diplômés, que la plupart des pays de l'OCDE. Plus généralement, une faible proportion de la population en âge de travailler possède un niveau de troisième cycle universitaire. La pénurie de personnel qualifié risquerait de devenir un important goulet d'étranglement si l'activité d'innovation en Hongrie se faisait plus dynamique.

- *Insuffisances de la politique STI.* Les principaux progrès accomplis dans le domaine de la gouvernance - notamment l'établissement d'une base juridique solide pour la politique STI, la création d'institutions spécialisées et de dispositifs de financement nouveaux - ne peuvent pas porter tous leurs fruits, en raison de la façon dont la politique STI est mise en œuvre en pratique, comme expliqué ultérieurement.

Opportunités et menaces

Pour assurer son développement futur, la Hongrie doit conjurer un certain nombre de *risques* :

- *Une perte de dynamisme conduisant à une marginalisation du pays comme destination d'investissement pour les capitaux mobiles et comme pôle d'innovation.*
- *Une incapacité à s'adapter à une concurrence de plus en plus tirée par l'innovation,* en particulier de la part des pays émergents, et à exploiter des nouvelles opportunités de l'économie mondiale.
- *Un tarissement des ressources humaines en science et technologie,* dans un contexte de concurrence accrue à l'échelle mondiale pour attirer les talents.

Mais d'importantes *opportunités* sont aussi à saisir :

- *Se doter d'un système d'innovation hautement performant et adaptatif* afin de progresser sur la voie d'une économie fondée sur le savoir.
- *Concrétiser le potentiel* des *organismes de recherche publique* et renforcer leur contribution à la performance globale du système national d'innovation.
- *Faire le meilleur usage des fonds de l'UE* alloués en quantité appréciable pour la nouvelle période de planification (2007-13).
- *Intensifier le développement des liens internationaux dans le domaine de la STI afin de tirer parti de la mondialisation de la R&D au profit de l'innovation, de la croissance économique et du bien-être social en Hongrie.*

Insuffisances de la politique scientifique, technologique et d'innovation

En dépit de louables efforts pour corriger ses faiblesses et valoriser ses atouts face aux nouvelles opportunités la Hongrie doit encore remédier à un certain nombre de points faibles de sa politique STI afin que cette dernière contribue mieux aux objectifs nationaux en matière de croissance durable.

Manque d'engagement politique

Certes, la science, la technologie et l'innovation sont cités comme des domaines prioritaires des politiques dans d'importants documents programmatiques, mais l'investissement public nécessaire et l'attention prêtée au plus haut niveau aux questions liées à l'innovation ont trop souvent fait défaut.

Manque de stabilité

La politique scientifique, technologique et d'innovation pâtit d'un certain manque de stabilité, comme l'illustrent les fréquents changements qui affectent le statut, le mandat et le fonctionnement des principales institutions (par exemple, Le NKTH et ses prédécesseurs). Cette instabilité excessive a très vraisemblablement des effets négatifs sur la capacité des agences gouvernementales à agir de manière cohérente, brouille les messages gouvernementaux et provoque une grande incertitude parmi les bénéficiaires des mesures d'action publique. De plus, elle oppose un obstacle majeur au processus d'apprentissage des institutions et à l'adoption par la Hongrie d'une démarche d'élaboration des politiques STI « fondée sur des faits ».

Défauts de mise en œuvre

Les difficultés qui ont empêché une mise en œuvre optimale des politiques arrêtées sont en partie liées au manque d'engagement et de stabilité. Si le niveau d'attention des responsables politiques est faible et si les structures et les institutions connaissent des remaniements fréquents, il n'est pas surprenant que la mise en œuvre des politiques en pâtisse. Toutefois, il est d'autres facteurs qui nuisent également à l'efficacité de l'action publique :

- *Des capacités aux niveaux national et régional insuffisantes pour mettre en œuvre un assez grand nombre de programmes.*
- *Les retards dans les* décisions *et dans le versement de fonds publics promis* rendent très difficile la planification des projets par des acteurs de la R&D qui sont souvent des entreprises commerciales. De plus, face aux contraintes budgétaires, le gouvernement a sacrifié le financement de l'innovation (par exemple, pendant un certain temps, le cofinancement du Fonds pour la recherche et l'innovation technologique).

Lenteur de la réforme

En dépit de remaniements fréquents – parfois trop – des structures institutionnelles d'élaboration des politiques et de mise en œuvre de la politique d'innovation, l'évolution reste lente dans certaines pans importants du système d'innovation hongrois. La Hongrie s'est montrée assez lente à réformer son Académie des sciences. Faute d'avoir rapidement adopté des pratiques modernes d'évaluation, d'avoir clarifié et séparé les différentes fonctions de l'Académie (société savante, acteur de la recherche, bailleur de fonds pour la recherche, institution qui décerne diplômes et titres et conseiller en matière de politique scientifique), le système scientifique hongrois n'a pas su pleinement s'adapter à l'évolution des besoins de la recherche scientifique (multidisciplinarité et importance croissante de la recherche fondamentale applicative) et attirer de jeunes chercheurs de grande qualité.

Un processus d'apprentissage lent et insuffisamment informé

Cela se traduit par l'absence d'une évaluation systématique et d'une consultation suffisamment large dans la préparation des décisions stratégiques. Les outils de renseignement et d'apprentissage des politiques stratégiques tels que la surveillance, l'évaluation et la prospective technologique ne sont utilisés que sporadiquement, même s'il est vrai que la plupart des programmes et des institutions examinés ne sont pas en place depuis suffisamment longtemps pour permettre une évaluation de leur impact. Jusqu'à présent, la politique STI n'est que très peu « fondée sur des faits ».

- *Coordination et consultation insuffisantes*. Des organes de coordination et de consultation politique à haut niveau ont le mérite d'exister (le Conseil des politiques scientifiques et technologiques, TTPK, présidé par le Premier ministre, et le Conseil de la politique et de la compétitivité scientifiques et technologiques, TTT), mais ils ne se sont pas réunis depuis deux ou trois ans ou n'ont pas été suffisamment impliqués concrètement dans les grandes décisions d'action publique.

- *Faible niveau d'implication des parties prenantes (entreprises, communauté de recherche publique, secteur financier, etc.)*, notamment dans les processus d'élaboration des politiques les plus importantes comme la formulation de la stratégie politique STI à moyen terme.

- *Pas d'usage systématique de la surveillance, de l'évaluation* et d'autres outils pour éclairer l'élaboration des politiques. Un petit nombre seulement de programmes de soutien publics ont fait l'objet de bilans externes, et aucune évaluation globale de l'actuel « cocktail de politiques » (aides directes et incitations fiscales) n'a été effectuée.

- *Manque d'informations statistiques.* Dans certains domaines, les données statistiques sont inexistantes ou ne sont accessibles que difficilement.

Missions stratégiques et principes directeurs

La première tâche stratégique de la politique d'innovation de la Hongrie est de renforcer l'innovation en tant que moteur d'une croissance élevée et durable qui permette d'achever la convergence avec les économies les plus avancées de l'OCDE, et d'accroître le niveau de vie de la population. Grâce au renforcement de la capacité d'innovation, les entreprises hongroises deviendront plus concurrentielles dans les activités axées sur le savoir. Dans cette optique, les principaux objectifs à atteindre par les pouvoirs publics sont :

- *Accroître l'intensité de R&D et de savoir de l'économie hongroise dans son ensemble,* en favorisant les entreprises innovantes dans les industries manufacturières et les services, en renforçant les capacités d'innovation et d'absorption des PME, en soutenant les « grappes » (« *clusters* »), ou pôles d'innovation, et en tissant des liens avec les sources de savoir et les marchés d'innovation internationaux.

- *Renforcer les infrastructures du savoir en Hongrie* et améliorer leur capacité à contribuer à un système d'innovation efficient.

Pour ce faire, le gouvernement hongrois devra suivre un certain nombre de principes directeurs :

- *Des politiques prévisibles, « fondées sur des faits ».* Suivre ce principe comporte de nombreux avantages. Au niveau de la mise en œuvre, la hiérarchisation des priorités et l'adaptation aux besoins s'en trouvent facilitées, et l'amélioration par l'apprentissage est accélérée. Pour les bénéficiaires des mesures, notamment les entreprises, la prévisibilité tend à optimiser l'impact des mesures d'incitation. Cette prévisibilité n'est effective que s'il existe un engagement politique au plus haut niveau de l'exécutif.

- *Une gouvernance efficace.* La volonté politique doit se traduire non seulement par une allocation avisée de budgets suffisants en faveur des activités STI, mais aussi par le fonctionnement efficace d'une structure de gouvernance chargée de la préparation du budget de S&T, par le pilotage et le financement de la politique STI, et sa coordination avec les politiques des différents ministères dont le champ d'action a un impact sur le système STI. Une séparation plus claire des fonctions du système de gouvernance STI doit être réalisée, en établissant une distinction claire entre la formulation et la mise en œuvre des politiques. Cette dernière doit reposer sur toute la gamme des mécanismes qui ont fait leur preuve : coordination, concurrence (financement concurrentiel, par exemple), coopération (projets de recherche conjoints) et dispositifs de pilotage axés sur les performances (contrats de performances, critères de financement, etc.).

- *Une approche participative de la hiérarchisation des priorités.* Étant donné le caractère limité des ressources et les économies d'échelles associées à certains investissements de R&D, il est impératif de hiérarchiser les priorités. L'affectation de ressources par des mécanismes partant de la base doit donc être complétée par une démarche plus centralisée de hiérarchisation des priorités, afin d'atteindre l'échelle et la masse critique nécessaires. Parmi les mécanismes compatibles avec les forces du marché, on peut citer les partenariats public-privé de recherche et d'innovation. La politique de l'innovation doit être à l'écoute des besoins évolutifs des parties prenantes du système d'innovation. Il est indispensable de bâtir une vision des objectifs à atteindre qui soit partagée par tous les acteurs privés et publics, afin que puisse être formulée et mise en œuvre une politique gouvernementale mêlant de manière équilibrée les initiatives émanant de la base et sommet.

- *Évaluation et obligation de rendre compte.* Les évaluations externes régulières des programmes de soutien et des institutions bénéficiant d'aides publiques doivent devenir la norme, et être suivies de conséquences concrètes pour l'octroi ultérieur de financements. Toutefois, il faut trouver un équilibre entre la nécessité d'apporter des ajustements périodiques pour tenir compte des évaluations et le besoin d'offrir une certaine stabilité des financements, afin de pérenniser l'impact des aides sur le comportement des bénéficiaires.

- *Une approche globale du soutien à l'innovation,* afin de renforcer les capacités d'innovation dans toute l'économie, y compris dans les activités qui ne font pas appel directement à la R&D. La politique d'innovation doit éviter d'être trop étroitement centrée sur « la R&D » ou « les hautes technologies ». L'innovation non technologique, ou « innovation douce », notamment dans le secteur des PME, particulièrement peu innovant en Hongrie – offre de nombreuses possibilités pour relancer la productivité et accroître les revenus. Dans le même temps, il convient aussi de renforcer le nœud du système d'innovation que constitue la R&D.

- *Un arsenal de mesures complet et déployé d'une manière équilibrée.* Les dosages de mesures doivent être conçus en fonction du degré d'importance des objectifs de politique et de la quantité d'aide nécessaire à l'efficacité des programmes les poursuivant. S'agissant de l'aide aux activités de R&D et d'innovation des entreprises, il s'agit de trouver le bon équilibre entre les aides directes (par exemple les fonds d'appoint), les aides indirectes (par exemple crédit d'impôt) et les aides sectorielles, en tenant compte du type de défaillance du marché ou du système que ces mesures visent à compenser. Dans le cas des aides aux organismes publics de recherche, il faut veiller à l'équilibre entre les financements institutionnels et les financements concurrentiels, tout en encourageant l'accès aux ressources externes.

- *Qualité, pertinence et masse critique de la recherche publique*. Pour concilier ces trois objectifs, il importe d'opérer une sélection rigoureuse des projets et des équipes de recherche qui prétendent aux aides, d'assurer la participation active des utilisateurs finals de la recherche à la définition de ses priorités, et de réaliser une certaine concentration de ressources dans des domaines particuliers.

- *Ouverture internationale.* Les flux internationaux de savoir vont demeurer critiques pour le développement du système d'innovation hongrois. Dans une petite économie ouverte, l'essentiel du savoir nécessaire pour assurer une croissance mue par l'innovation doit – d'une manière ou d'une autre – être « importé » de l'étranger. La mobilité internationale des chercheurs étrangers et nationaux, les investissements de R&D en Hongrie des entreprises internationales, ainsi que les recherches réalisées en Hongrie par d'autres organismes d'origine étrangère sont à cet égard essentiels. Ces modes d'internationalisation doivent être complétés par d'autres : l'accès au savoir par l'intermédiaire des marchés de technologie, des investissements à l'étranger par les entreprises hongroises dans la R&D et d'autres activités fondées sur le savoir et la participation active aux réseaux internationaux d'innovation et de recherche en coopération.

Recommandations

Conditions cadres pour l'innovation

Les conditions cadres nécessaires sont la stabilité macroéconomique, un système fiscal et un régime de la propriété intellectuelle propices à l'innovation, une concurrence vive, l'ouverture au commerce international et aux flux de capitaux et l'efficience des systèmes d'information. En prêtant une importance accrue à leur impact sur l'innovation, les pouvoirs publics devraient s'assurer en permanence que ces conditions cadres sont bien remplies, avec essentiellement les objectifs suivants :

- *Rétablir et pérenniser une situation macroéconomique saine avec notamment des finances publiques viables,* qui constituent l'une des conditions primordiales du dynamisme de l'investissement privé et public dans l'innovation.
- *S'assurer que la politique de concurrence et d'autres régimes réglementaires sont propices à l'innovation.*
- *Poursuivre les efforts de réduction de la charge administrative* pesant sur les entreprises, notamment les entreprises nouvellement créées.
- *Veiller à la bonne application de la législation des droits de propriété intellectuelle.*
- *Mobiliser le secteur financier pour soutenir l'innovation.* Les pouvoirs publics peuvent dans un premier temps stimuler l'engagement du secteur financier au moyen de différents programmes basés sur le principe du partage des risques entre public et privé.
- *Identifier d'éventuels autres aspects des conditions cadres qui diminuent la motivation ou la capacité des PME d'être plus innovantes, et y porter remède.*

Renforcer les ressources humaines pour la science, la technologie et l'innovation

Le système éducatif hongrois peut toujours être considéré à maints égards comme un pilier solide du système national d'innovation. Il est toutefois confronté à des défis de taille, et il lui faut évoluer pour continuer d'apporter une contribution positive aux objectifs socioéconomiques nationaux. L'un des principaux enjeux est de maintenir un niveau de qualité élevé en dépit d'un accroissement spectaculaire du nombre d'élèves (entre

1990 et 2006, le nombre d'inscrits a triplé et le nombre de diplômés à doublé). Les ressources investies dans le système éducatif ont, certes, augmenté, mais pas au même rythme. Par ailleurs, la part des diplômés dans des disciplines scientifiques et d'ingénierie a nettement diminué sur le long terme. Ce changement dans la répartition entre les disciplines des inscrits et des diplômés est susceptible de créer un goulet d'étranglement majeur dans le système d'innovation. Le troisième défi concerne la nécessité d'adapter les programmes à l'évolution des besoins de l'économie et de la société. Pour que l'innovation prospère, il faut non seulement des compétences « dures » en sciences et technologies, mais aussi des compétences « douces » pratiques, notamment la capacité à communiquer et à coopérer au sein des équipes. Il faut aussi un esprit d'entreprise et des compétences en matière de gestion de l'innovation. Le système éducatif a été lent à accomplir les changements organisationnels nécessaires. De fait, les établissements hongrois d'enseignement supérieur n'ont pas réussi entièrement à mettre en œuvre des nouvelles structures de gouvernance. Par ailleurs, les critères de performance des institutions ne sont pas suffisamment liés à ceux déterminant les décisions en matière de financement. Il faudrait que les pouvoirs publics :

- *Renforcent l'éducation en mathématique, en technologie et en science à l'école primaire et dans le secondaire* afin que les étudiants qui abordent l'université soient plus motivés et mieux préparés pour des études scientifiques ou d'ingénierie.

- *Envisagent des mesures supplémentaires pour accroître la proportion de diplômés d'études scientifiques et d'ingénieurs.*

- *Étudient la possibilité de changer les critères de financement et d'appliquer des critères de qualité plus stricts pour l'accréditation des établissements d'enseignement supérieur ou pour la certification des diplômes* afin d'encourager les universités à miser davantage sur la qualité de l'enseignement et des diplômés.

- *Renforcent la formation au niveau des entreprises, y compris dans les entreprises multinationales (EMN)*, ainsi que la formation professionnelle, tout en développant les mécanismes par lesquels les entreprises peuvent contribuer à influencer les programmes en fonction de l'évolution des besoins.

Améliorer la gouvernance du système d'innovation

Ces derniers temps, beaucoup a été fait pour mettre en place un cadre juridique et institutionnel moderne pour la politique scientifique, technologique et d'innovation. Cela étant, le système est très jeune et il faut aller plus loin dans certains domaines pour parvenir à des dispositifs répondant aux besoins actuels et futurs du pays et pour permettre une mise en œuvre efficace des politiques. La formulation et la mise en œuvre des politiques STI doivent être encore améliorées de manière à obtenir davantage de résultats avec les fonds dépensés, puisque la Hongrie doit investir davantage en R&D afin d'accomplir un rattrapage en matière d'intensité de R&D.

Le système de gouvernance de la politique d'innovation de la Hongrie a subi un certain nombre de changements ces dernières années, au plus haut niveau de décision et au niveau des ministères ou des agences chargés de la mise en œuvre. Ces changements ont, certes, parfois donné lieu à des solutions innovantes, telles que l'établissement du Fonds pour la recherche et l'innovation technologiques financé par une taxe, mais ils résultent de décisions ponctuelles liées à des changements de gouvernement et non d'une évaluation approfondie des institutions et des instruments dans le cadre d'une stratégie de long terme. Ces changements n'ont pas résolu certains problèmes majeurs (notamment le positionnement institutionnel du NKTH) et leur fréquence a induit une certaine incertitude dans le système, réduisant la fiabilité, la transparence et la responsabilité d'institutions capitales pour la politique d'innovation de la Hongrie, en particulier le NKTH et le Fonds pour la recherche et l'innovation technologiques.[5]

Parmi les réorganisations en cours et envisagées, on peut citer une nouvelle répartition de certaines compétences en matière de politique d'innovation, qui passeraient de l'actuel Ministère du développement national et de l'économie à un nouveau ministère sans portefeuille. Il semble que d'autres réformes soient imminentes. Le Plan d'action pour la politique STI envisage un renouvellement des institutions qui chapeautent le système de gouvernance de l'innovation, notamment une restructuration du Conseil de la politique scientifique et technologique et du Conseil consultatif sur la compétitivité. On peut espérer que ce nouveau train de réformes va remédier de manière durable aux principales déficiences de la gouvernance qui pénalisent depuis un certain temps l'efficacité de la politique d'innovation hongroise. Cela supposera de palier les problèmes suivants :

5. Le NKTH et le Fonds d'innovation ont tous deux connu d'importants changements récemment : fusion du NKTH avec l'Agence pour la gestion des fonds de recherche et l'exploitation des recherches (KPI) début 2008, et redistribution des compétences de gestion entre le NKTH et le Centre de développement de l'économie hongroise (MAG).

Gouvernance générale

- *Tenir les priorités et les objectifs stratégiques de long terme de la politique STI* et sauvegarder le financement public de la science, de la technologie et de l'innovation face à la multiplication des besoins de court terme.

- *Rehausser durablement le statut de la politique STI au plus haut niveau décisionnaire* du gouvernement afin qu'elle fasse l'objet de l'attention et de l'engagement qu'elle mérite. La nomination d'un ministre de la R&D, du développement des technologies et de l'innovation pourrait être un pas dans la bonne direction.

- *Repenser la répartition des compétences et veiller à la bonne coordination des acteurs gouvernementaux*, afin de mieux intégrer la politique STI dans l'élaboration de l'ensemble des politiques.

- *Maintenir le niveau de financement des STI, même en périodes de consolidation budgétaire.* Dans ce contexte, on ne saurait prétexter de l'afflux de fonds de l'UE pour délaisser le financement de la R&D et de l'innovation par des fonds de source nationale. Dans le même temps, les fonds doivent être mieux répartis et mieux dépensés - notamment en réduisant l'arsenal de dispositifs de financements afin d'en alléger la gestion et d'atteindre une masse critique.

- *Assurer un minimum de stabilité* aux organismes chargés de concevoir et de mettre en œuvre les programmes et instruments de la politique scientifique, technologique et d'innovation, tant en termes d'organisation que de financement. Il s'agit là d'une condition essentielle pour que le soutien apporté soit prévisible et continu, sachant que, comme déjà souligné plus haut :

  – Une trop grande instabilité (notamment l'irrégularité de l'offre de programmes de soutien) brouille la perception des mesures par les acteurs du système d'innovation et diminue leur motivation à y répondre.

  – Une plus grande stabilité améliore la transparence de la politique STI et de sa mise en œuvre, et renforce ses bienfaits pour les groupes ciblés.

  – Il est nécessaire que les organisations, les institutions, les programmes et les instruments fassent preuve d'un minimum de stabilité pour pouvoir baser les politiques « fondées sur des faits » et pour que l'apprentissage des politiques puisse se faire.

- *Améliorer le positionnement institutionnel du NKTH en appliquant le principe d'une séparation claire entre l'échelon de la formulation des politiques et celui de leur mise en œuvre.* Dans ce contexte, la transformation du NKTH en agence indépendante contrôlée par le ministère en charge de la R&D et de l'innovation pourrait être envisagée.

- *Favoriser l'élaboration de politiques « fondées sur des faits »* en ayant systématiquement recours à des pratiques avancées de suivi et d'évaluation et à d'autres outils de gestion modernes. A cette fin :

  - Bâtir les compétences au sein des institutions qui mettent en œuvre la politique STI aux niveaux national et régional, notamment pour répartir les fonds qui viendront de l'UE dans les années à venir. Cet objectif ne saurait être sacrifié au profit d'économies de court terme sur le personnel, même en périodes de restrictions budgétaires.

  - Établir des procédures de suivi permettant de procéder, d'ici deux ou trois ans, à une évaluation des programmes conforme aux standards internationaux actuels. Dans l'intervalle, consolider et mieux exploiter les capacités dans ce domaine, et ce à deux niveaux : l'administration des programmes et la communauté des scientifiques et des experts liés à la politique d'innovation.

  - Impliquer davantage les experts internationaux dans les évaluations. La participation quasi systématique d'experts de l'étranger fait désormais partie des bonnes pratiques internationales mais n'est pas encore la règle en Hongrie.

Arsenal de mesures

Il existe actuellement en Hongrie une quarantaine de dispositifs destinés à aider l'innovation, dont 20 qui visent à promouvoir la R&D et l'innovation des entreprises. Un grand nombre de mécanismes de soutien ciblent également le travail en réseau et la coopération (17 au total, dont six pour la coopération internationale). Quatre dispositifs relativement récents visent les aspects régionaux de la politique de l'innovation, thème qui suscite une attention croissante.[6] Ces instruments, dans leur ensemble, touchent à tous

6. Dans la deuxième moitié des années 1990, le Comité national pour le développement technologique (OMFB) a lancé des dispositifs de financement spéciaux pour promouvoir l'innovation régionale. Ces dispositifs étaient administrés par les Chambres de commerce locales. Ils ont depuis été supprimés.

les domaines des processus d'innovation dans lesquels une intervention des pouvoirs publics est clairement justifiée. Dans certains cas (tels que les Centres coopératifs de recherche, KKK, et les Centres régionaux du savoir, RKC) ils s'inspirent d'expériences réussies dans d'autres pays de l'OCDE ; dans d'autres, il s'agit de nouvelles idées que la Hongrie teste (comme le Fonds pour la recherche et l'innovation technologiques ou l'initiative Innocsekk). Les fonds européens ont facilité le développement assez rapide de cet ensemble assez complet d'instruments d'action publique.

Dans le perfectionnement de l'arsenal des politiques STI, il faudra porter une attention particulière aux aspects suivants : le risque de doublons entre des mesures existantes, la combinaison des mesures génériques et sectorielles, du financement de la recherche appliquée et de celui de la recherche fondamentale, l'articulation entre financements nationaux, régionaux et européens, la combinaison d'aides directes et indirectes.

- *Éviter la prolifération des instruments.* Un défi majeur sera de savoir profiter de l'afflux de fonds européens pour accroître l'efficience globale de l'arsenal de mesures. Pour empêcher que le rendement des fonds publics ne décroisse, il faudra en particulier résister à la fragmentation d'une boîte à outils déjà bien remplie.

- *Procéder à une évaluation approfondie* du portefeuille de mesures, notamment l'équilibre entre les incitations fiscales à la R&D et les instruments de soutien direct, de l'impact de la politique d'innovation sur la recherche publique, et de l'effet des aides pour différentes catégories d'entreprises, notamment les entreprises nouvellement créées.

- Toutefois, cette évaluation ne sera pas possible tant qu'une institution centrale telle que le Fonds pour la recherche et l'innovation technologiques n'aura pas elle-même fait l'objet d'une évaluation approfondie.

- *Poursuivre le renforcement de la dimension régionale de la politique STI.* L'un des objectifs majeurs de la politique régionale de l'innovation devrait être de mieux aligner et combiner les capacités industrielles et l'infrastructure régionale d'éducation et de R&D publique. Cela pourra être accompli en associant des mesures ascendantes (politiques de « grappes » (« *clusters* »), par exemple), et des mesures descendantes (renforcement des infrastructures locales). La politique régionale d'innovation doit jouer un rôle prépondérant dans la poursuite de l'objectif prioritaire que constitue la meilleure intégration des EMN au système hongrois d'innovation.

- *Trouver un meilleur équilibre entre les mesures axées sur l'offre et celles visant la demande.* Les nouvelles plates-formes technologiques doivent être utilisées afin de mieux articuler la demande avec les capacités d'innovation hongroises. Plus généralement, les pouvoirs publics devraient reconsidérer certains aspects de leur politique en matière de commandes publiques afin de la rendre favorable à l'innovation, suivant en cela les meilleures pratiques internationales en la matière.

- *Revoir à la hausse les objectifs en matière d'administration électronique.* Les initiatives actuelles sont louables mais ne sont pas encore au niveau des meilleures pratiques internationales.

Promouvoir l'innovation dans le secteur des entreprises

L'intensification de la R&D et de l'innovation dans les entreprises hongroises, en particulier les PME, est citée à juste titre comme une tâche prioritaire de la politique d'innovation dans un certain nombre de documents de politiques (notamment le plan d'action en cours). Outre l'amélioration des conditions cadres (cf. infra) il faudra pour cela continuer de fournir des aides financières à la R&D et à l'innovation dans les entreprises afin de palier les déficiences du marché, qui se traduisent pour l'instant par un trop faible niveau d'investissement du secteur privé.

Ce type de soutien aux entreprises s'est accru ces dernières années, en particulier depuis le lancement en 2004 du Fonds pour la recherche et l'innovation technologique ; mais cela pourrait être encore insuffisant à déclencher suffisamment de croissance de la R&D des entreprises pour atteindre l'objectif de 1.8 % d'intensité globale de R&D. La Hongrie sera en mesure de tirer un meilleur parti des ressources nationales consacrées au soutien de la R&D et à l'innovation grâce à de nouveaux financements apportés par l'UE, en particulier les Fonds structurels, dont le montant pourrait être d'un niveau comparable à celui des financements nationaux (c'est-à-dire de l'ordre de 200 million EUR). En outre, il faudra que les chercheurs hongrois continuent de parvenir à obtenir les fonds des Programmes-cadres européens. Dans cette optique, il est nécessaire de :

- *Veiller à ce que les financements européens n'évincent pas les financements nationaux.* Étant donné les besoins du secteur hongrois des entreprises et la nécessité de mesures spécialement adaptées, il est important de tirer pleinement parti de cette nouvelle opportunité, tout en évitant le risque de voir des financements externes se substituer aux fonds nationaux. Il ne sera justifié de maintenir l'effort budgétaire national que si toutes les conditions sont réunies pour que les fonds soient utilisés de manière efficiente.

- *Muscler les mesures visant à renforcer les capacités d'innovation des PME,* compte tenu de leurs différents besoins spécifiques.[7]
- *Faire un effort particulier en direction des PME pour les stimuler à innover et à collaborer* avec d'autres entreprises et avec les organismes publics de recherche (par exemple dans les pôles régionaux d'activité).
- *Veiller à ce que les mesures destinées à soutenir la R&D et l'innovation n'aboutissent pas à une discrimination* de facto *contre les start-up innovantes.*
- *Envisager des mesures supplémentaires pour encourager la R&D et l'innovation dans le secteur des services.*
- *Faciliter la diffusion des nouvelles technologies, notamment les TIC,* qui continuent de jouer un rôle clé dans la croissance de la productivité. Le moyen le plus rapide d'accélérer la « démocratisation » des technologies est d'instaurer de bonnes conditions cadres – ouverture internationale, marchés concurrentiels et réglementation favorable à l'innovation – mais des outils plus spécifiques peuvent aussi être mis en œuvre. Il faut une combinaison d'incitations spécifiques et de services sur mesure. Leur mise en œuvre nécessiterait la mobilisation d'acteurs tels que les agences d'aide gouvernementale, les organisations professionnelles et les organismes de recherche publique. La dimension régionale des processus de diffusion technologique doit être faire l'objet d'une attention prioritaire.

Renforcer les liens au sein du système d'innovation

Le gouvernement hongrois n'ignore pas que l'efficience du système d'innovation pâtit du fait que ses acteurs entretiennent trop peu de relations mutuelles. Depuis le milieu des années 90, des mesures ont été prises pour renforcer les collaborations et les réseaux, notamment entre les entreprises et les universités. Depuis la fin des années 90, les politiques de promotion des « grappes » *(« clusters »*) sont également devenues un instrument majeur de la politique régionale d'innovation. Le gouvernement doit intensifier ses efforts en ce sens tout en tirant les enseignements de son expérience pour

7. Par exemple, les Instituts Bay Zoltán, qui proposent des services de R&D appliquée et axés sur l'innovation aux entreprises (principalement aux PME, sur la base d'un contrat de recherche à 100 %) ont enregistré ces dernières années une forte croissance qui devrait se poursuivre au même rythme dans les prochaines années. Il y a là la preuve qu'une « demande des moyens de l'innovation » existe de la part de ces entreprises.

améliorer certains des instruments utilisés pour promouvoir l'innovation collaborative.

- *Favoriser des liens plus forts entre les entreprises à capitaux étrangers et les fournisseurs et clients locaux, de même qu'avec les établissements de recherche,* et encourager le développement de liens entre entreprises hongroises et organismes de recherche étrangers (et hongrois). Il est justifiable de soutenir les efforts visant à attirer et à retenir les unités de R&D des entreprises multinationales afin d'offrir de multiplier les occasions d'apprentissage tant pour les entreprises que pour les universités.

- *Veiller à ce que les programmes visant à favoriser les relations entre industrie et science correspondent aux besoins réels de l'industrie.* Dans la pratique, une grande partie, sinon la majorité, des thèmes de recherche et de la production des projets industrie-science sont d'initiative universitaire et pilotés par les universités. Cela reflète sans doute, du moins en partie, un biais des incitations fournies par les dispositifs de financement actuels, notamment certaines dispositions de la taxe pour l'innovation.[8]

- *Fonder l'amélioration des liens industrie-science sur une base renforcée grâce à des mesures supplémentaires pour améliorer la capacité d'absorption des entreprises, en particulier des PME.* Les pouvoirs publics pourraient envisager d'exploiter plus efficacement à cette fin le système de chèques-innovation Innocsekk.

- *Évaluer l'efficacité des organisations de transferts de technologies* au sein des universités par rapport aux bonnes pratiques internationales.

Viser l'excellence, veiller à la pertinence et assurer une masse critique dans la recherche publique

Le système actuel de financement de la recherche publique envoie des signaux brouillés voire parfois contradictoires aux acteurs concernés. Les organismes publics de recherche (principalement les universités et l'Académie

8. Par exemple, le calcul stratégique des organisations publiques de recherche peut les amener à soumettre au NKTH des projets qui sont en réalité de la « recherche fondamentale déguisée ». De même, il semble que les projets « collaboratifs » entre organisations de recherche publique et entreprises ne donnent souvent lieu dans la pratique qu'à une participation ou une contribution symbolique de la part des entreprises. Il semble qu'ils ne soient utilisés que comme véhicule de financement pour les établissements publics de recherche et non comme un moyen pour les entreprises de renforcer leurs capacités de recherche.

des sciences) bénéficient de financements forfaitaires importants ou possèdent un patrimoine non négligeable (notamment immobilier). En règle générale, ce mode de financement institutionnel n'est pas suffisamment lié à des critères stricts en matière de qualité de la recherche et, dans le cas des universités, à la contribution de la recherche à l'éducation. En Conditionner davantage le financement, en fonction de critères de performance permettrait de mieux répondre à l'exigence de masse critique dans les activités de recherche et de renforcer les centres d'excellence ayant une visibilité internationale.

La recherche appliquée bénéficie déjà de la plus grande part des financements à octroi concurrentiel. Il est probable que ce déséquilibre, au détriment de la recherche fondamentale, s'accentuera avec l'arrivée des nouveaux fonds en provenance de l'Union européenne dans la période allant jusqu'en 2013.

- *Prendre des mesures pour accroître la contribution des organismes publics de recherche,* notamment les universités et l'Académie des sciences, à la performance globale du système d'innovation hongrois. Il conviendrait d'accélérer le processus de réforme de ces organisations, pour lesquelles les mécanismes d'incitation devraient être plus fortement axés sur les performances, de façon à mieux exploiter leurs grandes compétences dans la poursuite des objectifs socioéconomiques prioritaires du pays.

- *Poursuivre la réforme des structures de gouvernance de l'Académie des sciences,* afin de permettre une approche plus stratégique de la gestion de son portefeuille d'instituts, d'accroître sa réactivité aux nouvelles opportunités de recherche, et d'accroître son attractivité pour les jeunes chercheurs prometteurs. Les fonctions multiples de l'Académie doivent être séparées plus clairement afin de minimiser les conflits d'intérêt et d'améliorer la gestion des différentes fonctions. La question de savoir s'il est souhaitable que l'Académie conserve toutes ses fonctions (en particulier la fonction de financement de la recherche) mériterait d'être posée.

- *Augmenter les financements par octroi concurrentiel au bénéfice de la recherche fondamentale.* Afin d'accroître la transparence (et pour orienter les incitations en conformité avec les objectifs déclarés), le financement concurrentiel de la recherche fondamentale par l'intermédiaire de l'OTKA devrait être considérablement renforcé.

- *Dans le même temps, améliorer le processus de sélection pour le financement des projets de recherche,* notamment en impliquant davantage des panels internationaux de pairs.

Valoriser les retombées positives de l'internationalisation de la R&D

La recherche hongroise est bien connectée internationalement ; il faut toutefois continuer de la soutenir pour qu'elle puisse tenir sa place dans des réseaux mondiaux en croissance et transformation rapides.

- *Soutenir l'internationalisation de la science, de la technologie et de l'innovation dans tous les domaines.* Les initiatives visant à permettre aux chercheurs hongrois d'accéder aux réseaux internationaux (en particulier les Programmes-cadres de l'UE, dans lesquels la recherche hongroise fait assez bonne figure) et à l'infrastructure internationale de recherche doivent être poursuivies.

- Pour compléter la politique visant à attirer les investissements étrangers, *soutenir les entreprises hongroises qui suivent une stratégie d'ouverture vers l'étranger* par delà la promotion des exportations (par exemple pour établir une présence dans des pôles d'innovation dans des pays avancés ou émergents).

- *Participer plus activement aux initiatives de la Méthode ouverte de coordination de l'UE* afin de favoriser l'apprentissage en matière de politiques publiques (notamment la participation à ERAnet, dans les activités de benchmarking international, etc.).

- *Adopter une approche globale de la coopération internationale.* Parallèlement à une participation accrue aux programmes et initiatives de l'UE, la Hongrie devrait intensifier ses efforts pour développer des liens avec des puissances établies ou émergentes dans le domaine de la science et de la technologie hors de l'UE.

Tableau synthétique : forces, faiblesses, opportunités et risques

Forces	Opportunités
• Croissance soutenue à moyen terme de la productivité totale des facteurs et du PIB par habitant, permettant une convergence vers les pays plus avancés • Forte croissance de l'industrie manufacturière • Niveau élevé d'ouverture internationale • Main d'œuvre généralement bien qualifiée • Conditions cadres pour l'innovation satisfaisantes à maints égards • Base juridique de la politique STI solide • Quelques points forts en matière d'innovation industrielle et domaines d'excellence en recherche scientifique • Forte participation aux programmes européens de recherche	• L'innovation comme pilier de la stratégie de rattrapage • Renforcement des performances économiques en soutenant les capacités d'innovation et l'infrastructure du savoir • Maintien d'un niveau élevé d'investissement pour doper d'acquisition et le développement des technologies, ainsi que des capacités d'apprentissage et d'absorption • Attraction de l'investissement direct étranger dans les activités liées à la R&D • Meilleure adéquation des capacités de la recherche publique aux besoins du secteur privé • Utilisation des relations entre industrie et universités comme « mécanismes de ciblage» pour développer l'infrastructure du savoir • Renforcement de la compétitivité des industries et des services à forte intensité d'innovation et de savoir • Formation de « grappes » (« *clusters* ») d'innovation dynamiques • Utilisation judicieuse des fonds croissants de l'UE destinés à la STI
Faiblesses	**Menaces**
• Faible niveau d'investissement de R&D et d'innovation • Forte concentration de R&D dans quelques grandes entreprises, quelques secteurs et quelques régions • Déficit de compétences entrepreneuriales et technologiques dans le secteur des PME (« économie duale ») • Liens trop lâches entre les acteurs du système d'innovation • Capacités de gestion de la R&D insuffisantes dans les organismes publics de recherche • Insuffisances dans la formation des ressources humaines en science et technologie • Lenteur de la diffusion des applications TIC • Instabilité du système de gouvernance des politiques de l'innovation • Insuffisante culture de l'évaluation • Faible implication des parties prenantes dans l'élaboration des politiques • Faiblesses dans la mise en œuvre des politiques	• Potentiel de croissance non concrétisé, processus de rattrapage freiné • Perte de compétitivité, notamment *vis-à-vis* des économies émergentes • Perte de ressources humaines hautement qualifiées nécessaires à l'innovation • Marginalisation de la Hongrie comme centre de R&D

Chapter 1

ECONOMIC PERFORMANCE AND FRAMEWORK CONDITIONS FOR INNOVATION

This chapter presents an overview of Hungary's economic performance and some main features of the country's development path, openness to international trade and foreign direct investment (FDI), and patterns of structural change. It considers the role of innovation in the country's development in the longer term. It also discusses some aspects of the prevailing framework conditions for innovation. Finally, it provides some basic information about Hungary's performance in science, technology and innovation in international comparisons.

1.1. Economic performance and level of innovative activity

1.1.1. Good macroeconomic performance and robust productivity growth

Hungary has made remarkable progress in a relatively short time. Over the past two decades the Hungarian economy has been transformed into a functioning market economy and the institutional framework for sustaining it has been established. The process of European integration – culminating in Hungary's accession to the European Union – has strengthened the institutional framework. In fact, Hungary scores satisfactorily among OECD countries on a number of basic institutional indicators (OECD, 2008a). The economy has also become tightly integrated in the global economy. For example, according to the KOF Index of Globalisation (Dreher *et al.*, 2008)[9] – which provides a synthetic measure of economic, social and political globalisation – Hungary is among the world's 15 most globalised countries and ranks as high as eighth in the economic dimension of globalisation. Hungary has committed to join the euro area.

9. The data are available on the KOF (Swiss Economic Institute) Index of Globalization website: *http://globalization.kof.ethz.ch*.

The institutions and frameworks put in place in the transition to a market economy have underpinned robust medium-term growth. In the years preceding a pronounced slowdown in 2007, real per capita GDP grew quite steadily at an annual rate of 4 to 5% (Figure 1.1), placing Hungary among the three fastest-growing OECD economies. Indeed, Hungary's economy has consistently grown faster than that of the more advanced European and OECD economies and has thus narrowed the gap in GDP per capita, which rose from under 52% of the 1997 average of the current EU27 countries to more than 63% in 2006. Labour productivity improved significantly over the same period, from 62% to nearly 75% of the EU27 average.

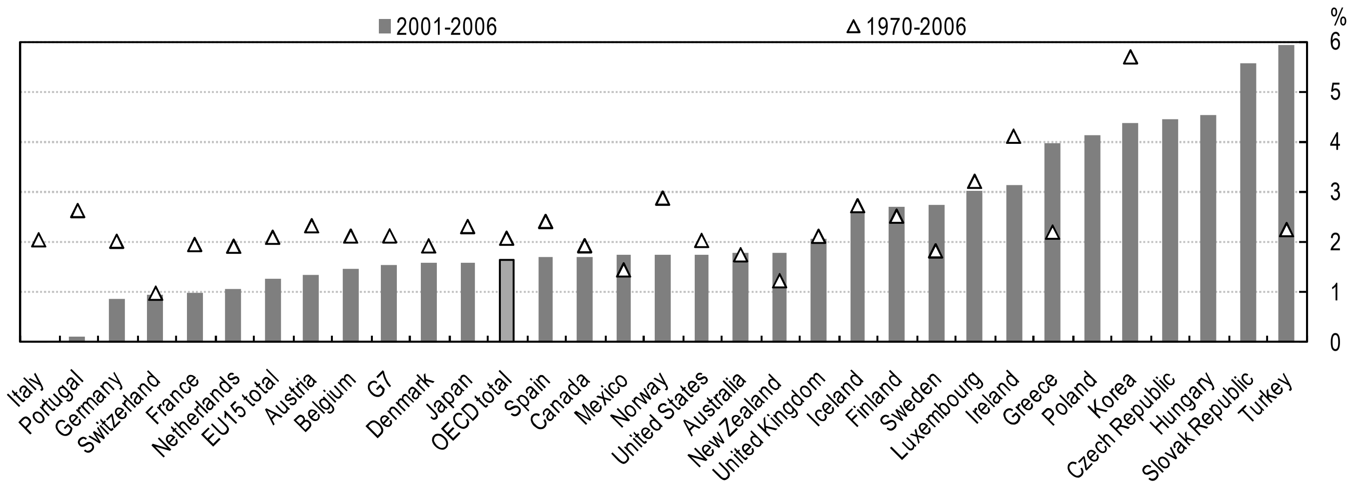
The catching-up process has been temporarily interrupted by the slowdown which set in during 2005. In the short run, budgetary consolidation measures, including sharp cuts in public expenditure (affecting mainly public services and investments in the infrastructure) and frontloaded tax increases, are dampening economic activity. While fiscal consolidation will provide a solid basis for longer-term growth, it may take some time for the economy to return to its previous growth path. In contrast to Hungary, growth picked up in the neighbouring Slovak Republic and, to a lesser extent, in the Czech Republic (Figure 1.2). This is one of several indications that Hungary has not fully realised its economic potential in recent years.

In some parts of the Hungarian economy, the post-1990 transformation was accompanied by what may be characterised as a surge in innovation. It was primarily based on the diffusion of international best practices through transfer of technological knowledge developed and already in use abroad, the adoption of advanced management practices and business models, the importation of knowledge "embodied" in intermediate and capital goods (machinery and equipment), etc.[10] It is to some extent reflected in growth in total factor productivity (TFP), which may also involve factors other than technical innovation, such as "organisational and institutional change, shifts in societal attitudes, fluctuations in demand, changes in factor shares, omitted variables, and measurement errors" (Hulten, 2000, p. 61).

10. Three-quarters of total innovation expenditure – R&D expenditure as well as expenditure on machinery, equipment, licences and know-how for the introduction of new products and processes – of Hungarian firms is spent on acquiring external knowledge embodied in machinery and equipment. Spending on both in-house and external R&D was comparatively low (13% and 7%, respectively).

Figure 1.1 Growth in GDP per capita

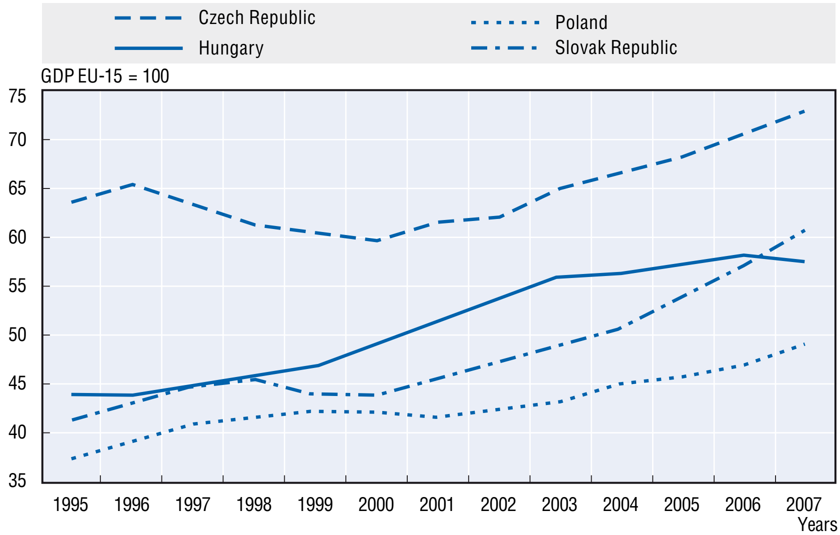
Percentage change, annual rate



Source: OECD Factbook 2008.

Figure 1.2. GDP convergence in the European Union

GDP in purchasing power parity



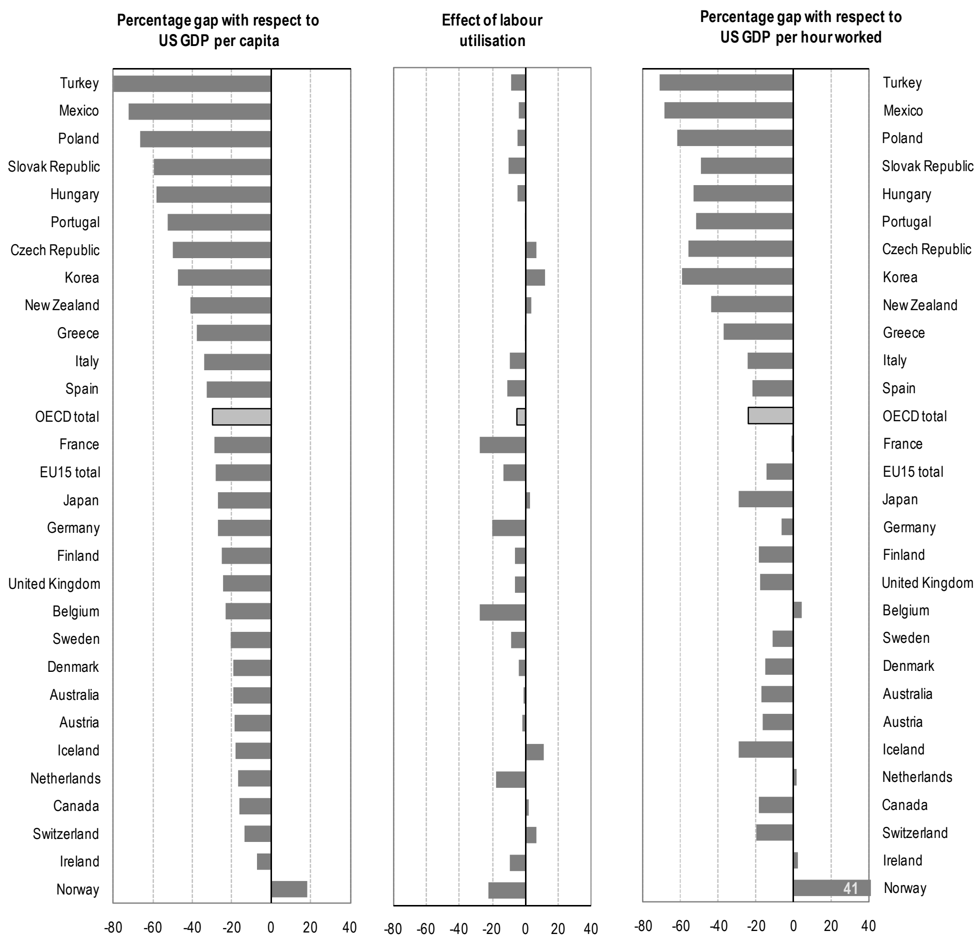
Source: OECD (2008a) based on Eurostat.

According to results of *Productivity in the European Union: A Comparative Industry Approach* (EU KLEMS) (van Ark *et al.*, 2007), Hungary recorded stable and – compared with the other EU member states – high growth of gross value added (4.1% a year from 1995 to 2004). Growth of gross value added varies widely across sectors and was exceptionally high in the "Electrical machinery, post and communication" industry (15.1%). About half of the growth in total gross value added in the market segment of the Hungarian economy during the period (2.2 percentage points) can be attributed to multi-factor productivity growth. The remainder is due in equal parts to labour and capital inputs. While the former is roughly equally divided between changes in the composition of labour and total hours worked, the information and communication technology (ICT) capital component is somewhat higher than the contribution of non-ICT capital. The contribution of TFP to the expansion of value added varies widely across industries. While it was 10.9 percentage points in "Electrical machinery, post and communication", it was just 1.1 percentage points in the rest of manufacturing. In the services sector, the TFP contribution was 1.9 percentage points in "Distribution services" but appears to have been negative in some other services industries. Overall, the evidence points to substantial gains in efficiency in the economy.

While robust growth in the medium term has resulted in convergence to the levels of the more advanced countries, Hungary's current GDP per capita is still one of the lowest among OECD countries. In 2006 the gap *vis-à-vis* the United States was still 59 percentage points (Figure 1.3). This gap mainly reflects lagging labour productivity (as measured by GDP per hour worked), while lower labour utilisation accounted for the much smaller remaining difference. Thus, despite robust growth in the past, boosting productivity remains a major issue for economic policy.

Figure 1.3. Income and productivity levels

Percentage point differences with respect to the United States, 2006



Source: OECD Factbook 2008.

Table 1.1. Hungarian rankings in international comparisons

Indicator	Ranking institution/author	Year	Hungary's ranking among: OECD	Hungary's ranking among: OECD CEECs[3]
			Ranking/number of countries	
Business R&D intensity[1]	OECD, Main Science and Technology Indicators database, May 2007	2005	24/30	2/4
R&D personnel (per 1000 employment)	OECD, Main Science and Technology Indicators database, October 2007	2006	24/29	3/4
Rate of tax subsidies for USD 1 of R&D	OECD Directorate for Science, Technology and Industry, EAS division, 2007	2006-2007	9/30	2/4
Firms collaborating in innovation activities	Eurostat, CIS4 (New Cronos), May 2007 and national data sources	2002-2004	21/26 (all firms) 23/26 (SMEs)	4/4
Triadic patent families[2]	OECD, Patent database, April 2007	2005	22/27	2/4[4]
Scientific articles	OECD, Main Science and Technology Indicators, June 2007; National Science Foundation (2006), Science and Engineering Indicators 2006	2003	25/30	3/6[5]
Business use of Internet and websites	OECD, ICT database and Eurostat, Community Survey on ICT usage in enterprises, April 2007	2006	28/28	4/4
Broadband penetration	OECD, ICT database and Eurostat, Community Survey on ICT usage in enterprises, April 2007	2006	23/28	2/4
Broadband prices	OECD, Communications Outlook 2007	2006	4/29	1/4

1. Ratio of growth in expenditure on R&D to GDP.

2. Patents filed at the European Patent Office (EPO), the US Patent & Trademark Office (USPTO) and the Japan Patent Office (JPO) which protect the same invention.

3. OECD CEECs (central and eastern European countries) include the Czech Republic, Hungary, Poland and the Slovak Republic.

4. Includes Slovenia but not the Slovak Republic.

5. Also includes Romania and Slovenia.

Source: *OECD Science, Technology and Industry Scoreboard 2007*.

1.1.2. Low level of innovative activity

In spite of the robust growth in TFP, the overall level of innovation activity as measured by most standard indicators of innovation input, output and even technology diffusion (such as ICT-related indicators) has remained comparatively low in the economy at large (for an overview see Table 1.1). The weakness in recorded innovation activity seems to be at least partly due to the fact that much of the observed innovation activity and research and development (R&D) in particular are concentrated in some large, export-oriented, often foreign-owned enterprises, operating in a limited number of manufacturing industries, and – to a lesser extent – in some parts of the services sector. In contrast, a vast number of small and medium-sized enterprises (SMEs) record no or only feeble innovation activity. What seems to be lacking is a strong segment of the medium-sized innovation-oriented firms which play an important role in many of the more innovative OECD countries. Moreover, relatively little innovation activity is based on domestic R&D and technology development (Havas, 2006).

While the structure of production has already converged to that of more advanced economies, thus limiting future re-allocation effects, the (former) transition economies can still realise additional gains from adopting new technologies and methods of production and from investment in infrastructure, improved regulations and institutions, and law enforcement.[11] In order to maintain and foster the dynamism of TFP growth, more attention needs to be paid to the innovative performance of Hungarian businesses.

While the current economic situation puts fiscal stabilisation at the top of the policy agenda and, beyond the short term, calls for maintaining sound macroeconomic policy and forging ahead with structural reform, fostering innovation is necessary to achieve sustainable growth in the long term. In this context, the provision of framework conditions and more dedicated innovation policy will have a major role to play.

11. See Kátay and Wolf (2006), based on firm-level data.

1.2. International trade and foreign direct investment

For a small and open economy such as Hungary, foreign trade and cross-border investment flows are of key importance for economic growth and development. The evolution of the world economy – notably globalisation and the rise of emerging economies – provides new opportunities but also requires continuous adaptation in order to remain competitive. International linkages through trade and FDI are also important for a country's innovation performance since they are channels of knowledge flows both in an immediate sense and more indirectly through the transfer of knowledge embodied in imported goods.

1.2.1. International trade

Hungary's external trade (exports plus imports) now represents 136% of GDP (2007) – a higher ratio than that of most OECD countries with a similar population – and FDI accounts for about 60% of total value added in manufacturing. With respect to the trade-to-GDP ratio, Hungary ranks high among OECD countries. Between 1993 and 2006 this ratio increased by 48 percentage points, a much larger increase than in most countries, including in economies of comparable size and which have a similar history of transition to a market economy and integration in the world economy (Figure 1.4). Only Luxembourg has surpassed the change recorded in Hungary.

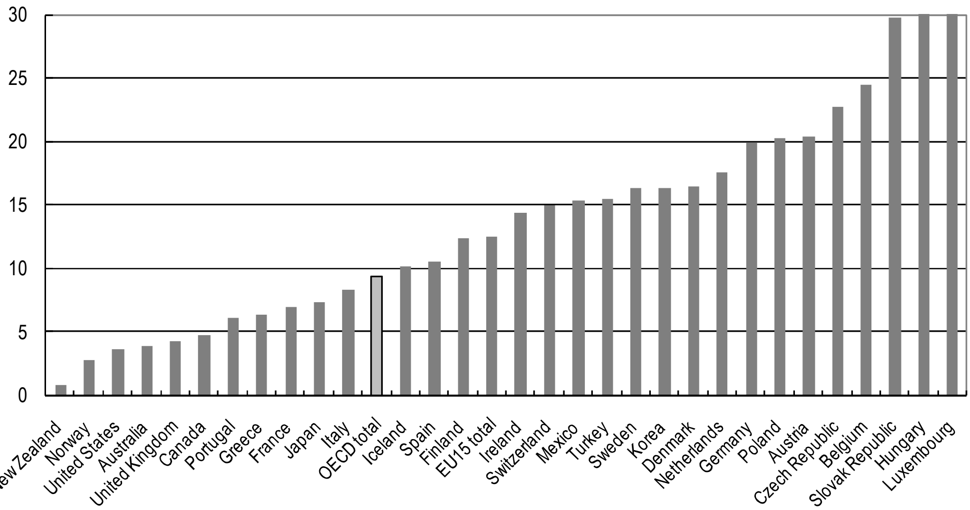
Exports (in Euro terms) grew at an average rate of 17% a year between 1997 and mid-2007. The most important engine of this expansion has been trade in machinery and equipment which has expanded at an average of 25% a year. Nevertheless, for most of the past decade, the external trade balance showed a deficit of about 3% of GDP.[12]

Most of Hungary's exports are carried out by a small number of foreign-owned firms, while domestic SMEs lag far behind. Large firms from two sectors (electronic machinery and equipment and the automotive industry) account for 52% of all Hungarian exports. The share of SMEs is 22.7%, of which 1.1% from micro-enterprises and a modest 13.9% from medium-sized enterprises. Compared to the EU, large Hungarian firms have a much higher share in total exports, while micro-enterprises have a much lower one (KSH, 2006b).

12. It has been argued that a more balanced external position would reduce the likelihood of a financial crisis and improve investment conditions and thus favour the introduction of innovative products and processes (Hornok *et al.*, 2006).

Figure 1.4. Trade to GDP ratios

Difference between 2006 and 1993 ratios in percentage points



Source: OECD Factbook 2008.

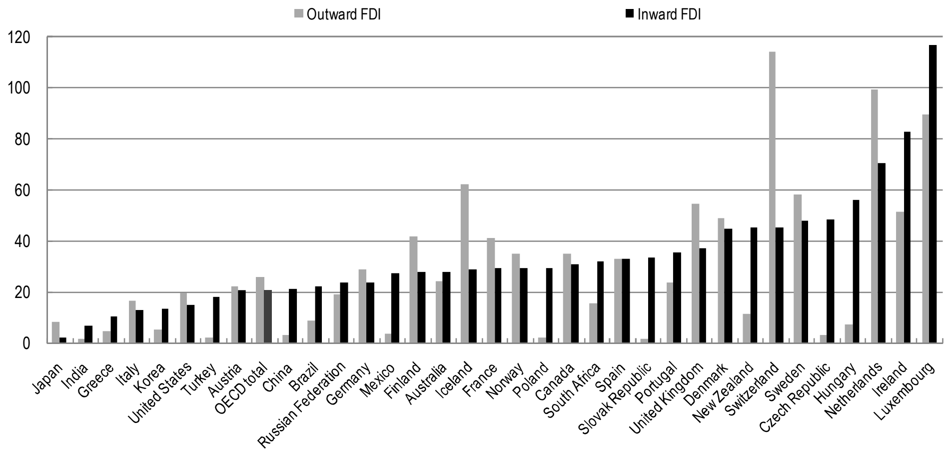
Not only the volume but also the structure of trade flows has changed radically in a relatively short time (see the following section). In 1995 all central and eastern European countries' export structures were quite similar and different from those of the EU15, but by 2003 nearly all had increased their similarity with the latter, and Hungary – along with the Czech Republic and Slovenia – were more similar to the EU15 than to the other central and eastern European countries (Crespo and Fontoura, 2007a, p. 622). More broadly, the countries with the highest degree of similarity tend to be those with the largest stocks of FDI in manufacturing.

1.2.2. Foreign direct investment

FDI serves multiple purposes in the economic development process. It can potentially play a key role in the performance of the national innovation system. Inward FDI acts as a channel of knowledge flows and, in principle, provides opportunities for learning in domestic firms and for establishing innovative regional networks around or involving foreign-controlled companies. There is now a considerable amount of empirical evidence concerning the spillovers from FDI to the host economy (*e.g.* Crespo and Fontoura, 2007b). Outward FDI that links the economy with knowledge centres and innovation networks abroad can also play an important complementary role in gaining access to cutting-edge information and technology.

Figure 1.5. FDI stocks

As a percentage of GDP, 2005 or latest available year



Source: OECD Factbook 2008.

As it has opened to the world economy, Hungary has attracted inward FDI flows of considerable magnitude. In 2005, its stock of inward FDI was 56% of GDP, and nearly 66% in 2007, one of the highest levels of foreign ownership among OECD countries. In contrast, its outward FDI stock is comparatively small (7.2%), although Hungarian companies are beginning to seize opportunities in the region, notably as a result of EU enlargement. The corresponding OECD averages are 25.7 and 21.0%, respectively (Figure 1.5). In per capita terms, Hungary (together with the Czech Republic), has the largest FDI stock in central Europe.[13] The share of multinational enterprises (MNEs) is particularly high in manufacturing sales (71.6% in 2002), second only to Ireland (79.5% in 2001) among OECD countries.

FDI has contributed to Hungary's economic growth in various ways. Foreign-owned manufacturing firms, for example, have provided access to export markets through their parent companies. They have significantly increased their output and have become major players in the economy. In addition, their presence helps Hungarian firms learn about advanced methods and skills in production, finance and marketing. Such spillovers help to improve economic performance indirectly (Békés *et al.*, 2006; Halpern and Muraközy, 2007). The share of MNEs in business sector expenditure on R&D (BERD) is very high: according to the Hungarian Statistical Office (KSH) they financed about 70% in 2006.

13. Including all new EU member states, Estonia is well ahead of Hungary.

In recent years, the inflow of FDI came to a halt, and the rise in the capital stock has been mainly due to reinvested profit. Non-debt-generating financing of the current account, including FDI and portfolio transactions, showed a EUR 2.5 billion outflow in the first half of 2007 compared with half this amount in 2005 and 2006. In 2006 and 2007, a larger share of profits was remitted abroad than in 2005. Indeed, in the second half of 2007, FDI to Hungary was negative: outward FDI reached EUR 1.3 billion. This suggests that the unfavourable macroeconomic environment may have affected foreign firms' investment decisions, while local firms attempted to seize opportunities in fast-growing neighbouring countries such as the Slovak Republic and Romania.[14]

1.3. Structural change

1.3.1. Industry structure

The growth of the Hungarian economy has been accompanied by considerable changes in the structure of production and of exports (*e.g.* Hawlik, 2004; Crespo and Fontoura, 2007a). The export-oriented manufacturing sector – which received significant flows of FDI during the transition process – has been an important engine of growth. Hungary's share in OECD exports increased from 1998 to 2004. Service industries supplying both domestic and foreign markets have expanded as well. Openness to FDI and international trade and European integration in particular have underpinned economic development in the recent past.

Structural changes in exports can be characterised as follows (Crespo and Fontoura, 2007a):

- *Shift towards medium- and high-technology exports.* Hungary records one of the highest combined shares of high- and medium-high-technology industries in total exports of manufactured goods and primary products among OECD countries and is far ahead of peers in central Europe such as the Czech Republic, the Slovak Republic and Poland (Figure 1.6). Between 1996 and 2005 the growth of high- and medium-high-technology exports was on a par with that of China and even ahead of it in high-technology exports. A shift towards technology-driven exports is observed in all central and eastern European countries but has been particularly pronounced in Hungary. Use of a factor-input-based taxonomy[15] shows that in

14. Hungarian firms started investing abroad in the early 1990s, notably in neighbouring countries. In 2007, the outward stock of FDI reached EUR 9 billion.

15. Factor input-based categories include technology-driven as well as mainstream, labour-intensive, capital-intensive, marketing-driven industries (Peneder, 2001).

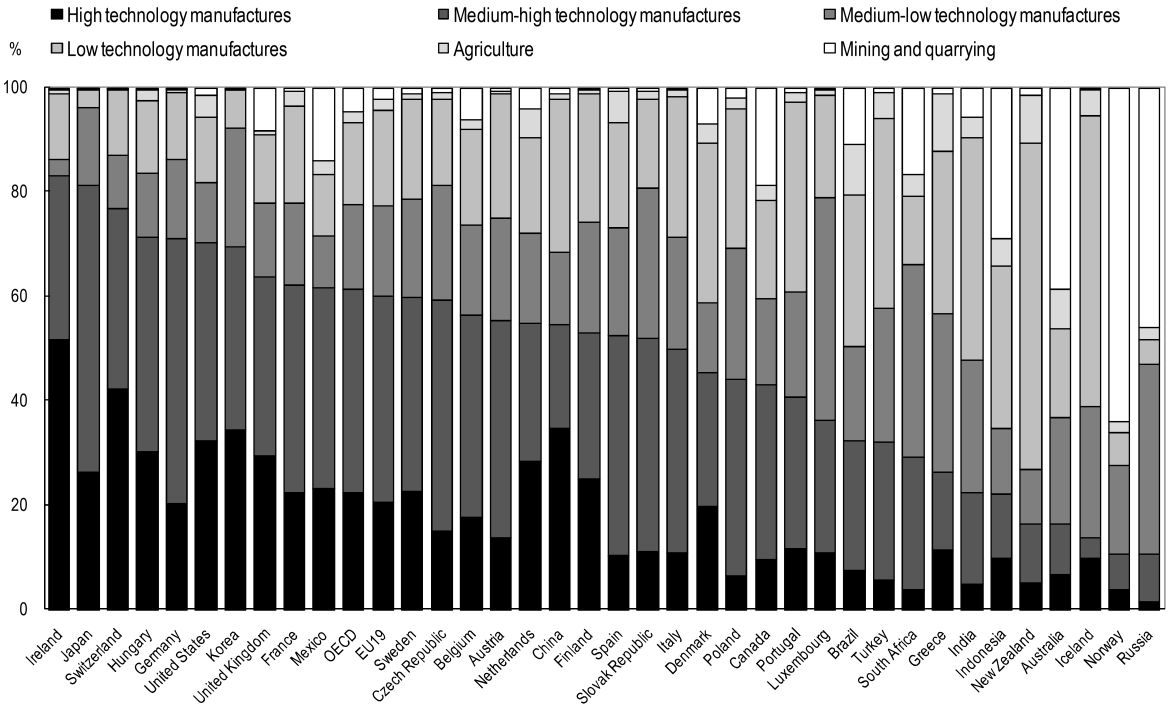
Hungary the share of all other export categories has declined (Crespo and Fontoura, 2007a, p. 615).

- *Shift towards higher skills.* On the basis of skill categories,16 after the Czech Republic and nearly on a par with Slovenia, Hungary has the highest share of high-skill industries and succeeded in drastically reducing low-skill industries between 1996 and 2005.
- *Shift towards fast-growing industries.* Hungary has also been able to move towards the most dynamic industries in terms of EU demand. Specifically, it increased the share of its most dynamic industries from 11.3% in 1995 to 31.7% in 2003. This is clearly the highest value among central and eastern European countries and far above the central and eastern European and even the EU15 average (13.2 and 20.4%, respectively).
- *Shift towards higher-quality exports.* The structure of exports to the EU15 has shifted towards the higher-quality product segment, proxied by the unit value of exports, *i.e.* revenue per quantity unit (Crespo and Fontoura, 2007a). By 2003 more than one-quarter of Hungary's exports (26.7%) was in the highest-quality product segment (here defined as a ratio between the unit value of the country's exports to the EU15 and the unit value of world exports to the same destination). Among the central and eastern European countries (average share 18.8%) only Estonia (37.0%) and the Slovak Republic (28.3) had higher shares. In these three countries the share of the highest-quality segment had far surpassed that of the lowest segment by 2003.

In some ways Hungary's trajectory resembles the development path of countries such as Ireland (and in some respects China) in that it has an industrial specialisation characterised by a high share of "high-technology" industries without a strong domestic industrial R&D base. As global competition among countries for becoming an attractive location for high-technology manufacturing increases, it raises the question of whether this type of development trajectory – high-technology manufacturing with little own R&D – will be sustainable in the medium to long term.

16. Skill-based categories include low-skill, medium-skill/blue-collar workers, medium-skill/ white-collar workers and high-skill industries.

Figure 1.6. Share of technology industries in total exports of manufactured goods and primary products, 2005



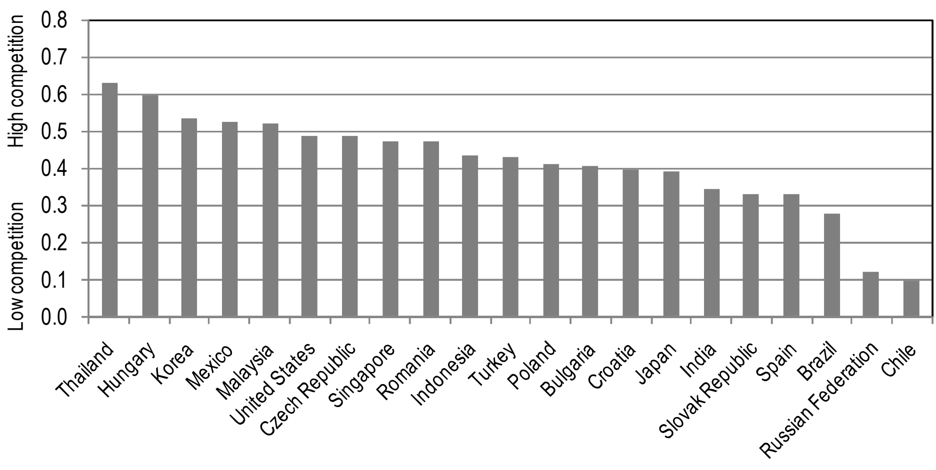
Source: *OECD Science, Technology and Industry Scoreboard 2007*.

Hungary's export structure is extraordinarily similar to that of China's (Figure 1.7). For this reason the challenge of increased competition from China may be more daunting for Hungary than for countries whose export structure is more complementary to China's. The challenge is particularly acute because China can be expected to retain for the foreseeable future its comparative advantages in the area of low skill-intensive manufacturing while, at the same time, it builds new areas of comparative advantage in a broad range of knowledge- and technology-intensive segments of production (OECD, 2008b).

This implies that Hungary has to take serious steps to move its development towards a knowledge-based economy, with specialisation patterns that make good use of its potential and its corresponding niches of competitiveness. Hungary's integration in the large European market is of course a substantial advantage. Other OECD countries that have gone through a successful catching-up process (including Korea, or, with rather different initial conditions, neighbouring Austria) have been trying to raise the R&D, knowledge and skill intensity of their economies in order to achieve a shift in their growth patterns.

Figure 1.7. Export competition with China for selected countries, 2000-05

Average coefficients of specialisation (CS) and coefficients of conformity



Source: *OECD Latin American Economic Outlook 2008*, based on WITS and Comtrade (2007) data.

1.3.2. Distribution by firm size[17]

The size distribution of a country's population of business firms is important for several reasons. Among others, a firm's size is related to its capabilities, not least in the area of R&D and innovation; it also influences the role it plays in the regional or national innovation system, and it gives rise to specific requirements for facilitating its operations.

Table 1.2. Comparison of enterprises in the European Union (EU19[1]) (2003) and Hungary (2005)

Averages

		Micro	Small	Medium	SMEs	Large	Total
Average size (persons)	EU19	3	19	98	5	1 052	7
	HU	2	20	100	3	874	4
Sales revenues per enterprise (EUR thousands)	EU19	440	3 610	25 680	890	319 020	1 550
	HU	73	1 689	8 083	183	95 952	293
Value added/enterprise (EUR thousands)	EU19	120	1 180	8 860	280	126 030	540
	HU	12	226	1 359	28	21 244	52
Proportion of export in sales revenues (%)	EU19	9	13	17	12	23	17
	HU	11	12	18	13	41	23
Value added per employee (EUR 1 000/person)	EU19	40	60	90	55	120	75
	HU	7	11	14	9	24	13
Labour cost per value added (%)	EU19	57	57	55	56	47	52
	HU	41	63	74	58	56	57

Note: EU19: EU15 plus Iceland, Liechtenstein, Norway and Switzerland.

Source: OECD (2008a, Chapter 7), based on Observatory of European SMEs (2003), *SMEs in Europe 2003*, No. 7; calculations based on data provided by APEH; Hungarian Tax and Finance Control Administration, see MoET (2007), "State of Small and Medium sized Business in Hungary 2005–06", Budapest.

In the former centrally planned economy the size distribution of firms was heavily biased towards large companies. The transition towards a market economy has brought about a fundamental change. Today, 96% of SMEs operating in Hungary are micro-enterprises with fewer than 10 employees, a

17. This part draws on Chapter 7, "SME Promotion: Increasing Competitiveness and Fostering Successful Entrepreneurship", in OECD (2008a).

higher proportion than in most OECD countries, with 75.6% in the 0-1 size class.[18]

The large share of small firms might suggest a high degree of entrepreneurship or innovativeness. However, innovation survey data indicate that the share of innovative SMEs – especially among small firms – is rather low by international standards, and far below the share of innovative large firms. SMEs are concentrated in low-productivity industries such as the craft and retail sectors, with limited presence in manufacturing, especially in more advanced industries. Entrepreneurial capacity is limited, human resources are often unskilled, and the level of innovative activity is low. Most of the micro and small businesses are undercapitalised; risk taking ability is weak. Across size classes, performance indicators of Hungarian SMEs tend to be low compared to the EU19[19] average, regardless of the size class (Table 1.2). Notably, value added per employee – a measure of productivity – is comparatively low in all size categories.

1.4. The role of innovation in economic development

As indicated above substantial efficiency gains have been realised in the Hungarian economy. There are still unexploited opportunities and a variety of potential sources for fostering growth in the Hungarian economy; for example, the labour participation rate is still low by international standards (OECD, 2007a). However, boosting innovation will be important for achieving sustainable growth of productivity and GDP per capita in the longer term. As in other OECD countries, both effective adoption of knowledge generated abroad and knowledge generated by the R&D of Hungarian performers are necessary to drive innovation processes at the necessary scale and scope.

Cross-border diffusion of technological knowledge is clearly very important for small countries and especially – as emphasised by the literature on catching-up economies – for those that trail behind the technological frontier.[20] This is obviously Hungary's situation. However, even for large, technologically advanced economies such as the United States or the European Union as an entity, cross-border knowledge diffusion is of key importance for economic performance in the longer term.[21] Consequently,

18. More than one-quarter of registered enterprises (depending on the methodology used) are not even operating.

19. EU19 represents the EU15 plus Iceland, Liechtenstein, Norway and Switzerland.

20. See Gerschenkron (1962), Abramovitz (1986) and the survey by Fagerberg (1994).

21. See Hollenstein and Hutschenreiter (2001). The importance of international knowledge diffusion was illustrated by Eaton and Kortum (1996) who found that more than 50% of the productivity growth in each of the 19 OECD countries included in their sample could be attributed to innovations from just three countries (the United States, Germany and

the diffusion of technology and of international best practices in organisation and management will continue to play an important role in Hungary's productivity growth, especially since the catching-up process is far from complete. Extrapolating the growth differentials observed in recent years (before the slowdown in 2007) implies catching up with average per capita GDP in the EU within about 25 years (OECD, 2007a).

In a forward-looking perspective, Hungary can benefit greatly from improving its R&D and innovation performance and achieve sustainable high growth in the future. Relevant issues include:

- Technological knowledge, even if publicly available, is in many cases not unconditionally appropriable (and thus differs from textbook definitions of public goods). Rather, potential innovators have to have certain capabilities, referred to as "learning" or "absorptive capacities" (Cohen and Levinthal, 1989) if they are to adopt and make efficient use of existing technological knowledge. In this sense, the appropriation of technology is itself a knowledge-intensive process. Own R&D activity may also help to build and maintain absorptive capacities. There is evidence that more productive firms benefit more from spillover opportunities created by investment by foreign multinationals. Recent empirical research on spillovers of FDI in Hungary indicates that (their level of) "productivity influences domestically owned firms' capacity to absorb knowledge and achieve higher productivity" (Békes *et al.*, 2006, p. 21). Specifically, more productive firms receive more horizontal and backward spillovers from foreign-owned MNEs.

- Innovation based on domestic R&D can be expected to gain even more in importance in its own right as the income and productivity gap with the more advanced countries gradually narrows and Hungary moves closer to the technological frontier. Already today, many Hungarian business firms exposed to international competition cannot survive or grow unless their own research and technological development activities feed a constant flow of innovation.

- The ongoing process of globalisation of R&D (OECD, 2008d) though only in its early stages, provides new opportunities but also raises challenges owing to increased international competition from a larger number of actors. Emerging economies, including China, are set to compete not simply on the basis of their traditional comparative advantage – primarily the abundance of unskilled

Japan). Only these three countries, together with France and the United Kingdom, derive more than 10% of their growth from domestic research. On this issue also see Eaton and Kortum (1999), and the survey by Gong and Keller (2003).

labour – but increasingly in economic activity with higher knowledge content (OECD, 2008b). In addition, some of these countries are emerging as major destinations of FDI not just for production sites but also for R&D. Hungary will need to strengthen its R&D capabilities and related infrastructure and improve the links between foreign companies and the Hungarian innovation system in order to stay internationally competitive as a location of R&D-related activities.

To sum up, raising innovation capabilities, including R&D-based innovation throughout the economy, remains a major challenge for securing long-term productivity growth and rising income and living standards. While the Hungarian government has recognised the role of R&D and innovation, there remains ample scope for improving the performance of the Hungarian innovation system by favourable framework conditions for innovation and specific policies to promote science, technology and innovation.

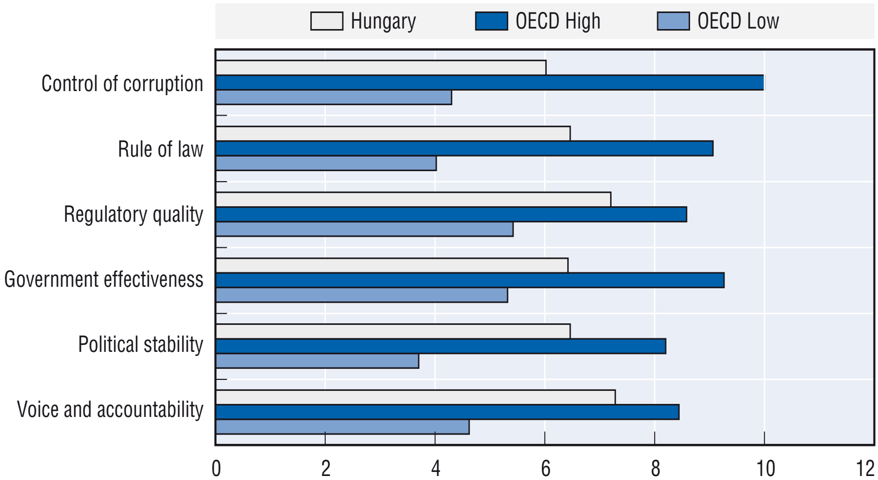
1.5. Framework conditions for innovation

The transition required establishing the basic institutions of a market economy. Hungary has been quite successful in this respect. A number of governance indicators show that basic framework conditions for economic and political institutions are well within the range covered by other OECD countries (OECD, 2008a, p. 10; Figure 1.8). OECD indicators of labour and product market regulation show that Hungary has made significant progress since the early 1990s.

The macroeconomic framework, the general business environment, the degree and quality of entrepreneurship, the intensity of competition, and product and labour market regulations are all of key importance for a country's innovative performance. The existence of favourable framework conditions enables and facilitates innovation throughout the economy. Innovation policy is not likely to compensate for seriously flawed framework conditions. At the same time, OECD experience shows that in many cases specific policy measures are needed to address specific market or systemic failures that hamper R&D and innovation.

Figure 1.8. Comparison of institutional indicators

Range from 0 to 10 from lowest to highest performance



Source: OECD (2008a); OECD calculations based on D. Kaufmann, A. Kray and M. Mastruzzi (2007), "Governance Matters, VI: Governance indicators for 1996-2006", *Policy Research Working Paper*, No. 4280, World Bank, Washington, DC, available at *www.worldbank.org/wbi/governance*.

There are several reasons why framework conditions are a key prerequisite for strong innovation performance:

- Innovation activity requires a medium- or long-term horizon and thus a sufficiently stable environment. This is particularly important for R&D and more fundamental types of innovation activity.
- The regulatory framework is of crucial importance for the speed of diffusion, and in some cases for the generation, of new technologies. This was demonstrated worldwide by developments in the telecommunications sector in recent decades.
- The quality of framework conditions also has an impact on the effectiveness of innovation policy itself. Unfavourable framework conditions are likely to reduce the effectiveness of specific policy measures designed to foster innovation; for example, no amount of dedicated innovation policy measures can compensate for the absence or the serious malfunctioning of markets or other fundamental economic institutions.

As this review will show, Hungary has a comprehensive set of instruments to promote R&D and innovation, Good framework conditions are needed to allow them to bear fruit. The following sections consider the macroeconomic framework, competition and intellectual property rights as they relate to innovation.

1.5.1. Macroeconomic framework and the business environment

A stable macroeconomic framework is of key importance for innovation performance:

- A stable macroeconomic environment – and in particular strong and stable rates of output growth – provides conditions that encourage firms to pursue medium- to long-term goals. A medium- to long-term horizon is a salient feature of R&D investment and of more demanding types of product, process and organisational innovation. A sound macroeconomic framework may also encourage investment in R&D and innovation via low and stable rates of inflation and a reduction in the level and volatility of real interest rates (Jaumotte and Pain, 2005b; OECD, 2006a).

- Apart from these direct impacts of macroeconomic conditions on the extent of business R&D there may be indirect effects through the policy-making process. Under tight budgetary conditions public expenditure for long-term objectives risk being crowded out by other categories of expenditure. Related long-term issues tend to be moved down the list of policy priorities.

The opening of the economy has helped to create well-functioning product markets and an improved business environment.

- In the short term the macroeconomic environment is somewhat unfavourable for firms' innovation activities: growth is slow, the domestic market is weak, government investment is falling, inflation has been on the rise and net FDI inflows have been small or negative. In 2008, improvements are expected owing to a more stable environment due to the reduction of fiscal imbalances. Successful attempts to reduce the level of indebtedness imply the possibility of establishing a more business-friendly macroeconomic environment in the medium term. Significantly larger amounts of EU funds will become available from 2008, and this is likely to boost R&D as well as innovation activities.

Economic policy changes have been difficult to predict and have created uncertainties. A lack of stability in the institutional system and in regulations has tended to undermine business confidence and has prompted many Hungarian firms to focus on short-term issues, *i.e.* day-to-day survival, rather than long-term strategic goals. The weakening propensity to invest is one of the most important signs of this. The annual growth rate of fixed capital investments in the business sector has been slowing even at current prices. The ratio of investment to GDP has remained at around 11% since 2002, after being at over 14% from 1998 to 2000 (MNB, 2006).[22] Fixed capital formation decreased by 2.5% in 2006 and remained unchanged in 2007.

1.5.2. Competition

Product market competition is a driver of productivity growth either directly or indirectly through a positive impact on innovation (Baumol, 2002), at least until a certain intensity of competition is reached.[23] It appears that the type of product market competition also affects the type of innovation activity (Aghion and Howitt, 2006). Although the relationship between competition and innovation is complex,[24] empirical evidence, as summarised by Ahn (2001, 2002), shows that:

- While there is no clear-cut relationship between market concentration or firm size on the one hand and innovation activity on the other, there is a robust relationship between product market competition and productivity growth (which in the long term can be expected to be closely related to innovation activity). An increase in the intensity of competition (*e.g.* through regulatory reform or opening of markets to foreign suppliers) results in an increase in productivity growth and higher consumer welfare.
- Competition has a long-lasting, dynamic impact on firms' behaviour.
- Competition between existing firms is important, but competition from innovative new firms may be even more important for securing productivity gains at the cutting edge of technology; hence the importance of free entry.

22. Adverse macroeconomic framework conditions are also reflected in the *Global Competitiveness Report*. In its 2005-06 edition, Hungary ranked 63rd among the 117 countries in terms of the macroeconomic environment index.

23. Aghion *et al*. (2005) established an inverse U-shaped relationship between competition and innovation.

24. On the following, see OECD (2008e).

The interaction between competition in product, labour and financial markets has an important influence on innovation and growth. In particular, narrow and illiquid capital markets and inflexible labour markets hold back most types of innovation activity.

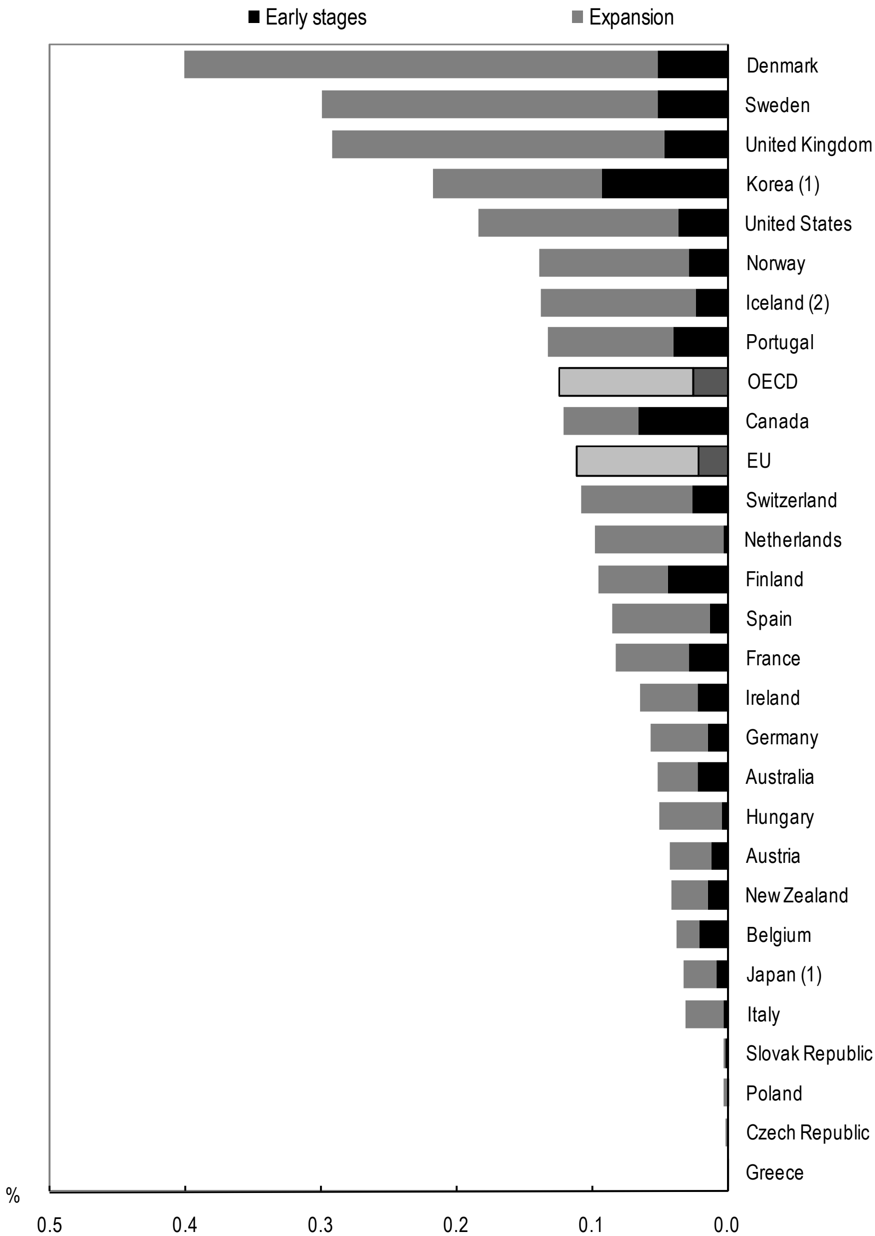
As the most recent *Economic Survey* concludes, Hungary has caught up with typical OECD practice in terms of competition legislation and oversight. As in other areas, progress has been spurred by entry into the European Union, and policy is backed by EU legislation and institutions (OECD, 2007a, p. 31). Overall, exposure to competition has increased with the economic transformation and accession to the European Union. In the past, a lack of competition seems to have slowed technology diffusion in some areas, such as the spread of some ICT applications, in connection with the late liberalisation of the telecommunications industry. While progress has since been made, and steps have been taken to increase competition in both fixed-line and mobile telephone services, prices for various telecommunications services in Hungary are still relatively high by international standards. This deserves attention since it may adversely affect downstream producers and have a detrimental effect on innovation throughout the economy.

1.5.3. Financing innovation

There are dozens of venture capital funds in Hungary, but the overall amount of venture capital is rather small in an international comparison (Figure 1.9); as a share of GDP it is only 6% of the EU average. Moreover, as in many other central and eastern European countries, most of these funds are invested in non-innovative activities, with most of the private equity and venture capital industry biased towards late(r)-stage, commercially proven ventures. Indeed, a recent survey, conducted by the Hungarian Venture Capital and Private Equity Association, reveals that only 7.4% of total private equity invested in 1989-2004 funded innovative firms. Altogether, only 34 enterprises introducing new products, services or processes were assisted by venture capital (Karsai, 2006a, 2006b). One explanation for this low level is the misalignment of prospective partners. Potential innovators complain about lack of capital, while fund managers blame the lack of attractive and viable business plans. Another mismatch concerns the amount to be invested: because of significant managerial and project assessment costs, investors prefer to invest much more in terms of capital than the projects proposed require (Karsai, 2003).

Figure 1.9. Venture capital investment, 2005 or latest available year

As a percentage of GDP



Source: *OECD Science, Technology and Industry Scoreboard 2007*.

Some investors have moved towards early-stage investment in technology-based firms. This is a promising sign, although the number of investments is still small. At the same time, business angels are rare in Hungary: there are no more than 40 members of the Innostart Business Angel Club, and the estimated number of business angels is fewer than 2 000.

Spin-offs are a rather new phenomenon in the Hungarian innovation system. In the 1990s, venture capital activities drove the establishment of some high-technology and/or knowledge-intensive start-ups as spin-offs from higher education or academic research institutes. Owing to financial incentives and favourable regulation (the Law on Research and Innovation), the number of spin-off companies from universities and the natural science institutes of the HAS has started to increase.

1.5.4. Intellectual property rights

Protection of intellectual property rights (IPRs), through patents or in other ways (trademarks, copyright, etc.) stimulates research by enabling successful innovators to reap rewards and by preventing free riding. The publication requirements for patents also contribute to the dissemination of scientific and technological knowledge and help prevent costly duplication of research efforts. However, these benefits have to be weighed against the social costs arising from delayed diffusion and thus reduced use of the invention over the lifetime of the patent, administrative costs, etc. While the relationship between IPRs and innovation is a complex one (see Jaumotte and Pain, 2005a), the adoption and implementation of effective IPR legislation is an essential aspect of the overall framework conditions for innovation.

Hungary's IPR legislation has been brought in line with EU legislation and international agreements. The relevant industrial property laws[25] comply with the requirements of a market economy and offer adequate protection for innovators. After Hungary joined the European Patent Convention on 1 January 2003, patent applications at the Hungarian National Patent Office dropped markedly (to 700-800 a year) since many, notably foreign, applicants now file patents immediately with the European Patent Office (EPO).

Only 65% of Hungarian enterprises are aware of industrial property rights protection issues even though 40% are directly concerned by trademarks, patents and licences. Promoting intellectual asset management by SMEs, developing systems to value intellectual assets adequately, and

25. Act XXXVIII of 1991 on the Protection of Utility Models, Act No. XXXIII of 1995 on the Protection of Inventions by Patents, Act XI of 1997 on the Protection of Trademarks and Geographical Indications, Act No. XLVIII of 2001 on the Legal Protection of Designs.

creating and promoting online marketplaces for intellectual assets so that SMEs can show their offerings easily and inexpensively, are examples of actions that could help to improve this situation (OECD, 2008a).

At the initiative of the Hungarian Patent Office (MSzH), a national intellectual property information network was set up and has operated successfully since 2003. It includes an industrial property information centre in 21 towns in the framework of chambers of commerce and industry, information points in three towns, with participation of experts of the Federation on Technical and Scientific Societies, and five patent information (PATLIB) centres established in regional university knowledge centres. These centres provide in-depth information and customised services for researchers, students and entrepreneurs.

1.5.5. Entrepreneurship and administrative burden

Survey results suggest that the share of genuine entrepreneurial businesses is rather small in Hungary. The most important motivation to set up a business is the difficulty of obtaining employment,[26] and among the motives for establishing self-employed status, "a business opportunity" only ranks third (KSH, 2006b). A further sign of weakening entrepreneurial drive is the decrease from 13% in 2001 to 9% in 2005 in enterprise creation. The number of new enterprises (which represent genuinely new capacity) decreased by 24% during the same period. The decline has been even more pronounced in manufacturing, which suffered a setback of 45%. The birth/death ratio decreased from 1.2 (2001) to 0.9 (2004) and among medium-sized firms the death/birth ratio increased from 3 to 6.2 (KSH, 2007b).

The single most important factor impeding firms' operations identified by entrepreneurs is the high tax and social security burden. The second main obstacle to the operation of SMEs is the volatility and unpredictability of economic regulation, which is mostly of domestic origin (MoET, 2007).

Overall, the World Bank's *Doing Business*[27] ranks Hungary 45th out of 178 countries in terms of "ease of doing business", and 7th in eastern Europe and central Asia (EECA). The World Bank also identifies "starting a business" and "dealing with licences" as a serious obstacle to SME formation. Hungary ranks 67th and 87th respectively in the global comparison and 14th and 10th for the EECA region. Reforms aim to improve this situation: the number of days required to start a business is targeted to decrease from 38 in 2007 to 16 in 2008. Closing a business is also unsatisfactory (Hungary's global rankings are 53rd and seventh, respectively). Current bankruptcy

26. This is usually referred to as forced entrepreneurship.

27. For details, see *www.doingbusiness.org*.

procedures have several drawbacks; in particular, they do not facilitate business rehabilitation, particularly for small enterprises (OECD, 2008a).

An indicator-based international comparison covering nine sectors shows that Hungary's level of regulatory restrictiveness on FDI is at the OECD average (Koyama and Golub, 2006).

In summary, Hungary's accession to the EU has accelerated the adoption of a modern set of framework conditions in key areas (*e.g.* competition policy and IPRs). As a consequence, framework conditions for innovation have improved. In some sensitive areas – such as the macro-economic framework and the administrative burden on enterprises at various stages of their operations – there is considerable room for improvement.

1.6. Performance in science, technology and innovation in an international comparison

1.6.1. Inputs to innovation

1.6.1.1. Investment in R&D

The leading OECD economies tend to spend significant resources on R&D. In Hungary, however, gross domestic expenditure on R&D (GERD) is low by international standards despite substantial increases in R&D spending, which roughly doubled in nominal terms between 1998 and 2005 (Table 1.3). Following the restructuring and far-reaching reform of the Hungarian research and innovation system during the transition period, R&D intensity (the ratio of GERD to GDP) reached a low in the second half of the 1990s, fluctuating around 0.7%, but has since moved up to around 1% of GDP (2006). Hungary thus has an intermediate position among the eastern European catching-up economies between Slovenia and the Czech Republic, on the one hand, and Poland, the Slovak Republic and Romania, on the other. However, all lag far behind the OECD and EU averages (Table 1.4).

Table 1.3. Gross domestic expenditure on R&D (GERD) in Hungary, 1998-2006

	1998	1999	2000	2001	2002	2003	2004	2005	2006
GERD (millions of current USD at PPP)	728.9	773.6	975.6	1 271.2	1 492.6	1 459.5	1 439.2	1 616.7	1 831.3
GERD/GDP (%)	0.66	0.67	0.78	0.92	1.00	0.93	0.88	0.94	1.00
GERD per capita (USD)	71.0	75.6	95.5	124.8	146.9	144.1	142.4	160.3	181.8

Source: OECD Main Science and Technology Indicators (MSTI), 2008/2.

Table 1.4. Total R&D intensity and business R&D intensity in selected countries, 2006

Country	R&D intensity[2]	Business R&D intensity[3]
Czech Republic	1.54	1.02
Hungary	**1.00**	**0.48**
Poland	0.56	0.18
Romania	0.45	0.22
Slovak Republic	0.49	0.21
Slovenia	1.59	0.96
Austria	2.45	1.66
OECD average	2.26	1.56
EU15	1.88	1.20
EU27	1.76	1.11
China	1.42	1.01
Chinese Taipei	2.58	1.74
Israel	4.65	3.64
Russian Federation	1.08	0.72
Singapore	2.31	1.52
South Africa[1]	0.92	0.53

1. Data for 2005.
2. Gross domestic expenditure on R&D (GERD) as a percentage of GDP.
3. Business enterprise expenditure on R&D (BERD) as a percentage of GDP.

Source: OECD Main Science and Technology Indicators (MSTI), 2008/2.

Table 1.5. Business expenditure on R&D (BERD), 1998-2005

	1998	1999	2000	2001	2002	2003	2004	2005	2006
BERD (million 2000 USD)	291.0	320.0	432.4	481.2	481.7	483.1	535.2	629.1	776.9
Growth rate (%)	-8.6	10.0	35.1	11.3	0.1	0.3	10.8	17.6	23.5
BERD as % of GDP	0.25	0.27	0.35	0.35	0.37	0.35	0.36	0.41	0.48
BERD as % of GERD	37.9	40.3	44.9	40.2	35.0	36.6	41.1	43.6	48.0

Source: OECD Main Science and Technology Indicators (MSTI), 2008/2.

Business enterprise expenditure on R&D (BERD), *i.e.* R&D performed in the business sector, has increased significantly since 2004 to account for 0.48% of GDP in 2006 (Table 1.5). Even with these recent increases, BERD still falls short of the OECD average (1.56% of GDP in 2006). In an international comparison of BERD as a percentage of GDP, Hungary's ranking is similar to that observed for overall R&D intensity: it falls between the Czech Republic (1.02) and Slovenia (0.96), on the one hand, and Romania (0.22), the Slovak Republic (0.21) and Poland (0.18), on the other. Again, most of these countries are far below the averages of the OECD, the EU15 (1.20) and EU27 (1.11).

The central government budget played a dominant role in the 1990s and was still (but only just) the largest contributor in 2006 (Table 1.6). The share of government funding has declined markedly in recent years, with business funding and funds from abroad increasing in importance. This coincides with the increasing amounts of funding of R&D by foreign firms, as well as Hungary's accession to the European Union and increased participation in the European Commission's Framework Programme.

A shift towards a greater share of business funding has set in since 2004 with business funding at about 43% of GERD in 2006 (Table 1.6), but it is far from clear that this shift will be maintained. Yet, the share is low by international standards. Hungary once more finds itself between Slovenia (59.3%) and the Czech Republic (56.9%) – which have already surpassed the average EU15 and EU27 share of about 54% (2005) – and the Slovak Republic (35.0%), Poland (33.1%) and Romania (30.4%). The average OECD share is 63.8%.

Table 1.6. Gross expenditure on R&D (GERD) by source of funds, 1998-2005 (%)

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Business	36.1	38.5	37.8	34.8	29.7	30.7	37.1	39.4	43.3
Central government budget	56.2	53.2	49.5	53.6	58.5	58.0	51.8	49.4	44.8
Other national sources	0.4	2.7	2.1	2.4	1.4	0.6	0.7	0.3	0.6
Funds from abroad	4.9	5.6	10.6	9.2	10.4	10.7	10.4	10.7	11.3

Source: KSH, *Research and Development* (various years).

The relatively low share of aggregate R&D funded by the business sector is a main characteristic and weakness of the Hungarian innovation system, particularly in view of the comparatively large share of R&D funding Hungarian firms receive from abroad (mostly through foreign-owned firms). This reflects the weak R&D activity of Hungarian firms, especially SMEs, and suggests that innovation is not sufficiently broad-based. As large firms tend to be foreign-owned, businesses with majority or full foreign ownership spend disproportionately more on R&D than domestic firms. Though the share of business R&D units operated at foreign-owned firms has remained below 15%, these firms account for about 70% of BERD (Table 1.7). At the same time, the share of micro- and small enterprises in BERD has increased (from 8.4% in 2000 to 14.8% in 2006). Medium-sized enterprises recorded the strongest decline in share (from 21.3% in 2000 to 12.3% in 2006). However, since 2004, the shares of micro, small and medium-sized enterprises have all picked up. This may be partly due to the establishment of the Fund for Research and Technological Innovation (2004) which supports business R&D and innovation, with a number of instruments aimed specifically at SMEs (Table 1.8).

Given the large proportion of public funding of research, the public research system undertakes a substantial share of the country's R&D. Accordingly, public research organisations (PROs) and higher education institutions (HEIs) account for a majority of research units (Table 1.9). As Figure 1.10 shows, PROs perform a relatively large proportion of R&D in Hungary, at levels similar to other eastern European countries in which national science academies have tended to dominate. Figure 1.10 also confirms the relatively low levels of research performed by the business sector.

Table 1.7. The number of business R&D units and BERD by ownership, 2003-06

	2003		2004		2005		2006	
	Units	HUF billions	Units	HUF billions	Units	HUF billions	Units	HUF billions
Majority domestic	496	12.4	452	15.1	496	19.1	679	28.1
Majority foreign	45	15.9	47	27.1	44	32.7	59	44.7
Foreign (100%)	45	27.0	56	28.0	62	32.9	77	35.3
Majority state-owned	31	2.6	29	3.7	34	3.7	38	4.1
Majority local government-owned	10	0.3	9	0.2	8	0.3	12	0.3
Unknown	47	6.4	76	0.5	105	1.0	108	1.6
Total	674	64.6	669	74.6	749	89.7	1 027	114.9
Share of foreign-affiliated business R&D units (%)	13.4	66.4	15.4	73.9	14.2	73.1	13.2	69.7

Source: KSH, *Research and Development*, 2006.

Table 1.8. Composition of BERD by size of firms (%)

	2000	2001	2002	2003	2004	2005	2006
Micro-enterprises (0-9)	3.0	3.1	5.3	5.2	3.3	3.7	5.1
Small enterprises (10-49)	5.4	4.9	6.9	6.7	6.9	7.1	9.7
Medium-sized enterprises (50-249)	21.3	22.4	12.2	9.6	7.9	8.6	12.3
Large enterprises (250 or more)	70.3	69.6	75.6	78.5	81.9	80.4	72.4
Unknown	-	-	-	-	-	0.2	0.5
Total	100	100	100	100	100	100	100

Source: KSH, *Research and Development*, 2006.

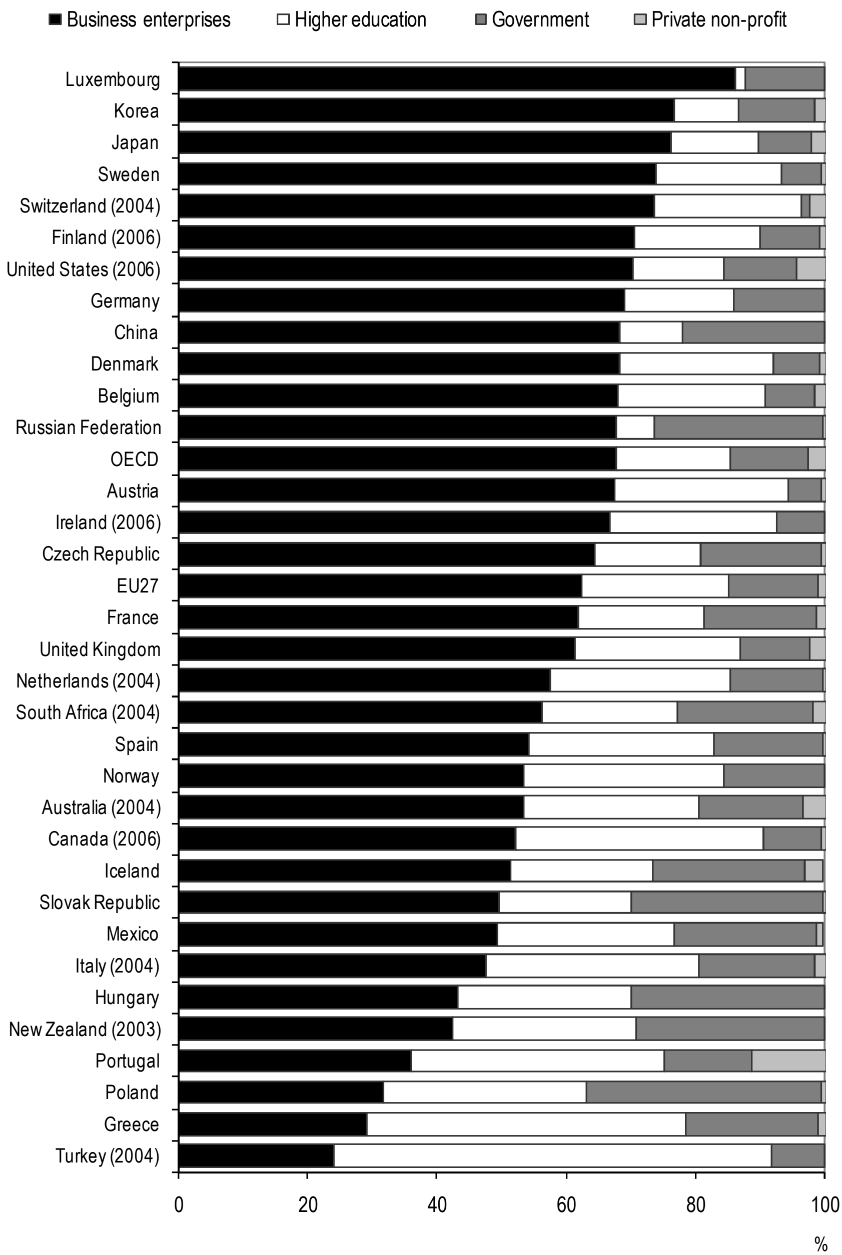
Table 1.9. The number of R&D units by sector, 1995-2006

	1995	2000	2002	2004	2005	2006
R&D institutes and other research units	107	121	143	175	201	208
R&D units at HEIs	1 109	1 421	1 613	1 697	1 566	1 552
R&D units of business enterprises	226	478	670	669	749	1 027
Total	1 442	2 020	2 426	2 541	2 516	2 787

Source: KSH, *Research and Development*, 2006.

Figure 1.10. R&D by sector of performance, 2005 or latest available year

As a percentage of the national total



Source: OECD Science, Technology and Industry Scoreboard 2007.

However, in terms of capital spending, the PROs fall well behind the private sector. Businesses spent more than HUF 30 billion (26.2% of their total expenditure) on capital investments, five times more than HEIs, and six times more than PROs (KSH, 2007a). These figures point to the continuing underinvestment in physical research infrastructure at PROs and HEIs (Table 1.10), but also highlight the major private sector investments in new research centres.

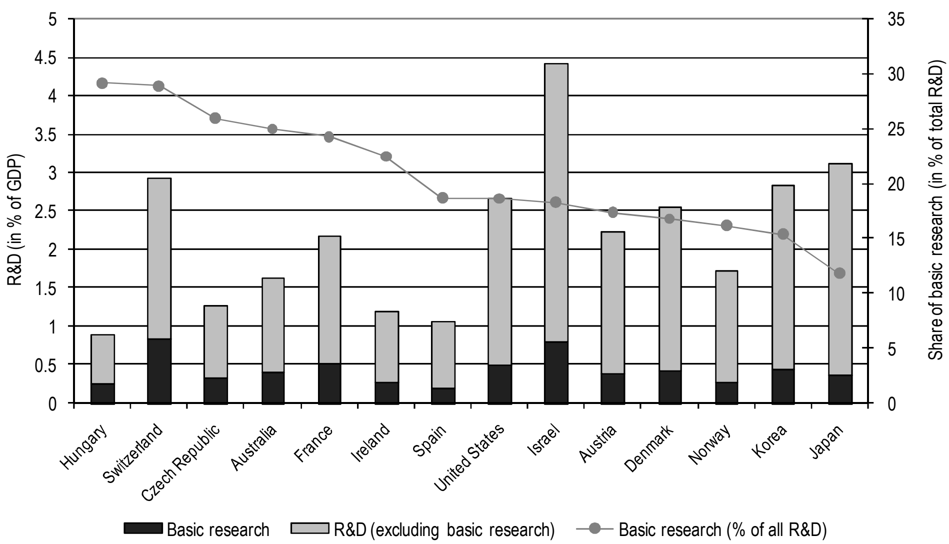
Table 1.10. Capital investment in R&D by sector, 2006

	Total spending (HUF millions)	**Capital investment** (HUF millions)	**Number of research units**	**Number of S&E staff** (FTE)	**Capital investment per**		
					Total spending (%)	Research unit (HUF millions)	S&E staff (HUF millions)
R&D institutes	60 373	5 071	208	5 226	8.4%	24.4	1.0
Higher education	57 943	6 543	1 552	6 073	11.3%	4.2	1.1
Business	114 872	30 129	1 027	6 248	26.2%	29.3	4.8

Source: KSH, *Research and Development*, 2006.

Figure 1.11. Basic research as a share of GDP and of total R&D

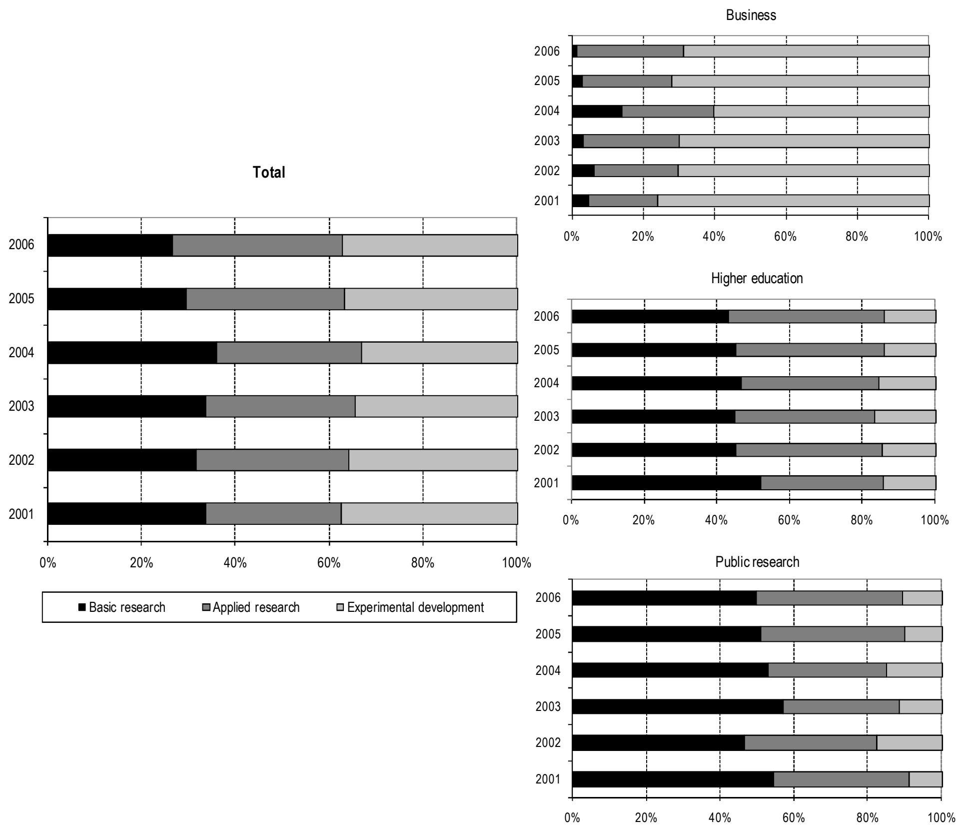
R&D in selected countries, 2004



Source: OECD, *Main Science and Technology Indicators*.

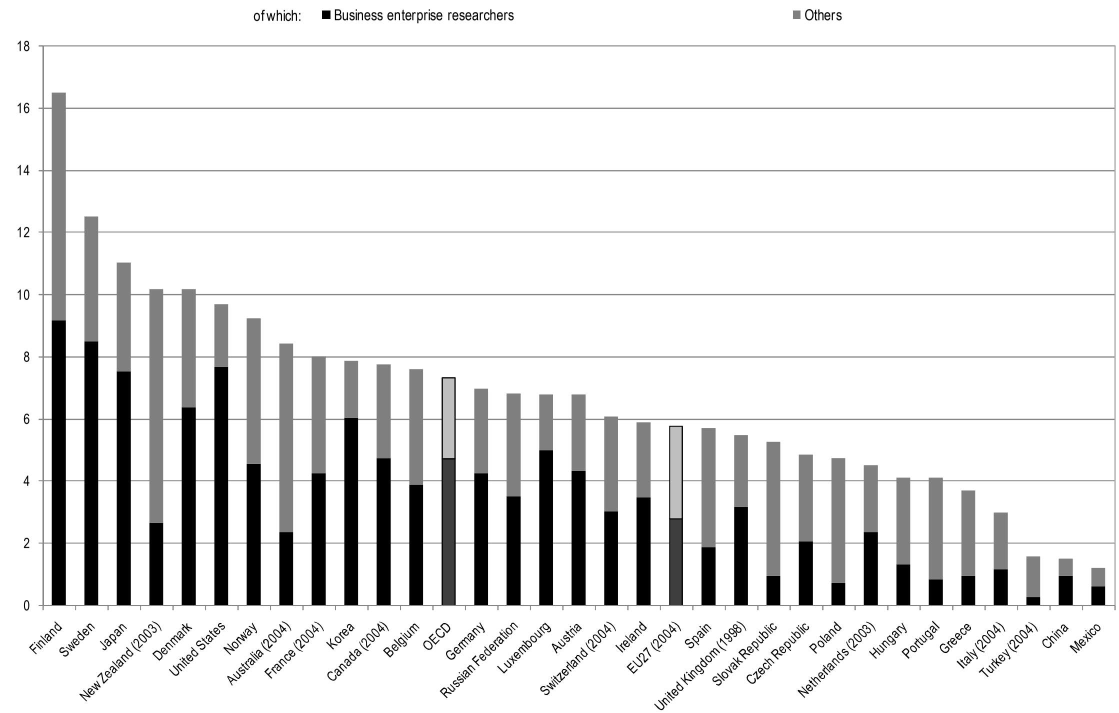
Figure 1.11 shows a large share of basic research in the overall Hungarian R&D effort compared to other countries for which similar data are available. Although the proportion has declined slightly in recent years, around one-third of Hungarian R&D is described as basic research. This betrays the fact that levels of BERD are relatively low in Hungary; firms tend to be more likely to fund applied research and experimental development than basic research. By contrast, basic research has been the most important activity in the portfolio of HEIs and most PROs; the importance of application-oriented R&D is increasing only slowly for both (Figure 1.12). While this research profile has resulted in substantial scientific output, the contribution of the public science system to innovation in enterprises is rather weak.

Figure 1.12. Share of R&D expenditures by type of activity



Source: KSH, *Research and Development*, 2006.

Figure 1.13. Researchers per thousand total employment, 2005



Source: *OECD Science, Technology and Industry Scoreboard 2007*.

1.6.1.2. Human resources for science and technology

The number of researchers per 1 000 total employment in Hungary stood at 4.1 in 2005 (3.8 in full-time equivalent), a figure just over half the OECD average (Figure 1.13). The number of researchers has increased almost every year since 1998 (Table 1.11), although the rise has only been sufficient to reach the level of 1990 (17 550), that is, to compensate for the heavy losses suffered in the early 1990s.

Table 1.11. Number of researchers (FTE) and share in total labour force in Hungary, 1998-2006

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total number of researchers (FTE)	11 731	12 579	14 406	14 666	14 965	15 180	14 904	15 878	17 547
Researchers per 1 000 labour force	2.9	3.1	3.5	3.6	3.6	3.6	3.6	3.8	…

Source: KSH, *Research and Development* (various years); OECD, *Main Science and Technology Indicators*.

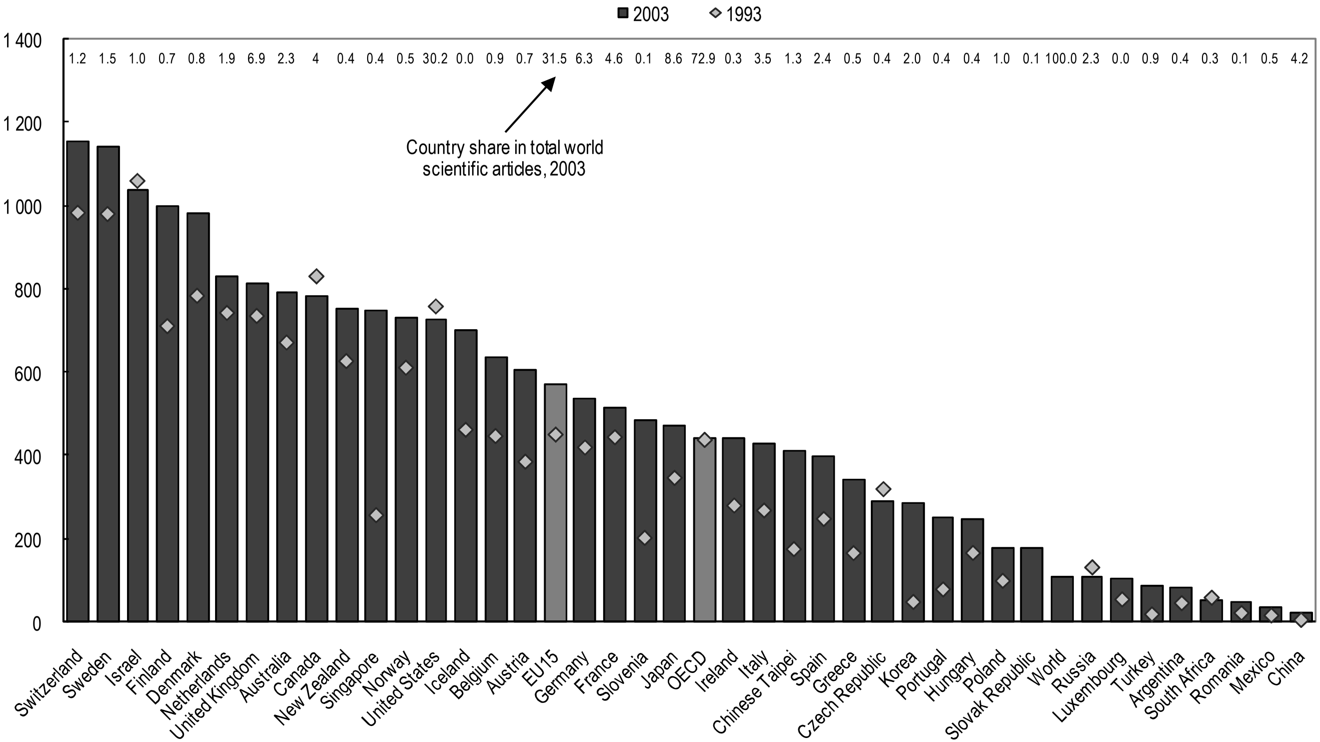
In 2006, business was the largest employer of researchers in Hungary, a position it has attained only very recently (Table 1.12). In fact, the growth in the number of researchers employed by business from 1998 to 2006 is remarkable, with an increase of 129%. This compares favourably with the much slower growth in PROs (13%) and HEIs (38%) over the same period, although from a larger base.

Table 1.12. Share of research employment (FTE) by sector (%)

	1995	2000	2001	2002	2003	2004	2005	2006
Business	27.9	27.1	27.7	29.0	29.5	28.9	31.6	35.6
Government	33.6	32.3	31.8	30.9	31.2	31.5	31.2	29.8
Higher education	38.5	40.6	40.5	40.1	39.2	39.3	37.2	34.6
Total	100	100	100	100	100	100	100	100

Source: OECD *Main Science and Technology Indicators*, 2007; KSH, *Research and Development* (various years).

Figure 1.14. Scientific articles per million population, 2003



Source: *OECD Science, Technology and Industry Scoreboard 2007*, based on the National Science Foundation's *Science and Engineering Indicators 2006*.

1.6.2. Output indicators of innovation

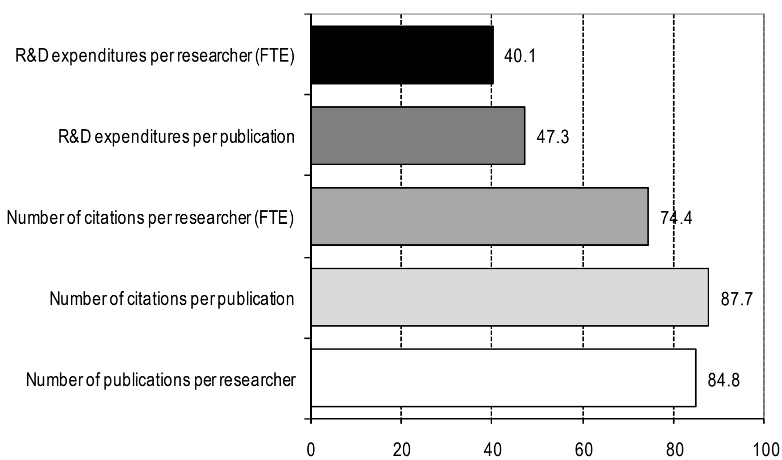
1.6.2.1. Scientific production

Research publications are one quantitative indicator available for evaluating and assessing scientific output. Publication counts have traditionally been used as an indicator of the scientific productivity of universities, public research centres, companies, individuals or nations. Across OECD countries, the geographical distribution of publications tends to reflect that of R&D expenditure. Taking Hungary's low spending on R&D into account, its small number of scientific articles relative to its population should come as no surprise. However, the number increased in the decade from 1993 to 2003 (Figure 1.14).

In fact, a closer examination of the data seems to suggest that the Hungarian science system performs quite well on a limited resource base. While the absolute output is small by international standards, publication output per researcher is close to the EU15 level (85%), although funding is just 40% of EU15 spending per researcher and 47% of funding per publication. In addition, citation-related indicators suggest that the quality of publications is much closer to the EU average than the level of funding would indicate (Figure 1.15).

Figure 1.15. Relative position of Hungarian scientific performance by selected indicators, 2004[1]

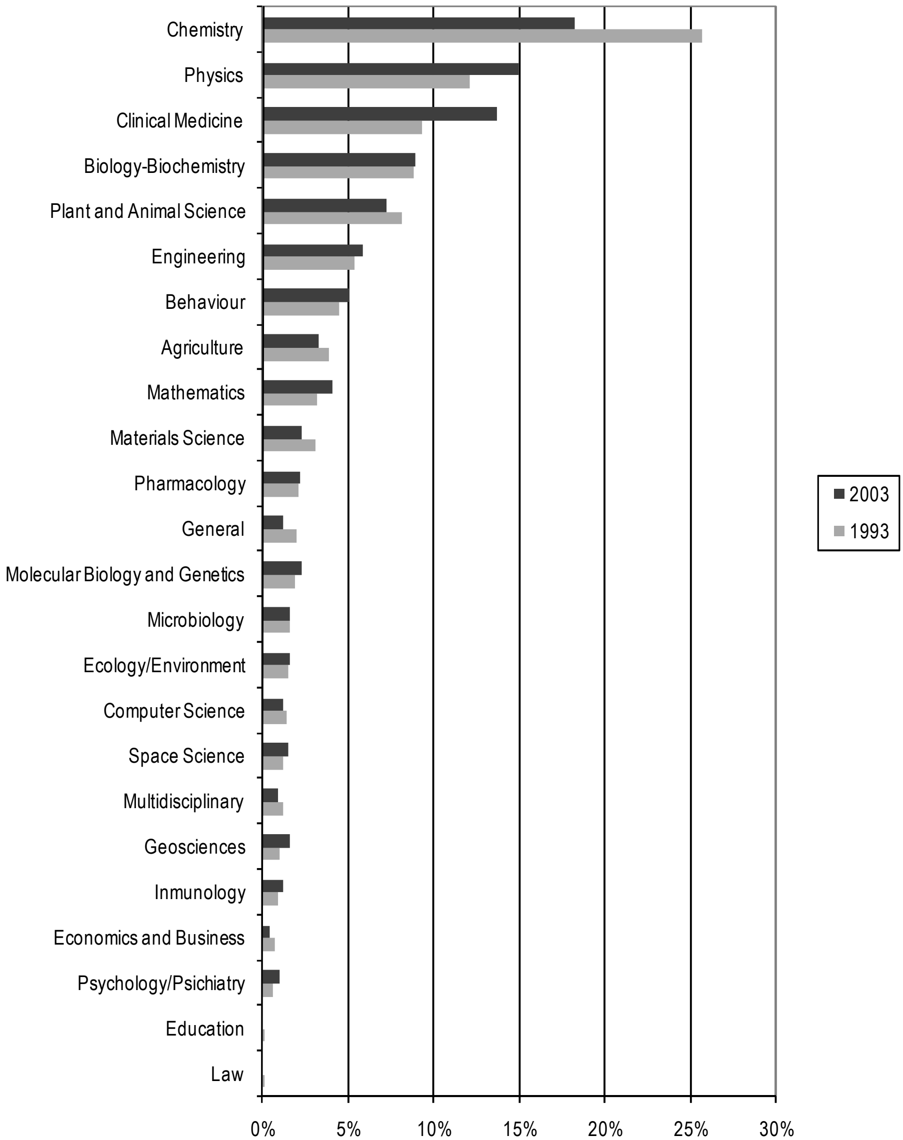
EU15=100[2]



1. Citation period: 2004-2006.
2. The figure follows the methodology and approach of Tolnai (2006).

Source: Eurostat for GERD and research personnel (FTE); Web of Science (Thomson Scientific) for publications and citations.

Figure 1.16. Shares of total publications by field of science, 1993, 2003



Source: ERAWatch Specialisation Report Hungary, June 2006. *http://cordis.europa.eu/erawatch/*.

Similarly, an analysis of the performance of Hungarian researchers by scientific fields, using the number of publications (output), the impact factors of journals for publications (publication strategy) and the citation rate (impact of publications) as comparative indicators, concluded that:

- Hungarian researchers have shown outstanding performance in chemistry, clinical medicine and physics in terms of the *number of publications*. Results have been fair in 11 other fields and average in the remaining six. No field was rated moderate/weak in this respect.
- Only space science achieved outstanding performance in terms of *citation rate*. Physics, engineering and computer science have a fair position and 12 fields of science a moderate position.
- For the *impact factor*, physics, engineering, materials science, and pharmacology and toxicology achieved fair performance, and nine fields only moderate performance.
- In addition, between 1993 and 2003, publication rates increased in almost all fields of science (Figure 1.16).

All in all, these findings seem to indicate quite good performance by the Hungarian science system.

1.6.2.2. Patents

Patenting and other activities related to intellectual property rights, both of business firms and public research organisations, are weak by international standards. Hungarian firms are far less active in filing applications for patents, industrial design and trademarks than counterparts in more advanced OECD economies. In fact, Hungary has one of the lowest numbers of patents filed per capita at the European Patent Office (EPO), the United States Patent & Trademark Office (USPTO) and the Japanese Patent Office (JPO) that protect the same invention (triadic patent families) (Table 1.13). Since joining the European Patent Convention on 1 January 2003, the number of national patent applications has also fallen (Table 1.14). Again, this pattern reflects the high share of foreign-owned firms and the low level of innovative activities of domestic firms.

Table 1.13. IPR performance in selected countries, per million population, 2003 (%)

	Patenting			Community trademarks	Community industrial designs
	EPO	USPTO	Triadic[1]		
EU25	**136.7**	**50.9**	**32.7**	**100.7**	**110.9**
Germany	311.7	123.0	85.2	140.5	186.5
Finland	305.6	104.6	101.7	106.8	95.5
Netherlands	244.3	78.3	59.6	141.0	132.8
Austria	195.1	74.7	33.7	187.0	195.8
France	153.7	56.8	36.5	76.0	88.1
Belgium	144.5	52.4	32.0	92.2	124.6
United Kingdom	121.4	44.6	33.0	125.2	76.1
Ireland	77.3	37.4	14.8	143.0	49.0
Slovenia	50.4	15.4	2.8	21.7	33.9
Hungary	**18.9**	**5.3**	**1.9**	**18.8**	**15.2**
Czech Republic	15.9	4.3	1.5	25.7	40.9
Estonia	15.5	1.2	0.0*	31.7	9.2
Greece	11.2	1.8	0.8	27.7	2.8
Slovakia	8.1	3.3	0.3	10.8	17.3
Portugal	7.5	1.9	0.6	73.8	49.8
Lithuania	5.9	2.2*	0.3	12.2	20.3
Latvia	5.8	1.0*	0.6	14.7	5.4
Poland	4.2	1.2	0.3	22.2	25.0

* 2002.

1. A patent is a triadic patent if, and only if, it is filed at the European Patent Office (EPO) and the Japan Patent Office (JPO) and is granted by the US Patent & Trademark Office (USPTO).

Source: OECD *Main Science and Technology Indicators*, April 2008; *European Innovation Scoreboard*, 2006.

Table 1.14. Patenting in Hungary

	2001	2002	2003	2004	2005	2006
National patent applications	5 451	5 906	4 810	2 657	1 275	924
Number of granted patents	1 306	1 555	1 379	977	1 126	1 089
Valid patents	10 927	10 784	10 385	9 513	9 125	8 408

Source: MSzH data published in KSH, *Research and Development*, 2006.

1.6.3. Regional distribution of R&D and innovation activities

Hungary is a unitary and centralised country; the capital, Budapest, is the political, economic, educational, cultural and transport hub. It is composed of 19 counties, which have no decision-making power in the areas of education, R&D and innovation. Following EU guidelines the counties have been grouped into seven statistical/planning (NUTS 2) regions for administrative purposes. The regions are the recipients of EU Structural Funds, Cohesion Funds and other financing, but do not have local governments.

Despite its relatively small size, Hungary has a rather high level of regional disparity. Its less advanced regions failed to catch up during the first decade of the transformation, despite considerable progress in several respects, including modernisation of institutions, changes in regional policy, substantial spending on regional development, and accelerated economic growth. This is largely due to the spatial concentration of FDI which has tended to exacerbate regional differences. Some regions, notably in the west, have caught up very fast and become "growth poles", while others have remained relatively underdeveloped.

As a consequence, economic, social and R&D indicators show significant disparities across regions. Central Hungary, including the capital, plays a disproportionately large, even dominant political and economic role, accounting for a very high share of GDP, GERD and human resources for science and technology (HRST) (Figure 1.17). GDP per capita and R&D intensity are about 1.5 times the national average. Some two-thirds of GERD and more than 70% of BERD are spent in this region. With 59 higher education institutions (40% of Hungary's HEIs), it also concentrates an exceptionally high share of university and college graduates. This concentration of HEIs and PROs does not always match the destination of FDI inflows, as there are some important strongholds (mainly in the automotive sector) in western Hungary. This situation has implications for policies to better embed foreign-owned enterprises in the regional innovation systems.

The analysis of regional patenting is another way of assessing the concentration of innovative activities. For example, the number of Patent Cooperation Treaty (PCT) applications by region can be used to identify innovative regions which are important sources of world knowledge (OECD, 2007b). While, in general, inventive activities can be expected to be concentrated in a small number of regions, the degree of concentration in Hungary is much higher than in other OECD countries (Figure 1.18). It is, for example, nearly twice as high as in neighbouring Austria despite the rather strong position of Vienna in that country.

Figure 1.17. Share of NUTS 2 regions in Hungary's GDP, GERD and HRST, 2006

(Hungary= 100)

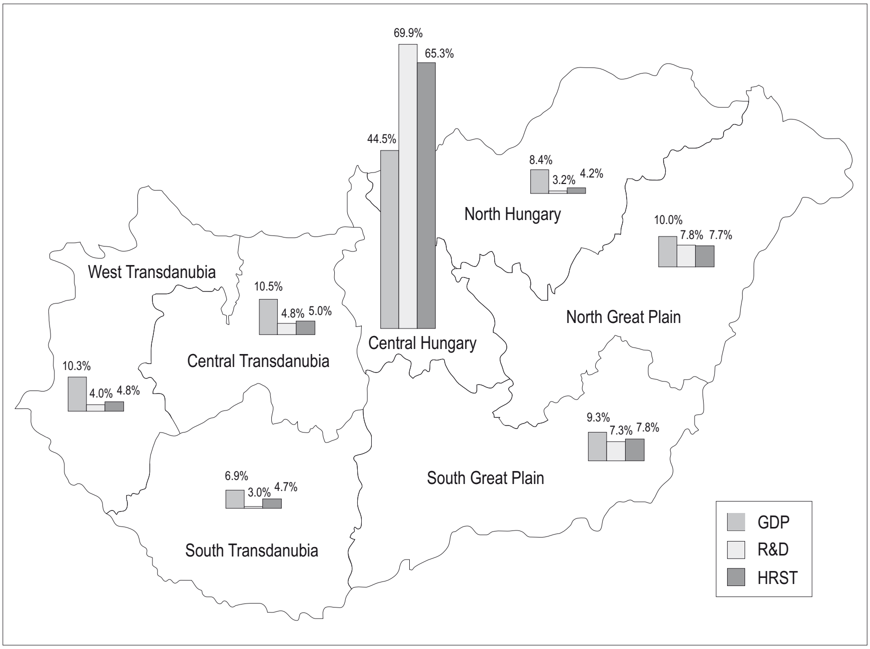
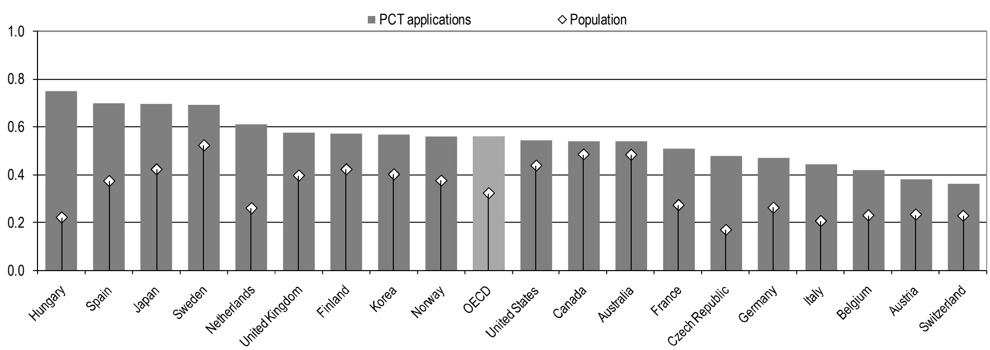


Figure 1.18. Geographic concentration in total PCT applications 2004[1,2,3]



1. Patent counts are based on the priority date, the inventor's region of residence and fractional counting.
2. Only countries with more than 100 PCT applications in 2004 are included.
3. Countries in which 60% or more inventors' addresses are assigned to regions are included. Regions are defined by NUTS2 in Austria, Belgium, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, and the United Kingdom. Regions are defined by TL2 in Australia, Canada, Korea, Switzerland and the United States. Region in Japan is defined by TL3. Denmark, Iceland, Ireland, and Luxembourg are treated as one region.

Source: *OECD Science, Technology and Industry Scoreboard 2007*.

In line with the high concentration of scientific and technological capacities, Central Hungary ranks 34th among 203 EU regions in terms of economic performance. Only Prague and Bratislava are better positioned among the new EU member states. Two other regions, Central and West Transdanubia, show relatively good economic performance, not least owing to large inflows of FDI (Table 1.15). Owing to imported technologies, innovation performance has also been improving in these regions, but there is still rather little "home-grown" innovation, as local R&D capacities remain insufficient.

At the other end of the spectrum, two Hungarian regions – North Hungary and North Great Plain – are among the ten poorest in the European Union. Yet, STI input indicators (such as the share of R&D expenditures and share of research personnel) as well as data on public funding of R&D suggest that both of these regions have a relatively strong science base, owing to the presence of public research institutions. Economic performance and the level of BERD, in contrast, are quite poor. This constellation of capabilities suggests that regional science bases are likely to be underutilised by companies in these regions. However, the existing science base and the local supply of HRST may be considered an opportunity for economic restructuring and the implementation of regional catch-up strategies.

Table 1.15. Relative performance of NUTS-2 regions in Hungary by selected indicators, 2006

(Central Hungary=100)*

	GDP/head - Index, EU27=100 (2004)		BERD/GDP (2004)		Regional Summary Innovation Index (2006)	
	In PPP	Relative to Central Hungary	%	Relative to Central Hungary	RSII	Relative to Central Hungary
Central Hungary	101.6	100.0	0.6	100.0	0.6	100.0
Central Transdanubia	61.1	60.2	0.2	40.3	0.33	55.0
West Transdanubia	66.8	65.8	0.2	34.5	0.25	41.7
South Transdanubia	45.6	44.9	0.1	12.1	0.26	43.3
North Hungary	42.5	41.8	0.1	17.8	0.25	41.7
North Great Plain	41.9	41.2	0.3	52.9	0.26	43.3
South Great Plain	44.2	43.5	0.1	24.4	0.24	40.0

Sources: Eurostat for GDP/head and BERD/GDP; *European Innovation Scoreboard* 2006 for RSII (Regional Summary Innovation Index).

Chapter 2

INNOVATION ACTORS IN HUNGARY

This chapter describes the key players and processes in Hungary's innovation system. It focuses on the actors that perform research and development (R&D) and innovation activities, mainly the business sector, the universities, the Hungarian Academy of Sciences and other public research institutes and intermediary organisations involved in both technological development and diffusion. Interactions among these groups are examined, followed by an assessment of human resources in science and technology (HRST). Finally, the role of information and communication technology (ICT) in the Hungarian economy is considered. The role of government in steering the public research system and in providing basic incentives, institutional frameworks and support measures for business R&D and innovation is examined in Chapter 3.

2.1. The business sector

As Chapter 1 has shown, the structure of the Hungarian economy has changed significantly since 1990, thereby altering the main characteristics of the innovation system. The size of enterprises has shrunk considerably, while the number of firms has increased sharply. Company density is higher than the EU average, while average size is smaller.[28] This section considers innovation in the business sector, by discussing R&D spending patterns and the results of innovation surveys of Hungarian firms.

2.1.1. R&D spending

Although it has a substantial share of high-technology industries, the Hungarian economy is characterised by low overall levels of business enterprise expenditure on R&D (BERD stood at 0.48% of GDP in 2006). As Table 2.1 shows, large enterprises accounted for around 70% of BERD while medium-sized enterprises show relatively weak levels of activity. More recently, micro-enterprises and small and medium-sized enterprises

28. In 2003 the number of enterprises per 1 000 inhabitants was 61 in Hungary and 49 in the EU15, and the average size of firm was five employees in Hungary and seven in the EU15 (KSH, 2006b).

(SMEs) seem to have gained a larger share of R&D. The number of business R&D units has risen significantly, from 258 in 1998 to 1 027 in 2006, with the main source of growth in the micro and small enterprise sector, which had just 256 units in 2000 (53.6% of the total), but 667 in 2006 (64.9% of the total). At the same time, however, the average size of these units (full-time equivalent [FTE] researchers per unit) declined from 31.0 in 1991 to 6.1 in 2006. This compares to an average of some 25 FTE researchers for public R&D institutes. Given that a handful of enterprises, especially in the pharmaceutical industry, operate rather large facilities, many R&D units in a number of sectors may be below critical mass. The chemical industry (mainly related to pharmaceuticals) accounted for around 60% of total R&D spending by manufacturing companies in 2006; this means that five or six large companies account for 35-40% of total Hungarian BERD.

Table 2.1. Distribution of business R&D activities by size of firms, 2000 and 2006 (%)

	2000				2006			
Firm size (employees)	Number of research units	R&D personnel (FTE)	of which researchers	R&D expenditure	Number of research units	R&D personnel FTE	of which researchers	R&D expenditure
Micro (0-9)	33.7	7.1	8.1	3.1	43.1	12	12.3	5.1
Small (10-49)	19.9	10	9.5	5.4	21.8	16.6	15.3	9.7
Medium (50-249)	21.1	27.7	28	21.1	17.6	19.3	18.6	12.3
Large (> 250)	25.3	55.2	54.4	70.3	14	51.5	53.2	72.4
Unknown					3.5	0.6	0.6	0.5

Source: KSH, Research and Development (various years).

Majority or fully foreign-owned companies have a dominant position, accounting for around 70% of BERD, while running less than 15% of the research units (Table 2.2). The activities of these firms are concentrated in a handful of sectors, notably the pharmaceutical, ICT and automobile industries. In this sense, Hungary exhibits some features of a “dual economy”: on the one hand, a segment of large, typically foreign-owned companies, which are well integrated in international production, distribution and, in some cases, R&D and innovation networks (see Box 2.1); on the other, a large sector of domestic SMEs characterised by low innovation capabilities and typically operating in local markets. A positive sign is the emergence of more sophisticated suppliers in certain areas of economic activity (*e.g.* in the automotive cluster) as well as an (albeit very limited) number of highly innovative, research-based firms.

Table 2.2. Distribution of Hungarian business R&D activities by ownership, 2006

Percentages

	Research units	BERD	Research personnel (FTE)
Majority domestic	70	24	39
Majority state or local government-owned	5	5	5
Foreign	8	31	34
Majority foreign	6	39	18
Unknown	11	1	4

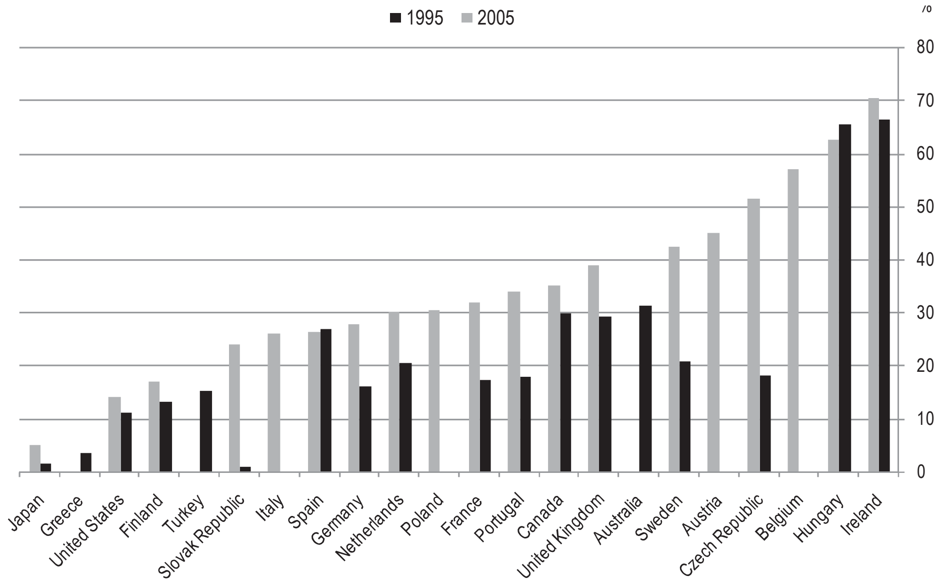
Source: KSH (2006a).

Box 2.1. The role of multinational enterprises in Hungary's development

The rapid modernisation of the Hungarian economy has been largely driven by imported technologies and technological knowledge, with foreign direct investment (FDI) a significant driver of the internationalisation of R&D and innovation activities (see Figures 2.1 and 2.2). The R&D and innovation activities of investing multinational enterprises (MNEs) (including training, organisational innovation, technology transfer and innovation management) have had a significant effect on the evolution of the Hungarian national innovation system (NIS), and global MNE networks continue to provide opportunities to further open up the Hungarian NIS. MNE affiliates actively integrate their Hungarian partners into international production and innovation networks by diffusing technological and organisational innovations, as well as by setting high performance and quality standards. At the same time, the R&D centres of MNEs have become part of the NIS, gradually building linkages with public research organisations (PROs) (particularly universities).

The important role of MNEs stems from the privatisation policy and special incentives to attract FDI of the early 1990s. For the most part, this FDI was export-oriented, efficiency-seeking investment rather than purely market-seeking investment. Furthermore, while purchase of existing production facilities was part of the investment strategy, a number of greenfield sites were also established. The business research labs subsequently established have become integral parts of parent companies' worldwide innovation network, *e.g.* GE Lighting Tungsram (lighting industry) or Chinoin (pharmaceutical industry). In a similar vein, companies such as Nokia, Ericsson, and Knorr Bremse have all upgraded their investments, establishing research centres in Hungary as greenfield sites between 1997 and 2002, primarily to benefit from the highly skilled and relative inexpensive labour force.

Figure 2.1. Share of affiliates under foreign control in total business sector R&D expenditure, 1995 and 2005



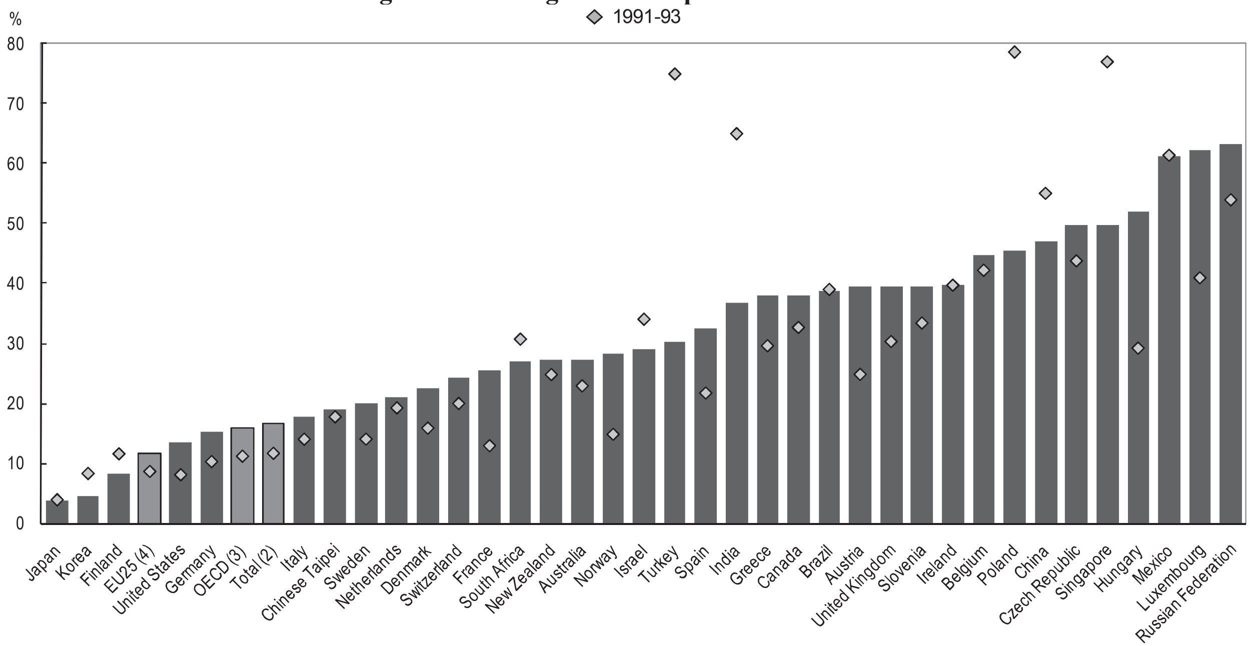
Note: Czech Republic: 1996; Finland, Hungary, Netherlands, Turkey: 1997; Portugal: 1999; Hungary: 2003; Austria, Canada, Italy, Japan, Netherlands: 2004.

Source: OECD, AFA database, January 2008 (OECD, 2008d).

2.1.2. Findings from innovation surveys

In addition to R&D funding, spending on innovation also includes expenditure on machinery, equipment, licences and know-how for the introduction of new products and processes. As such, it is a broader input indicator than R&D spending. The results from innovation surveys, which also capture non-R&D-based innovation, reinforce the impression that the vast majority of Hungary's firms have both a low propensity to innovate and an insufficient level of innovativeness. Only a small proportion of firms have put the development of new products and processes at the centre of their competitive strategy. Most firms focus instead on adapting imported technologies and know-how.

Figure 2.2. Foreign ownership of domestic inventions



Patent counts are based on the priority date, the inventor's country of residence, using simple counts.
1. Share of patent applications to the European Patent Office (EPO) owned by foreign residents in total patents invented domestically. This graph only covers countries/economies with more than 200 EPO applications over 2001-2003. 2. All EPO patents that involve international co-operation. 3. Patents of OECD residents that involve international co-operation. 4. The EU is treated as one country; intra-EU co-operation is excluded.
Source: OECD Science, Technology and Industry Scoreboard 2007.

According to the most recent European Commission innovation survey (CIS 4) data, Hungarian enterprises show a significantly lower propensity to innovate than businesses in most EU member countries. Accordingly, Hungary is among the bottom third of surveyed countries in terms of innovation expenditure (3.1% of turnover of innovative firms). Only about every fifth Hungarian enterprise (with more than ten employees) reports some kind of innovation activity (23.3% as compared to a 44% EU15 average in 1999-2001 (CIS 3), and 21% in 2002-04 (CIS 4). However, Hungarian firms appear to perform comparatively well in the share of new-to-market products in turnover.

As in most countries, innovation activity is concentrated in large enterprises. Innovation survey data, like data on R&D, show a marked difference between large and small firms: the share of innovative large firms (>250) was 52.4%, while it was just 16.9% for small firms (10-49 employees) in 2002-04 (Table 2.3). Moreover, and again mirroring R&D figures, CIS 3 results clearly show that indigenous firms innovate to a lesser extent (15.1%) than foreign (21.5%) firms, and especially jointly owned firms (34.2%). Because innovation activities are concentrated in large, foreign-owned companies in a limited number of sectors, several sectors perform far above the national average in terms of the share of innovative firms: chemicals, due to the presence of pharmaceutical firms (51.9%), financial service providers (47%), automotive (37.2%), and electrical machinery and instruments (33.8%).

Table 2.3. The share of innovative enterprises in Hungary broken down by economic sector and size categories, 1999-2001 and 2002-04 (%)

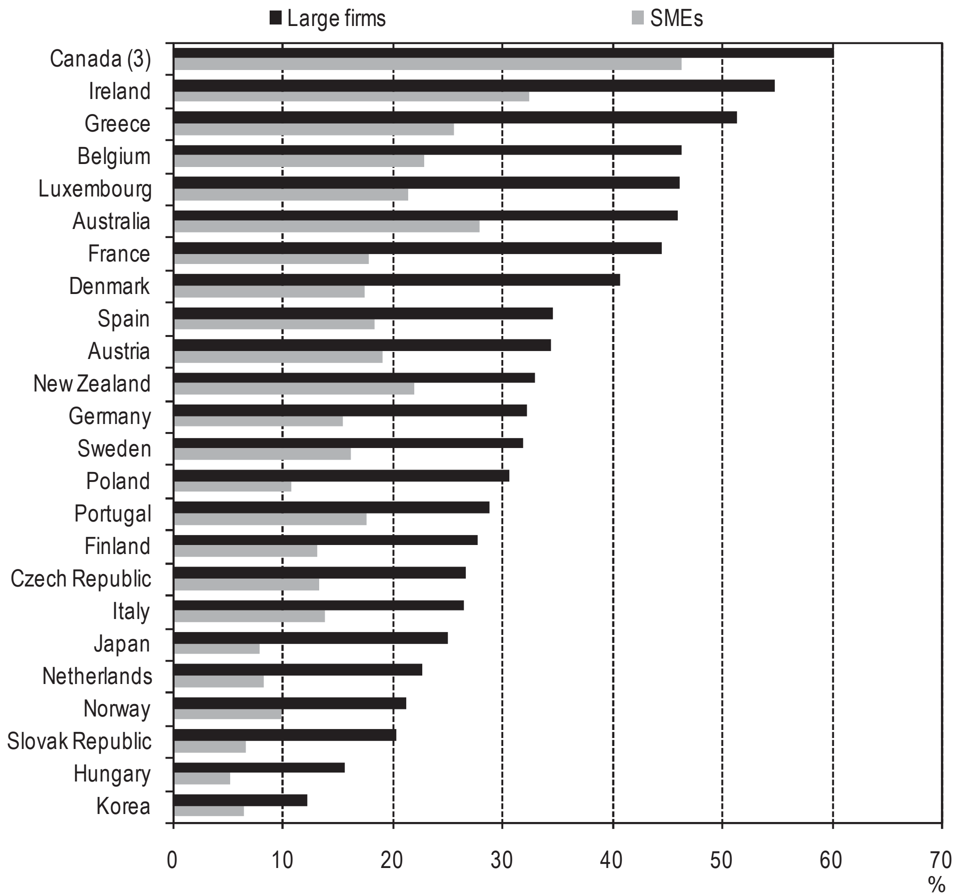
	1999-2001				2002-04			
	10-49	50-249	>250	Total	10-49	50-249	>250	Total
Manufacturing	25.1	32.6	47	28	15.9	32.3	53	21.2
Services	15	168	36.7	15.7	18.8	29.3	55.6	20.9
Total	20.9	28	44.4	23.3	16.9	30.5	52.4	20.9

Source: CIS 3 and CIS 4, Eurostat.

Hungarian firms report the lowest propensity to perform in-house product innovation among the 24 OECD countries for which comparable innovation survey data are available (Figure 2.3). This is also the case for in-house process innovation, both by SMEs and large firms (Figure 2.4). Hungary shares this feature with other new EU member states, such as the Slovak Republic and Poland.

Figure 2.3. In-house process innovators by size,[1] 2002-04[2]

As a percentage of all firms

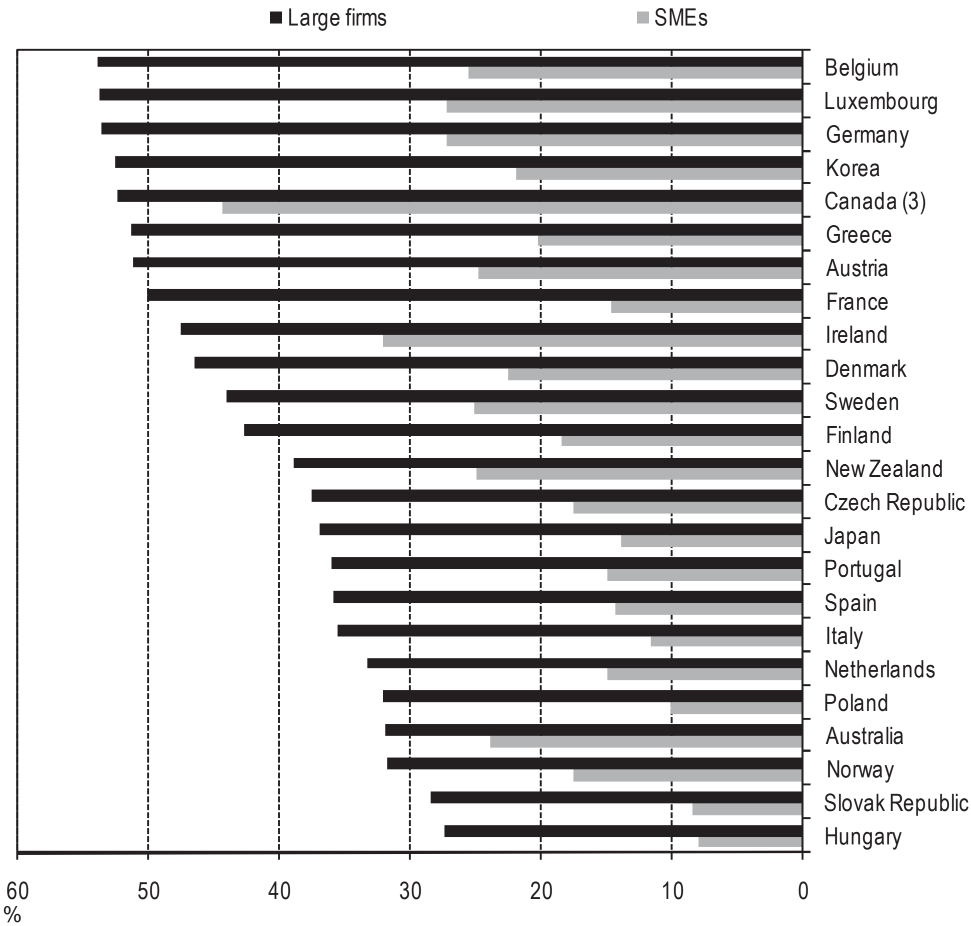


1. SMEs: 10-249 employees for European countries, Australia and Japan (persons employed); 10-99 for New Zealand, 10-299 for Korea, 20-249 for Canada.
2. Or nearest available years.
3. Manufacturing only.

Source: OECD Science, Technology and Industry Scoreboard 2007.

Figure 2.4. In-house product innovators by size,[1] 2002-04[2]

As a percentage of all firms

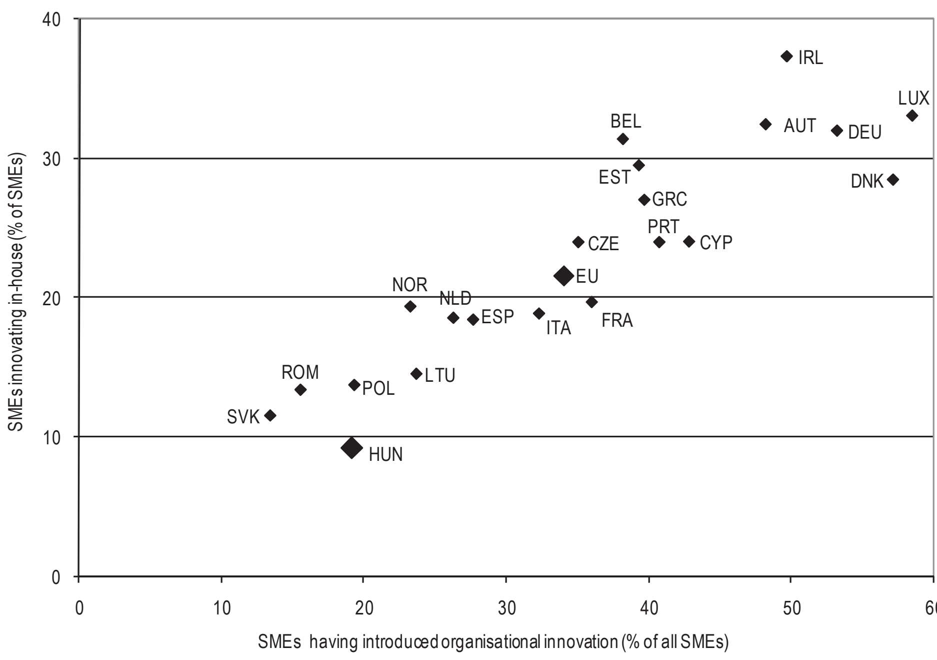


1. SMEs: 10-249 employees for European countries, Australia and Japan (persons employed); 10-99 for New Zealand, 10-299 for Korea, 20-249 for Canada.
2. Or nearest available years.
3. Manufacturing only.

Source: OECD Science, Technology and Industry Scoreboard 2007.

Hungarian firms, like their counterparts in other European countries, cite "innovation cost too high" and "lack of resources" (both internal and external) as the main obstacles to innovation. Another perceived obstacle is insufficient capabilities for co-operation. There are also indications that the low share of innovative business firms is related to a lack of (sophisticated) demand for innovative products and services: accumulation of firms' innovation capabilities seems to be strongly influenced by the fact that 59% consider the lack of demand for new products as the reason for a passive attitude to innovation. This may be mainly true for the many SMEs operating for regional markets.

Figure 2.5. In-house and organisational innovation at SMEs in the EU



Source: EC (2008a) *European Innovation Scoreboard 2007*.

The low overall level of innovation activities among firms is a serious challenge, especially in the indigenous SME category. Several European Innovation Scoreboard (EIS) indicators – such as SMEs innovating in-house, innovation expenditures, sales of new-to-market and new-to-firm products, the share of early-stage venture capital in gross domestic product (GDP) and SMEs using organisational innovation – reflect the difficulties to be faced. As Figure 2.5 shows, Hungarian SMEs are at the lower end of the

EU27 in terms of both in-house and organisational innovation activities (EC, 2007; EC, 2008a).

The reasons for the country's poor private R&D and innovation performance are still debated among Hungarian economists, businessmen and policy makers. However there is some degree of consensus on the influence of the following factors:

- First, there is perceived to be a lack of innovation culture in Hungarian society and a shortage of specialised human capital. The roots of this deficit can be traced from the schooling system through to the professional education of the labour force. The main criticism is that the education system reacts too slowly to fast-changing market demands. Further, non-academic, transferable skills and competences (like teamwork, project management, practical problem-solving, etc.) receive insufficient attention in curricula (Inzelt *et al*., 2007). According to some views, the lack of a widespread innovation culture also translates into loose enforcement of intellectual property rights (IPR), which may deter would-be innovators and limit the expansion of a market for knowledge.

- Second, the lack of a mature capital market. The financial sector has not yet learned how to cope with the uncertainties and to manage the risks involved at different stages of innovation processes in different business environments. The risk and seed capital markets are shallow although they are particularly important for entrepreneurs at an early stage of the R&D process, who have no record of successful research, have limited access to external funds and face internal financing constraints. This is further discussed below.

2.2. Public research organisations

In all OECD countries, public research and technological organisations make an important contribution to innovation, in addition to or in connection with the fulfilment of their missions of public interest in areas such as security, health or impartial scientific expertise. Not only do they provide training for the skilled workforce necessary for innovation in the business sector, but in the emerging "open model of innovation" they have the potential to offer vital sources of knowledge for firms, which increasingly tend to outsource the knowledge they need to complement and empower their core competencies. All countries also rely on technological organisations to facilitate technology diffusion and to help to ensure effective feedback from market-led innovation to basic research. In Hungary, a set of public and private technological institutes and universities (the latter are discussed in section 2.3) perform a variety of functions, including thematic research, technological development and knowledge diffusion. This section considers the activities of the Hungarian Academy of Sciences, a major player in the national research system, and briefly discusses other public and non-profit research organisations.

2.2.1. The Hungarian Academy of Sciences

With a history stretching back to 1825, the Hungarian Academy of Sciences (HAS) remains a main actor in the Hungarian research system. It is a scholarly public body founded on the principle of self-government, whose main task is the study of science, the publicising of scientific achievements, and aid to and promotion of research. It is composed of "academicians" and other representatives of the sciences with an academic degree.[29] Its organisational structure is briefly described in Box 2.2.

Box 2.2. Organisational structure of the Hungarian Academy of Sciences

The General Assembly is the supreme organ of the HAS and is composed of ordinary and corresponding members, and 200 representatives of non-academician members, who are elected by secret ballot for a three-year term. The General Assembly adopts the statutes, the bylaws and the annual budget of the Academy, and determines the science policy principles and programmes affecting the work of the Academy. The General Assembly elects the leading officials of the Academy (president, vice-presidents, secretary-general, and vice secretary-general) and the members of the presidium. The General Assembly also elects standing committees to perform various special tasks, including the supervisory committee, the board of curators of the Academy's property, the committee on the ethics of science, the committee on publishing scientific books and periodicals, and the nominating committee.

The presidium assists in the preparation of the general assemblies, determines the number of new members to be elected for each of the scientific sections, and settles disputes, should they arise, between the scientific sections. It is composed of the Academy's chief officials, of the chairs of the scientific sections and of members elected by the General Assembly. Relying on proposals forwarded by the scientific sections, the presidium makes decisions on awarding the Academy's prizes and other distinctions. It also acts as an advisory body to the president.

The governing board co-ordinates the work of the Academy's top executives in conjunction with representatives from branches of science. Its membership consists of leading officials and the representatives of each of the three major fields of study (*i.e.* mathematics and natural sciences, life sciences, and social sciences). The board sets up standing committees to solve special tasks, which at the current time are the committee on international relations, and the social welfare committee.

…/…

29. The law limits the number of Hungarian academicians under the age of 70 years to 200. Currently the average age of "full" members is about 73 years, while the average age of "corresponding" and "full" members taken together is slightly below 70 years. Citizens of foreign countries cannot become full members. At present, there are 249 full members and 92 corresponding members (see *www.mta.hu*).

Box 2.2. Organisational structure of the Hungarian Academy of Sciences *(continued)*

Based on the bylaws, the Academy currently has 11 scientific sections, covering broad domains of science: Linguistics and Literary Studies; Philosophy and Historical Studies; Mathematical Sciences; Agricultural Sciences; Medical Sciences; Engineering Sciences; Chemical Sciences; Biological Sciences: Economics and Law; Earth Sciences; and Physical Sciences. The sections operate committees corresponding to branches of scholarship and special fields of research.

The Academy maintains research institutes and other institutions (libraries, archives, information systems, etc.) to assist them in their work, and extends aid to university research centres. The operation of research institutes is directed by the 30-member council of academic research centres with the assistance of three advisory boards.

The council of doctors may confer the title of doctor of the Hungarian Academy of Sciences.

The HAS direct six regional committees that are organised by major geographical regions and are composed of academicians and representatives of highly qualified researchers working in the given region. The regional committees are located in Debrecen, Miskolc, Kolozsvár, Pécs, Szeged, and Veszprém.

Source: www.mta.hu/index.php?id=675 (28 August 2008).

The HAS maintains research institutes and support services (libraries, archives, information systems, etc.), and extends support to research centres in universities. As of 2007, it had 39 research institutes and 171 research groups associated with universities. It therefore has substantial weight in the Hungarian research system. It employs 2 900 researchers (16.7% of the national total) and accounted for 14.3% of research expenditures of all Hungarian R&D units in 2006. In the natural sciences its weight is even more pronounced, with almost 60% of total expenditures accruing to the HAS. In terms of scientific output, more than 26% of books and contributions to books and more than 27% of articles published in foreign scientific journals by Hungarian authors in 2006 were authored or co-authored by HAS researchers.[30] However, as a 2006 Hungarian State Audit Office report has noted, the number of publications has decreased in the first half of this decade (from 5 870 in 2001 to 5 189 in 2005) and the number of patents granted decreased from 21 to 11 over the same period.[31]

In addition to performing research in its own institutes, HAS plays a number of other roles. For example, it directs some of the funds given to it to research groups in the higher education sector. It also participates, on the basis of agreements with higher education institutions (HEIs), in education (especially doctoral training) and offers short-term fellowships for university researchers in its own institutes. With respect to policy making, HAS gives

30. However, until recently, foreign publications were counted as less valuable than publications in Hungarian (Schliermeier, 2006).

31. See ÁSz (Hungarian State Audit Office, 2006).

its expert opinion to the parliament or the government upon request. Moreover, every two years the president of the Academy provides to parliament an account not only of its own activities but also of the general situation of science in Hungary. The president also acts as vice-chair of the Science and Technology Policy Council (TTPK), legally the most important science policy advisory body in Hungary.[32]

The operation of the Academy is mainly financed through the government's budget, with additional income derived from assets,[33] public research funding (both national and international), enterprises and foundations, and donations. In 2006, the HAS's budget (excluding the funds earmarked for the Hungarian Scientific Research Fund, OTKA[34]) was HUF 34.5 billion (approximately EUR 138 million), *i.e.* 14.3% of Hungarian gross domestic expenditure on R&D (GERD) or 32.4% of public expenditures on R&D. Almost 97% of this funding was provided by the central budget for operating costs. Between 2002 and 2005, the central budget accounted for some 87% of the budget of the institutes.[35] With accession to the EU in 2004, participation in the EU Framework Programmes became much easier. According to preliminary data, HAS institutes participated in 186 6th Framework Programme (FP6) projects, with total contracted support of EUR 30.6 million over the FP6 period.

Of the research activities of the HAS, 62% are classified as basic research, 28% as applied research and 10% as experimental development. Basic research activities are financed mainly by the central budget and by OTKA, while applied research and experimental development activities are financed mainly by the National Office of Research and Technology (NKTH) and other national sources, such as the National Cultural Basic Programme or programme financing from various ministries.

32. However, the TTPK has been largely dormant in recent years (see Chapter 3).

33. Owing to recent legislation, the HAS – in stark contrast to most universities – has a good financial situation. In 2007, a newly established company was endowed with the property (buildings, land) of the state that was used by the HAS and transferred *a cura* to the HAS.

34. OTKA receives its budget from the HAS, but it operates independently and is regulated by a specific law.

35. In Hungary, a comparatively high share of core funding may be necessary to cover the costs of R&D equipment, etc. These costs tend to be similar to those prevailing in countries with higher income levels, but bear more heavily on the country's (low) public R&D expenditures.

The role of the HAS in the Hungarian innovation system and its functioning as a public research organisation has been subject to some debate recently. Given its strong position in the research system, the development of the HAS indeed calls for public attention.

The HAS's structure and governance has changed on several occasions. In the last two decades the most important reforms consisted of the adoption of a new law on the Academy of Sciences (Act XL of 1994) and a restructuring and consolidation of the funding system.

Since 2003, the HAS defines research objectives and priorities in agreements with the prime minister's office and receives ear-marked funds for this research. In 2008, funding from this source amounted to some HUF 250 million[36]. In this way, societal and strategically important research priorities are incorporated into the HAS's research portfolio.

In May 2006 the HAS's General Assembly agreed on the principles of the reform of the Academy. Responding to a debate, including on HAS's membership requirements and the structure and governance of institutes, the HAS has been preparing for a profound reform.[37]

In order to steer the reform process, the General Assembly appointed a Reform Committee headed by the president and deputy secretary-general of the Academy. This committee made 18 recommendations concerning changes in the structure, administration, and financing of HAS's research network as well as of its central administrative Secretariat.[38] The main recommendations include the following:

- Research units must fulfil tasks of public relevance in an accountable way, in exchange for the funding they receive from the central budget.
- On a basis of network co-operation, institutes, centres and laboratories must reach out to, and involve, undersized or under-performing research units.

36. Hungarian Prime Minister´s Office (2008), Agreement between the Hungarian Prime Minister´s Office and the Hungarian Academy of Science on Strategic Research Collaboration, Budapest. *www.meh.hu/misc/letoltheto/080620_meh_mta_megallapodas.pdf.*

37. Akadémiai Reformprogramm (Reform Programme of the Academy), *www.mta.hu/index.php?id=2817*,

38. *Előterjesztés a Magyar Tudományos Akadémia 2006. Október 30-ai rendkívüli közgyűlése részére az MTA reformjának folytatásáról* (Proposal for the HAS's extraordinary General Assembly held on 30 October 2006 about the continuation of the HAS reforms), *www.mta.hu/fileadmin/2006/10/kozgyules/MTA_reform_kozgyeloterjesztes.doc*.

- HAS must apply a professional system of property management, including the management of its own growing intellectual property. Research units must enjoy unlimited ownership of the intellectual property created or acquired by their staff.
- In the management and quality control of research institutes, personal powers and responsibilities must be coupled with socio-economic criteria as well as criteria applied in international scientific assessments.
- In keeping with the peculiarities of research, personnel should no longer be employed indefinitely. Employment should depend on performance, as measured by unequivocal criteria. No researcher can fill more than one full-time job at any one time.
- HAS should start surveying and increasing its intellectual assets, especially in the fields of technology transfer, patenting and publications.
- The HAS's research workers are encouraged to participate in higher education. MSc, MA and PhD courses should be taught at HAS research institutes.

These items are currently being implemented or are subject to further discussion. The HAS's Special General Assembly on 30 October 2006 concluded that the reforms outlined in the proposals of the Reform Committee needed to be carried further amid ongoing discussions concerning the particular details of the changes envisaged.[39]

In line with the political impetus for substantial reform of the innovation system (as articulated in the Mid-term Science, Technology, and Innovation Policy Strategy 2007-13)[40] HAS's Reform Committee has set up four sub-commissions comprising representatives of the government, HAS itself and enterprise and higher education sectors. The task of these sub-commissions is to monitor and discuss the execution of government measures envisaged in the Mid-term Strategy, several of which are explicitly linked to the reform process of HAS. These comprise: intellectual property issues, issues concerning so-called national laboratories, a new system of research evaluation, and issues arising from the possible formation of a united state-run research network.

39. HAS Reforms to Roll on, 2006.11.06, *www.mta.hu/index.php?id=977&no_cache=1&backPid=977&begin_at=10&swords=REform&tt_news=3171&cHash=e9f54efd94*.

40. Decree 1066/2007 of 29 August 2007.

- For intellectual property issues, HAS's research institutes, in collaboration with the Hungarian Patent Office, have prepared a draft of a unified set of rules for all HAS institutes. As a result, it is expected that IPRs can be taken by the institutes and that an intellectual property balance sheet can be drawn up for sound management of intellectual property. (At present, today, individual researchers and/or companies involved in the research hold the IPR.)

- The discussion of national laboratories envisaged the creation of a new type of research unit, much narrower in focus than a typical HAS research institute, but involved in a wider range of activities (beyond R&D). In contrast to centres of excellence, national laboratories would not be free to choose their research targets. The goal is to establish four or five such laboratories on a scale and quality that would make them visible at a European level.

- For the evaluation of research, the plan foresees a system of new indicators and new benchmarks to be operative at HAS by 2008 and at universities and other research units by 2009[41]. Universities and the HAS have to establish a joint committee to allow for coherence and comparability of their respective evaluation criteria. This new system of evaluation – which tries to incorporate international good practice – is meant to have an impact not only on the financing of the institution as a whole (in the form of larger shares of performance-based contracting) but should also have an effect upon wages.

- The Mid-term Science, Technology and Innovation Policy Strategy foresees that the Ministry of Education will develop a proposal for a united, centrally financed, professional network of public research institutes. The HAS, as the current major operator of such a network, has apparently been approached by many research units of various government organisations which have officially or informally signalled their intention of joining HAS's research network. The question of the shape and institutional set-up for such a network does not appear to have been settled, but will in any case have a major impact on the positioning of the HAS.

41. Currently, the institutes of the Academy publish annual reports of their scientific, educational and society-related activities which are regularly assessed internally by selected members of the Academy.

The General Assembly of May 2007 confirmed moves taken by HAS's management to improve the work of the central administration through reorganisation, to adjust applications for research grants to international standards and to decrease the number of unnecessary tenured jobs.[42]

In summary, it seems that awareness of the important role of the HAS as well as of the need to modernise its structures has already triggered a substantial reform process. Some measures envisaged have already been implemented (*e.g.* new rules for membership) or are being implemented (*e.g.* the new criteria for evaluation). Others, such as the reorganisation of research units (with a view to achieving critical mass and to react to new developments in the sciences) still seem a long way off. Nevertheless, the thrust of the reform measures seems to point in the direction of international good practice in the management and steering of research organisations. While an overall reform of the HAS is on the agenda, and the new law regulating the status of the HAS is expected to be approved in 2008 or 2009, it remains unclear how far the reform process will be carried and at what speed.

2.2.2. Other public and non-profit research organisations

The other major actor in this sector is the Ministry of Agriculture and Rural Development: 440 scientists and engineers (FTE), or 8.4% of the researchers employed by the government sector, or 2.5% of the national total, worked for institutes supervised by this ministry in 2006. There are also dozens of research units operated at/by hospitals, museums, libraries, national and regional archives, etc.

Still other units are financed by foundations, the most important being the institutes of the Bay Zoltán Foundation for Applied Research (following the model of the German Fraunhofer-Gesellschaft – see Box 2.3), and the Collegium Budapest, an institute for advanced studies, which works with a very small permanent staff; groups of fellows visit the institute on a project basis. As in most other OECD countries, this sector is rather small in Hungary: its share is below 1% of GERD.

42. Az MTA 177, *Közgyülésének határozata az Akadémia reformjának III. szakaszáról* (Decision of HAS's 177th General Assembly about the 3rd stage of the HAS's Reform Progress), *www.mta.hu/fileadmin/2007/tavaszikozgyules/akademiai_reformprogram.doc*.

Box 2.3. Bay Zoltán Alapítvány (Zoltán Bay Foundation)

Named after the world-renowned physicist Zoltán Bay, the Foundation was established in 1992 by the National Committee for Technological Development (Országos Müszaki Fejlesztési Bizottság – OMFB) to create an institute able to carry out efficient applied technological and scientific R&D.

The focus of the Foundation's operations at the institute is applied research, the development and adaptation of technologies, and technology transfer to companies, *e.g.* through the popularisation and teaching of certain modern industrial and agricultural technologies in demonstration centres.

Annual revenues, which come predominantly from contract-based research, were nearly EUR 6 million in 2006, and have been rising rapidly with the extension of the network of institutes. The Bay Zoltán institutes today have some 260 employees, three-quarters of whom are researchers. The Foundation actively co-operates with several partner universities, with researchers who lecture, provide consultation on theses (both graduate and PhD students), and involve students in their research. Some institutes are even operated jointly with universities (*e.g.* with the University Szeged and the University Veszprem). These joint institutes may also serve to foster industry-science links, as they are very applied in nature. The technological areas in which the Foundation is active today include material and laser technology, nanotechnology, biotechnology and genomics, ICT, and logistics and industrial production technologies.

Against a background of very low R&D and innovation activities by Hungarian SMEs, which are often attributed to the lack of demand for innovative products, the Foundation's recent rapid growth of around 30% a year is remarkable. Given the lack of institutions specifically addressing innovation in SMEs, the recent growth of the activities of the Bay Zoltán Foundation is perhaps an encouraging sign of a rise in demand from SMEs.

Source: www.bzlogi.hu/bzaka/bzaka_angol.main.page.

2.3. Higher education institutions

Since the early 1990s, the Hungarian higher education system has undergone profound changes, most notably the rapid increase in the number of students (threefold between 1990 and 2006) and graduates (twofold in the same period). This growth in numbers and a growing demand for new areas of competence led to the establishment of several new institutes and faculties during the early 1990s. There were around 90 HEIs in existence by 1998, when the government introduced measures to consolidate the sector. The aim was to create large-scale integrated HEIs able to better accommodate the increasing number of students, broaden curricula and reach critical mass for research. The process was backed by a requirement that only HEIs with at least two fields of science were entitled to be accredited as universities. This led to the merger of previously independent HEIs, often in different disciplines (such as social sciences and technology, economics and horticulture, etc.). Furthermore, the need for financial efficiency also led to the integration of several colleges, especially in Budapest. Currently Hungary has 72 HEIs, run by the state, churches or private funders (Table 2.4), 23 of which are universities.

Table 2.4. Higher education institutions in Hungary

	Universities	Colleges
State	18	13
Church	5	22
Private	-	14
Total	23	49

The adjustment and modernisation of Hungarian HEIs has been an on-going process since the initial years of transition. The latest Law on Higher Education, passed in 2005, provides the legal framework for the modernisation of university governance systems and puts Hungarian HEIs on course to implement the targets of the Bologna process. The law aims to achieve better alignment of higher education and the labour market and places great emphasis upon efficiency in the HEI sector. The focus has been on supplementing traditional modes of academic governance with systems dedicated to monitoring demand signals and implementing efficiency measures. The main governance structures brought about by the new law are briefly summarised in Box 2.4.

Box 2.4. New university governance system

The new Law on Higher Education (2005) provides the legal framework for the modernisation of university governance systems. Three important actors are as follows:

1. The *Rector*, as head of the HEI, has remained the traditional academic leader, while two new boards were introduced: the Senate and the Economic Council.
2. The *Senate* is the most important body. It oversees all aspects of the HEI, including the implementation of HEI strategy. It is the decision-making, advisory, executive and monitoring body of universities and colleges. The Senate helps define education and research tasks and monitors their execution. It is also responsible for the creation of R&D and innovation strategies and approves the HEIs' Development Plan. The president of the Senate is the Rector, and its members are elected from among the employees of the HEI, as well as contract teachers and researchers and representatives of the student union and trade unions.
3. An entirely new and unprecedented body is the *Economic Council* (variously translated as Financial Council or Financial Board) that was originally supposed to make financial decisions and to supervise their implementation. The Constitutional Court rejected the latter role. The Economic Councils therefore only have an advisory and monitoring role. For publicly financed HEIs, it is compulsory to set up an Economic Council, while for private ones, it is optional.

The senates and economic councils have now been set up and have started to function in all HEIs. Anecdotal evidence suggests that there are significant differences between the activities of various economic councils. Some are quite passive, as they only have an advisory role and little attention is paid to their advice. Others have been more active owing to the openness of their HEI and have even initiated further changes in governance and legal reforms. Thus, the management of HEIs has remained largely in the hands of academics, and an appropriate balance between the autonomy of education and research, on the one hand, and sound management of public resources, on the other, remains elusive, leaving plenty of room for further improvements and new legislation.

HEIs are financed by various sources, the most important being the core grant from the central budget which is based on student numbers and disciplines taught. A second channel is the core grant for R&D activities, but as this budget line is not closely monitored by the government, the money can also be used for financing education activities or covering general costs, such as heating and lighting. The Ministry of Education introduced several measures in 1996 to base a part of the research core grant – formerly disbursed as a lump sum – on performance. Following the law of 2005, however, research grants for HEIs have been based on the number of full-time professors and the number of professors holding scientific degrees. Publications, citations and patent applications per grant are not used as evaluation criteria. Recently, the Ministry of Education has been working on a new evaluation and benchmarking system, which specifies indicators on basic activities in education and research, supporting activities (*e.g.* collaboration and co-operation), and social linkages (*e.g.* regional role and participation in achieving social targets). In addition to the core funding, HEIs can also apply for various types of grants offered by national or foreign funding organisations.

In terms of research performance, the higher education sector has the largest number of research units – 1 552 out of a total 2 787 in 2006 – although their average size is rather small, at less than four FTE researchers. The sector employs just over one-third of all Hungarian researchers, though spending per researcher is low, at about half the amount spent per business enterprise researcher.

2.4. Interactions and linkages

The efficiency of a national innovation system depends very much on the interaction between the different actors in the innovation process. These processes are increasingly open, involving a number of actors with complementary assets and capabilities. Hence, smooth co-operation is very important for the development of an innovation system, a fact that is recognised in the various policy measures on this matter.

Types of interaction depend a great deal on the history and the structures of an innovation system and should be assessed against this background. For instance, intensive relations between science and enterprises are at the core of the innovation process in some sectors, while others depend more on a tightly knit network of SMEs. In yet others, large enterprises predominantly set the patterns of interaction. In a similar vein, the degree of internationalisation and the positioning of enterprises in increasingly global production chains strongly affect the geographical distribution of interaction. Thus, the composition of an innovation system, in terms of sectors, types of enterprises and knowledge-producing actors, also determines the structure of interaction.

2.4.1. Interactions in the Hungarian context

In this respect, Hungary's innovation system has some specific characteristics and some weaknesses that need to be addressed. A high share of R&D is financed from abroad and is concentrated in MNEs. Hungary is among the top OECD countries in terms of foreign funding of R&D,[43] a confirmation of the importance of international linkages for the Hungarian innovation system. While this investment has had significant positive spillover effects, Lengyel and Leydesdorff (2007) find that foreign-owned firms have had a "disturbing" effect on the patterns of interaction in Hungary by uncoupling more traditional medium-technology companies from their geographical roots. They view Budapest and the central region as the exception, as the level of system integration is much higher and interactions are much more intense. They conclude that Hungary does not have a coherent national innovation system but is characterised by three distinct regional patterns of interaction:

43. This share is likely to be underestimated in the figures, as funding provided through the EU Structural Funds is counted as part of the state budget and therefore as "national" funding.

- The western part of the country, through its medium- and high-technology manufacturing base, is more integrated in the innovation systems of Austria, Germany and other EU countries.
- Budapest and its surrounding area compete with other metropolitan areas, such as Bratislava, Vienna and Munich.
- The eastern part of the country, with a relatively strong knowledge base stemming from the public research institutions, has the potential to attract medium- and high-technology sectors, but, as is typical of scientific institutes, linkages tend to be more internationally oriented.

The challenge is to ensure that the innovation system is not too "decoupled" and that public research institutes and enterprises are not remote from one another. The innovation and research capacities of Hungarian regions vary widely. The capital and the larger university cities, *e.g.* in Debrecen, Miskolc, Szeged, Pécs, Győr or Veszprém, possess the important research centres. With the exception of Budapest, the latter have not yet been able to become the centres of innovation in their respective regions. Efficient consulting, innovation, bridging and technology-transfer institutions and their networks exist but are limited; it will be necessary to further develop knowledge transfer services.

Well-established links between scientific research and the innovation activities of enterprises are essential, especially for high-technology industries in which science-driven innovation is an important part of firms' innovation portfolio. Close contacts between local public research facilities and MNEs also serve to better embed these companies into the national or regional innovation fabric (see Box 2.5). The flows of funding for R&D indicate that there is a quite substantial share of research funding by enterprises at HEIs (mainly universities) and at PROs (mainly the Academy of Sciences) (Figure 2.6), and that it has grown substantially over time. Only 4-5% of total higher education expenditures on R&D (HERD) was financed by firms in 2000-01, but the share climbed to 13% in 2006, a comparatively high figure in international comparison. Similarly, at 14%, the share of government intramural expenditure on R&D (GOVERD) financed by industry is higher than both the OECD and EU25 average, and lower only than those of Finland, the Slovak Republic, the Czech Republic and the United Kingdom.

Box 2.5. R&D co-operation between MNEs and local actors

A survey conducted in late 2007 among a sample of the largest research, technological development and innovation (RTDI) performers revealed that MNEs have been broadening their strategic networks with higher education institutions and increasingly engaging in strategic joint research activities, which has resulted in a slow increase in the share of extramural activities. A relatively small share of these extramural activities can be traced to outsourcing of R&D activities *per se*, though most can be accounted for as joint research projects.

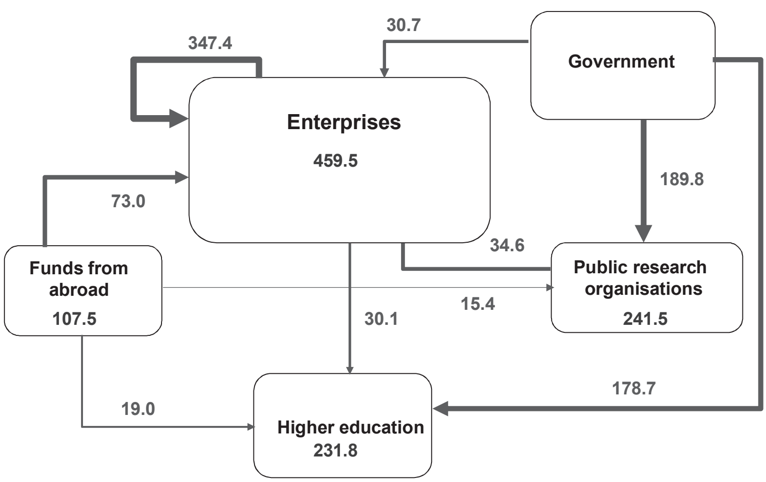
The highly diversified nature as well as the intensity of horizontal relations was a common feature of all the interviewed companies. Both the number and the intensity of university co-operative projects were increasing and some companies co-operated with public research institutes as well. Interviews revealed that although university co-operation was of exceptional importance for all the companies, the rationale for co-operation differed according to industry characteristics. Firms with ICT-related R&D activities engaged in networking with various universities in order to influence the curriculum and get access to the most talented students. Pharmaceutical firms were more interested in joint research projects, testing, etc. Both types of firms have been sponsoring universities with laboratory equipment, software and computers.

Horizontal co-operation ranges from local universities (joint research undertakings, grants and research competitions for students, participation in the definition of the academic curricula) to consultants and strategic partners (including clients, suppliers and even competitors). The evolution of other types of co-operation (within the MNE network or with clients, suppliers, competitors) is determined mostly by industry-specific factors. Software R&D labs co-operate closely with clients. Local research labs or at least researchers incorporated in the parent companies' global research projects were in close co-operation with the parent companies' research labs in different countries.

Source: Background Report.

Figure 2.6. Funding flows for R&D in Hungary, 2006

EUR millions



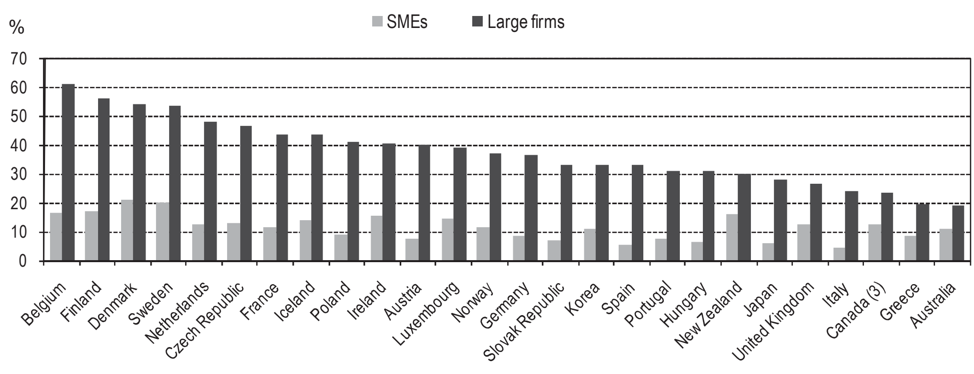
Sums do not add up because "other national services" were omitted.

Source: Based on KSH data.

Interaction between enterprises and academia therefore seems to be quite substantial in monetary terms. However, other data paint a less rosy picture. For instance, innovation surveys clearly show that the overall share of enterprises collaborating on innovation is substantially lower in Hungary than in many other countries, including other central and eastern European countries such as the Czech Republic, Poland and the Slovak Republic (Figure 2.7). Especially among SMEs, collaboration on innovation is rather rare. Furthermore, collaboration with national partners is much less pronounced on average in Hungary than in the EU27 (Figure 2.8), while co-operation with suppliers in Europe is almost at the EU average, a sign of good links between large multinational manufacturers and their suppliers in other parts of Europe but significantly weaker links with national entities (Figure 2.9). The data thus seem to reinforce notions of a dual economy composed of MNEs and Hungarian SMEs and to indicate limited success in linking the innovation activities of MNEs to domestic and regional innovation systems. In the long term, the high share of funding of business R&D from abroad is likely to be sustained only if R&D-intensive enterprises are more tightly linked to Hungarian research institutes and other businesses. Increasingly global sourcing of R&D facilities may also threaten Hungarian sites.

Figure 2.7. Firms collaborating in innovation activities, by size[1], 2002-04[2]

As a percentage of all firms

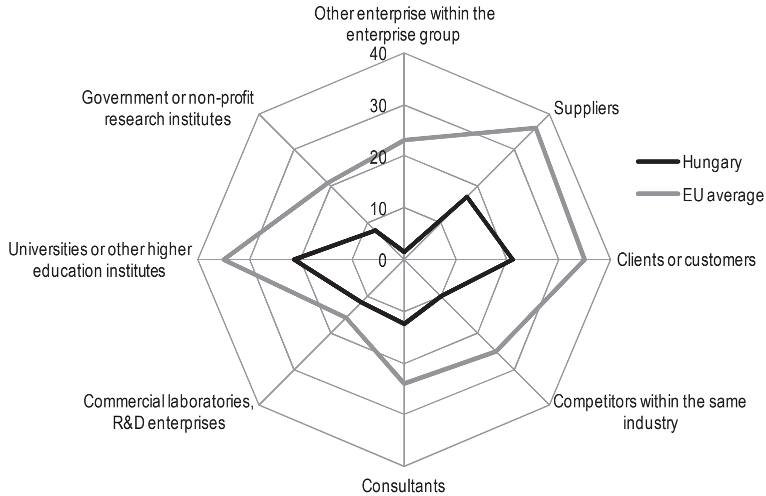


1. SMEs: 10-249 employees for European countries, Australia and Japan (persons employed); 10-99 for New Zealand, 10-299 for Korea, 20-249 for Canada.
2. Or nearest available years.
3. Manufacturing sector only.

Source: OECD Science, Technology and Industry Scoreboard 2007.

Figure 2.8. Firms collaborating on innovation with national partners as a percentage of all firms*

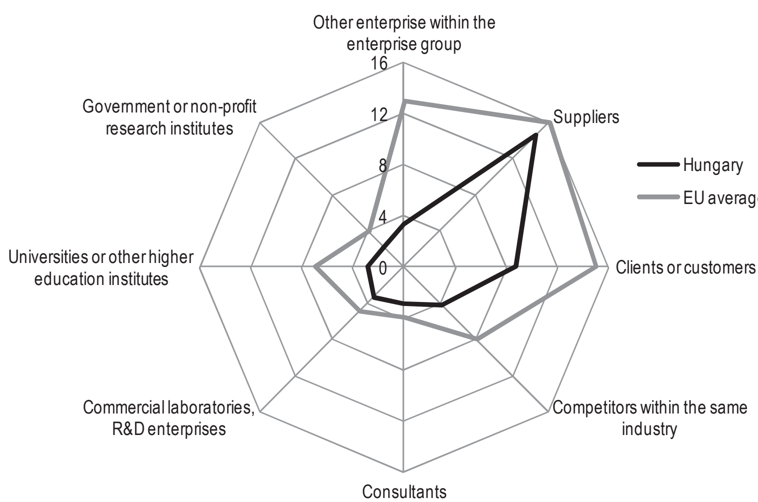
Hungary vs. EU average, 2002-04



* Innovative firms with more than 10 employees.
Source: Compiled by Balázs Borsi for Havas (2004).

Figure 2.9. Firms collaborating on innovation with partners in EU15 or EFTA as a percentage of all firms*

Hungary vs. EU average, 2002-04



* Innovative firms with more than 10 employees.
Source: Compiled by Balázs Borsi for Havas (2004).

Moreover, comparisons of the most recent rounds of the Community Innovation Survey (CIS 3 1999-2001, CIS 4 2002-04) show that while the share of innovative enterprises co-operating with other enterprises (either within the same group or with competitors in the same sector) has been rising, the share of innovative enterprises co-operating either with HEIs or public research institutes has fallen in recent years (Table 2.5). Nevertheless, at 13.6%, co-operation with HEIs remains strong when compared to the EU27 average (8.8%). Indeed, CIS 4 data suggest that *innovative* Hungarian firms (in contrast to *all* Hungarian firms) conduct at least as intense co-operation as the EU27 average across the board, with linkages to public research institutes the only category in which Hungarian innovators are significantly below the EU27 average. This pattern is also confirmed by CIS 4 data on major sources of information for innovation among innovative enterprises (Figure 2.10).

While the observations derived from the Community Innovation Survey do not allow for conclusions about the intensity and quality of co-operation, they certainly show that interaction is confined to a limited number of actors. Indeed, it seems that the major problem for establishing sufficiently strong collaborative links between industry and academia lies with the number of innovative (or rather non-innovative) firms, as innovative firms in fact co-operate quite intensively with academia and the financial flows involved are substantial.

Table 2.5. Share of innovative enterprises co-operating with specified partners

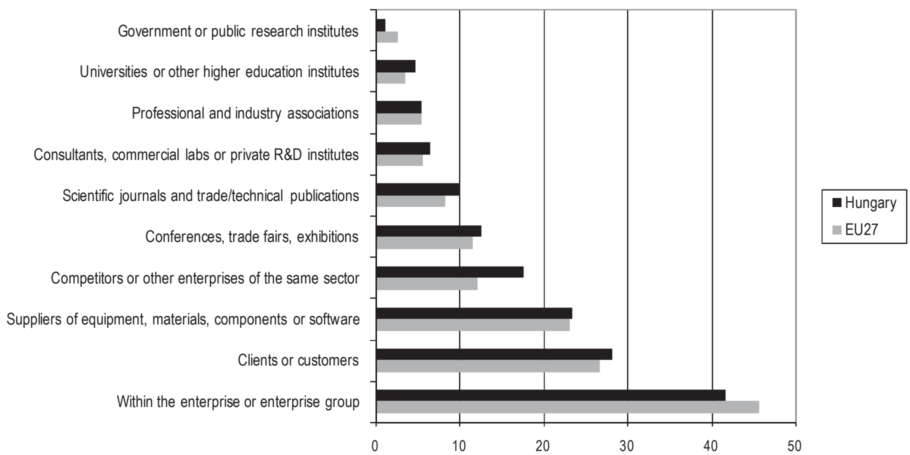
Percentage of all innovative enterprises

	1999-2001	2002-04
Other enterprises within the enterprise group	5.1	10.1
Suppliers of equipment, materials, components or software	26.8	26.2
Clients or customers	24.8	19.6
Competitors or other enterprises in sector	10.9	13.6
Consultants[1]	14.6	12.6
Private R&D organisations[1]	13.7	
Higher education organisations	21.6	13.7
Government or public research institutes	8.6	5.0

1. Co-operation with consultancy firms and private R&D organisations is merged in CIS4.

Source: KSH (various years) for 1999-2001; Eurostat (2007) for 2002-04.

Figure 2.10. Highly important sources of information for innovation, as a percentage of innovative enterprises, Hungary and EU27 average, 2004 (%)



Source: Eurostat (2007).

Table 2.6. Distribution of co-publications of 12 Hungarian universities[1], by partners, 2001-05 (%)

Affiliation of co-authors	Hungarian	Foreign	Total
Business firms	2.1	2	4.1
Health care organisation	4.3	3.9	8.2
Universities	11.2	45.7	57
Research organisation	14.8	14.1	28.9
Others	1.2	0.6	1.8
Total	33.6	66.4	100

1. Corvinus University of Budapest; Budapest University of Technology and Economics; University of Debrecen; Eötvös Loránd University; University of Kaposvár; University of Miskolc; University of West Hungary; University of Pécs; Semmelweis University; Szent István University; University of Szeged, Pannonia University

Source: Inzelt *et al.* (forthcoming).

In other work on the links between HEIs and other innovation system actors, Inzelt *et al*. (forthcoming) have looked at co-operation on scientific output in 12 Hungarian universities. They found that 73% of total publications were co-publications with actors outside the university but that only 4% were with businesses (see Table 2.6). In the same universities, 7% of total R&D spending was funded by businesses in 2000-04, with enterprises covering 17% of the R&D budget of engineering and technology faculties.

In spite of the high R&D intensity of the Hungarian pharmaceutical industry, the level of business-financed R&D in medical sciences is surprisingly low (4.3%), although the share of co-published scientific articles is high. The lack of joint R&D projects in this field might be explained partly by IPR regulations, which entitled universities to sole ownership of the intellectual property of its employees. It is only in recent years that new legislation and regulation have led to modification of these university procedures.

2.4.2. Infrastructure for industry-science co-operation

The two most important programmes on industry-science collaboration are the co-operative research centres (CRCs), which involve firms, publicly financed public research organisations and higher education institutions, and the regional knowledge centres (RKCs).

The co-operative research centres are a basis for the development of industry-science relations. They are established for a period of four years, with the possibility of renewal for a further three years, depending on the evaluation results. The 19 existing CRCs include approximately 300 enterprises and focus on breakthrough research in fields perceived to be of strategic importance for the innovation system. The research projects of the CRCs are assigned to departments or to partner research institutions to be performed by leading academics and researchers.

Another priority of the CRC is technology transfer, which includes adapting the results achieved in joint research projects for particular companies. The CRCs also offer services for setting up laboratories, purchasing new instruments, rental of R&D instruments and measurement services, etc. (NKTH, 2005). They also offer opportunities to students through their research activities as well as their education programmes. Owing to the low level of academia-industry co-operation in the regions, 11 of the CRCs have been established outside of the central region (*e.g.* in Debrecen, Gödöllő, Győr, Miskolc, Pécs, Sopron, Szeged and Veszprém) with a view to strengthening regional innovation systems and regional RTDI collaboration.

Given the long-term nature of their goals, much of the expected impact of CRCs (*e.g.* the development of fully fledged research clusters, commercialisation of pre-competitive research, etc.) will only be observable after several years. In the meantime, it is already clear that co-operation partners are mainly subsidiaries of foreign MNEs or innovative SMEs in high-technology industries, most of which have their own research departments (and spend up to 30% of their revenue on R&D and product development). During 2001-04, 23 patents were applied for with a further three patent applications pending. Box 2.6 describes four CRCs financed by the KKK Programme of the Research and Technology Innovation Fund (2001-04).

Box 2.6. Examples of co-operative research centres in Hungary

Co-operative Research Centre Mechatronics and Materials Sciences Miskolc

The University of Miskolc was awarded the status of CRC in Mechatronics and Materials Sciences in June 2001. In the first three years, the CRC received HUF 250 million through applications and HUF 250 million from consortium members. This fund was to be used for research for the members of the consortium associated with the CRC. In 2005-07, support was at HUF 360 million and own resources were about HUF 500 million. The main research topics are mechatronics, informatics and materials sciences. The CRC co-ordinates R&D institutes (BAYLOGI, BAYATI, TÜKI, and university departments), SMEs (*e.g.* Delco Remy Hungary Ltd., Fémalk Casting Ltd., SZIMIKRON Industry Ltd., etc.) and larger firms (DUNAFERR Co., Electrolux Lehel Ltd., GE Hungary Co., Hewlett-Packard Hungary Ltd., IBM Storage Co., PHILIPS Components Ltd., VIDEOTON Holding Co., etc.). The CRC wants to build and strengthen co-operation with the new Regional University Knowledge Centre in order to improve the supplier abilities of SMEs. (*www.meakkk.uni-miskolc.hu/).*

Rational Drug Design Laboratory, Co-operative Research Centre Semmelweis University

The Rational Drug Design Laboratory (CRC) was founded in 2001 as the first Hungarian co-operative research centre in biotechnology. The host institution is Semmelweis University, in collaboration with private biotechnology companies. The consortium provides a complete drug discovery and molecular diagnostic technology platform. A network of university clinics and hospitals provides access to clinical collaboration and clinical trials as well as tissue samples stored in a tissue bank for molecular research. Partners of the centre are the University of Pécs, Faculty of Medicine, Department of Microbiology and Immunology; the Biological Research Centre of the Hungarian Academy of Science, Institute of Chemistry; Intercell Biomedical Research and Development AG; Semmelweis University CRC, Rational Drug Design Laboratory; University of Szeged, Department of Medical Chemistry; University of Szeged, Faculty of Pharmacy, Department of Pharmacodynamics and Biopharmacy; KPS Biotechnology Ltd.; L&Mark Informatika (*www.drugdesign.hu*).

South-Transdanubian Co-operative Research Centre

The STCRC UP was founded by 18 research institutes and enterprises. Its role is to ensure the establishment of a network linking the universities, other Hungarian institutions of higher education, other non-profit research centres and the innovative business sector with a view to the strategic integration of education, economy- and society-oriented R&D and knowledge and technology networks. The focus of research is industrial and medical applications of lasers. Because of the wide range of research fields, STCRC UP is divided into six departments. The lead institution of the Centre is the University of Pécs with several departments of the Science, Technical and Medical Faculties. The major sponsor was the Innovation and Technology Development Centre pbc, Pécs, established by the Industrial Park plc, Pécs, and 13 other industrial partners. STCRC UP has connections throughout the country, with six partners in Budapest and two in Szeged and Szentendre. However, its main impact is in South Transdanubia (*www.ddkkk.pte.hu*).

…/…

Box 2.6. Examples of co-operative research centres in Hungary *(continued)*

University of Veszprém, Chemical Engineering Institute, Co-operative Research Centre

The CE CRC was founded in 2001 for innovation, market-oriented R&D, promotion of technological breakthroughs and to meet contemporary challenges – sustainable development, conservation and conditioning of the environment. The training of highly qualified specialists in the doctoral school of chemical engineers is an integral part of its aim to meet specific industrial requirements. The R&D activities of the centre are organised around 15 research topics in three main areas. They relate primarily to petrochemicals, polymers, fine chemicals, pharmaceuticals and chemical fertilisers and serve sustainable development goals. Research focuses on development of alternative motor fuel components, quality improvement of raw materials for olefine production, development of environmentally friendly gasoline and gasoline with high energy content as well as production of diesel oil. These fields are mainly related to the petrochemical, fine chemical and pharmaceutical industries (*www.vikkk.vein.hu/eng/index.htm*).

Source: NKTH (2005).

The regional knowledge centres of the Péter Pázmány programme (supported by NKTH) drew on and modified the "competence centres" model previously used in Hungary (in the so-called KKK programme) and in other countries.[44] RKCs are designed to exploit R&D results in close co-operation with industry. They are smaller than the CRCs in terms of size and financial support and are designed to contribute to the economic and social development of the region and to enhance the competitiveness of regional industry.

RKCs are designed to change the pattern of activities of an involved university in the following ways: *i)* the university should become more closely linked to the society and economy of the region; *ii)* the various faculties should engage in co-operation in areas ranging from education to R&D; *iii)* a larger share of the university's activities should focus on applied research and relate to the region's leading industries; *iv)* PhD programmes should focus more on applied research and research utilisation and PhD graduates should be allowed to work for innovative small enterprises or spin-off companies related to the RKC; *v)* over time, the RKC should become an innovation centre that helps to co-ordinate and harmonise the research of industry and academia.

Therefore, the programme might be instrumental in forming regional clusters around the co-operation of local industry and universities. However, this would require sufficient representation of industry and efforts are made to this end.[45]

44. Arnold *et al*. (2007).

45. NKTH (2006).

In another major effort to link science and industry, the Mobile Innovation Centre (MIK) was founded in 2005, with funding from the NKTH. Its aim is to provide research infrastructure for major electronics companies (another sector of industrial specialisation spurred by FDI). Though not a cluster in itself, it is an example of a research joint venture which might better link manufacturing companies operating at world scale better to Hungarian research capacities and the national innovation system (see Box 2.7).

Box 2.7. The Mobile Innovation Centre (MIK)

The Mobile Innovation Centre (MIK) involves co-operation among universities, an academic research institution, industrial companies, suppliers and organisations dealing with scientific research and innovation, including profit-oriented and non-profit sectors. MIK is a consortium founded by 17 partners to solve scientific and technological problems relating to future mobile and wireless systems and to contribute to: *i)* the implementation of 3G services, *ii)* the introduction of later mobile and wireless communication technologies, and *iii)* the development of up-to-date applications. Furthermore, it seeks to involve SMEs in R&D and innovation in these areas. The MIK operates at the Budapest University of Technology and Economics (BME) together with a professional test bed, and the necessary administrative/service units. Its mission is defined as:

- Supporting R&D in high-speed mobile and wireless technologies, including the B3G technological trends following the 3G mobile systems.
- Promoting the implementation of 3G/4G mobile and wireless technologies, network services, systems and applications based on these technologies and testing them in an independent environment.
- Encouraging the establishment, development and practical use of the latest mobile and wireless technologies/services.
- Supporting co-operation by universities, industrial companies and SMEs, and supporting SMEs established for the development of mobile and wireless technologies and services.

MIK actively participates in R&D programmes initiated by the European Union, increases its own incomes from domestic and international financial resources and is maintained by its products, services, applications and R&D contracts. Its testing system is used for research purposes, but is also available to domestic partner companies that produce and distribute telecommunication devices and develop telecommunication services. MIK aims at building new international relations, promoting the exchange of researchers, attracting students and PhDs, and creating fruitful relations with its project partners. In the long term, MIK seeks to become the regional R&D centre and encourages international high-technology companies to settle and invest in Hungary, thereby contributing to the rise in the country's technological level, the creation of new workplaces and overall economic development. The R&D activity of MIK is hierarchically organised under three main programmes. One focuses on the radio link of mobile systems. It studies presently available radio solutions and those of the near future. The development of radio systems, adaptive antennas and software radio are the main research interest. The second programme concerns the size of 3G/4G info-communication systems and investigates integration methods of wired and wireless systems, security issues and multimedia transmission in heterogeneous mobile systems. The third programme is devoted to the integrated development of mobile services and applications for different mobile platforms, multimedia content management and the analysis of user behaviour.

Source: MIK Annual Report, 2006; Péceli, 2007.

Several other organisations offer general innovation services, but the impact of their activities has not been thoroughly evaluated. For example, a dozen liaison offices operate at large universities. While their main task was supposed to be to develop and maintain contacts with businesses and to help university researchers reach out to the business sector, they have become preoccupied with monitoring domestic and international calls for project proposals and assisting university staff to prepare their proposals.

The number of larger bridging and technology transfer organisations that offer companies R&D services is estimated at between 15 and 20. More than half are situated in Budapest, and the others are located in the larger university cities of Debrecen, Miskolc and Szeged. Many of them operate in a science or technology park. Additionally, there are about ten industrial/business parks which have a high scientific profile and provide a home to successful companies that often co-operate with academic partners.

The Association of Business Incubators (VISZ) estimates that Hungary has 40 incubation facilities. Most operate as an industrial zone for SMEs and start-ups, and most have no links to universities or other research entities. However, they often provide assistance in writing proposals and in management, and in some cases this may involve innovation co-operation. About two dozen other organisations, half of them in Budapest, are estimated to have a bridging role in the Hungarian economy. They usually facilitate networking between companies, provide training and consultancy, and occasionally connect researchers and companies.

2.4.3. Networking and clustering

The role of clusters in national innovation systems is now well established. Innovative clusters can be defined as networks of interdependent firms, knowledge-producing institutions (universities, research institutes, technology-providing firms), bridging institutions (*e.g.* technology extension services) and customers, linked vertically or horizontally in a production chain which creates value added; they co-operate in developing and using sector-specific public goods, based on common physical and knowledge infrastructures. Innovative clusters can contain few or many enterprises and small and large firms in various ratios. They can be more or less knowledge-intensive, involve a larger or smaller set of knowledge-producing and bridging institutions, and have a narrow or broad sectoral and technological focus, since they occur in traditional as well as in new industries (see OECD, 2001a, 2001b). The geography of innovative clusters is often complex, transcending the traditional geographic boundaries of economic regulation.

Box 2.8. PANAC – The Pannon Automotive Cluster

The idea of a cluster-based regional economic development strategy first appeared in the Regional Innovation Strategy (RIS) of West Transdanubia in spring 2001. Several competitive economic sectors, with large numbers of employees and a strong presence of SMEs and large companies, were identified.

In West Transdanubia, all clusters were developed bottom-up. The most important – the Pannon Automotive Cluster (PANAC), the Pannon Wood and Furniture Cluster (PANFA), the Pannon Electronics Cluster (PANEL) and the Pannon Thermal Cluster (PANTERM) – have a common infrastructure and/or institutional management. In 2005, new bottom-up cluster initiatives were encouraged by the Pannon Business Initiatives and the Western Pannon Regional Development Agency. Three of these – the Pannon Textile Cluster (PANTEXT), the Pannon Logistics Cluster (PANLOG) and the Pannon Local Product Cluster (EcoCluster) – received significant financial support from the Innovation Fund. In addition, a cluster initiative is under way in the field of renewable energy and related technologies.

PANAC was founded in 2000 by nine organisations (the number increased to 12 in 2001); 70% are manufacturers. 40% are small, 34% medium-sized and 26% large companies. There are four automotive manufacturers (Audi, GM, Suzuki, Rába) and three suppliers (Luk, Benteler, Videoton). The cluster also includes service providers to automotive firms. Besides manufacturing companies and service providers, the other members of the cluster are Széchenyi István University, the Regional Development Council, Consulting & Research for Industrial Economics Ltd., and two banks.

The management of PANAC is in Győr. In 2006 it moved from the university to the Innonet Innovation and Technology Centre in the Győr Business Park, which provides an innovative environment close to the firms. While the initiative came from West Transdanubia, 35% of its members are located in Budapest or its agglomeration area, 32% in West Transdanubia (half of them in or around Győr), 20% in Central Transdanubia, and the rest in other Hungarian regions. This geographical dispersion is not conducive to the development of intensive co-operation and knowledge diffusion. In most cases, more than 100 km separate members, and the main flows of communication and information are between the management and the members rather than among the members.

PANAC is a division of West Pannon Regional Development Agency, the most important development organisation in the region. The formal decision-making body is the cluster committee, which is comprised of the founders, among which are the large manufacturers (Audi, Suzuki, GM, Rába, LuK). Members pay an annual membership fee and are the most important target of PANAC's services but are not involved in defining the objectives and tasks of the cluster management. The decision-making process is somewhat awkward both because of the structure of the cluster committee and the fact that, except for Audi, GM and Rába, the activity of most of the committee's members is limited. Smaller active firms in different areas should also participate.

The mid-term aim of PANAC is to be an autonomous organisation, fully independent from the regional development agency. Because of its current status, it cannot participate in programmes or funding schemes or receive cluster development funds. If the cluster were a legally independent organisation, it could be much more efficient than as a division of a large bureaucratic organisation. Full independence could also give the cluster a more stable financial framework and access to national and regional programmes and funding schemes.

Source: Grosz (2006).

Given the appeal of successful international examples of clusters, networks and industry-science collaborations, it is no surprise that innovation policy in many countries has tried to establish such webs of interaction, and Hungary is no exception. Especially in connection with monies available from the EU's Structural Funds, several cluster organisations have been set up for textiles, automotive, fruit processing, food and drink, thermal energy and water, tourism, construction, artisan arts, manufacture of precision instruments, and electronics. Automobile manufacturing is one of Hungary's main sources of FDI and is now a major area of industrial specialisation in Hungary with clusters developing around major factories in the western part of the country and the capital area. The example of the Pannon Automotive Cluster can serve as an illustration of the opportunities and problems of regional cluster policy in Hungary (see Box 2.8).

2.5. Human resources for S&T and innovation

In some respects Hungary's human resources for S&T are good. Hungary's emergence as a production platform in manufacturing, often in high-technology products, has further developed engineering skills in the workforce. Even if this may not involve much formally recorded R&D, it is likely to involve a degree of innovation and can serve as a transition to the provision of formal R&D services in product and process development.

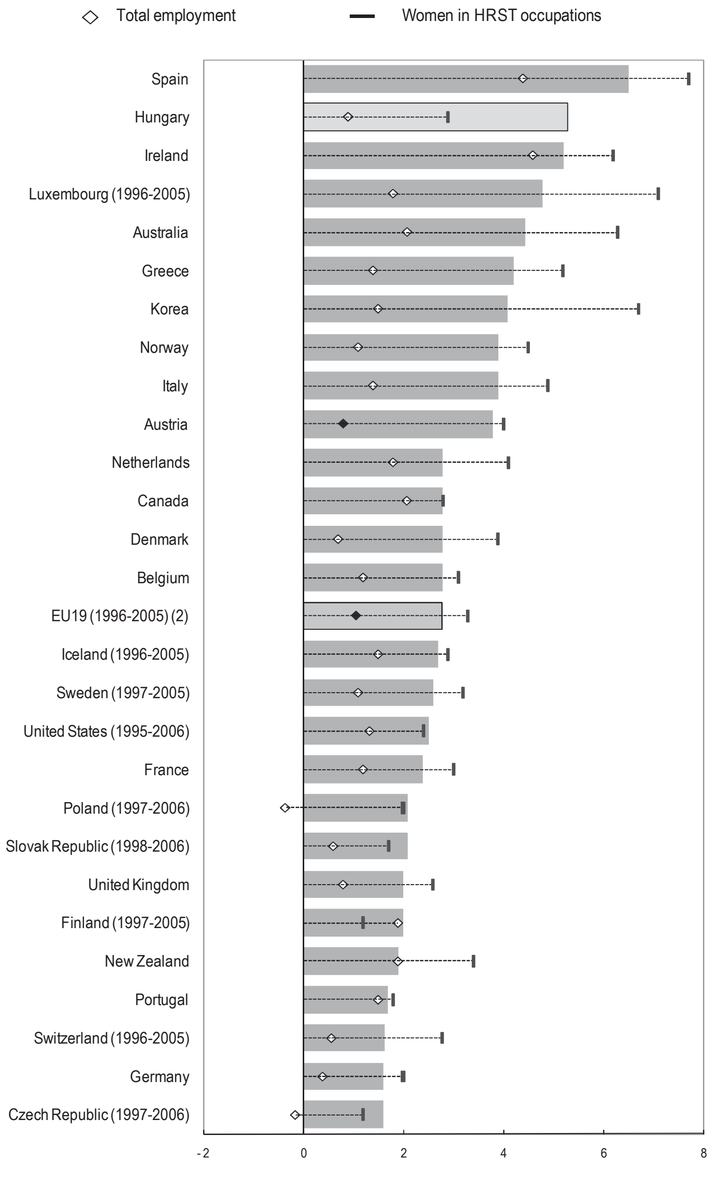
At the same time, however, the education system could be doing a better job of providing the right skills and of developing interest and expertise in R&D in the economy in general. In this regard, the education system has been slow to adjust to rapidly changing market requirements. Tertiary-level educational attainment of the working age population has been low, and there are signs of mismatches between demand and the perceived quality of graduates and the structure of enrolments. These, and other issues, are further explored below.

2.5.1. Contemporary snapshot

Though it started from a relatively low base, Hungary is clearly catching up in terms of the proportion of workers employed in professional and technical occupations (the so-called HRST occupations), as shown in Figure 2.11. Average annual growth in HRST occupations exceeded 5% in the ten years to 2006, the second highest rate among OECD member countries. Around 60% of Hungarian HRST positions are occupied by women, one of the highest proportions in the OECD area.

Figure 2.11. Growth of HRST occupations, 1996-2006

Average annual growth rate

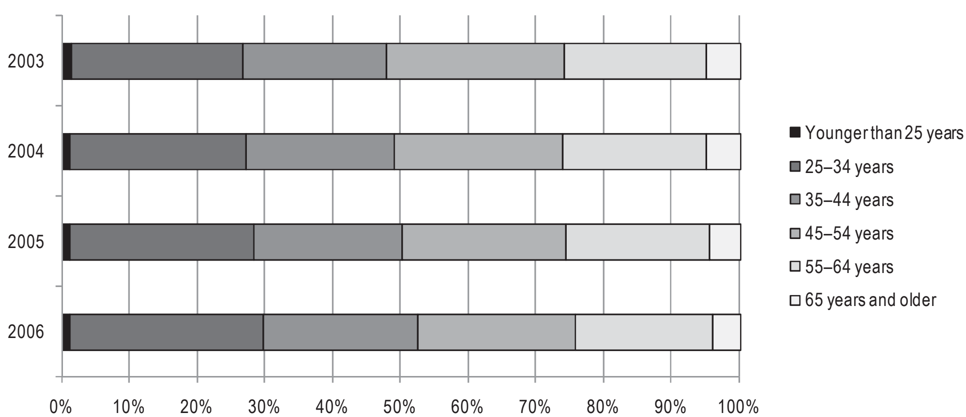


Source: OECD Science, Technology and Industry Scoreboard 2007.

Chapter 1 showed that Hungary has one of the lowest levels of employed researchers in the OECD area, despite recent increases in numbers, particularly in the business sector, which now constitutes the largest employer of researchers. A major recent concern regarding the researcher population is the age distribution. One-quarter of researchers are over 55 years old and fewer than 30% are under 34 years of age. Since 2000, a slight rejuvenation can be detected owing to a decrease in the average age of researchers in enterprises (Figure 2.12). While nearly half of business researchers are under 34 years old, the average age of researchers at universities and research institutes is rising (Figure 2.13). Several new incentives aim to encourage the employment of young PhD graduate researchers at firms, which may account in part for these recent shifts.

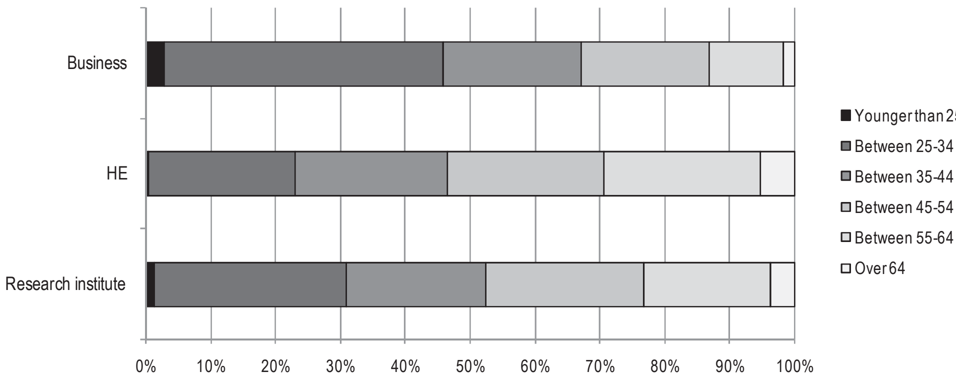
In 2006, the proportion of female scientists was 34%, with the highest levels in medical sciences and humanities and the lowest in engineering (Table 2.7). Figure 2.14 shows Hungary to be a mid-range performer among OECD countries, with most women researchers employed in HEIs.

Figure 2.12. Age distributions of researchers, 2003-06



Source: KSH, Research and Development (various years).

Figure 2.13. Research personnel: age cohort by sectors in Hungary, 2006



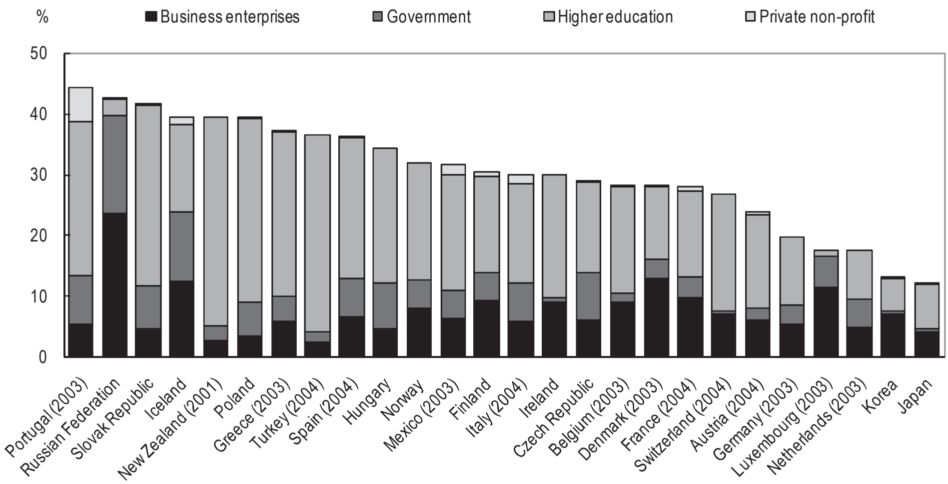
Source: KSH (2006a).

Table 2.7. Women in research jobs by scientific field

Fields of science	Number of researchers		Proportion of female researchers to total (%)
	Total	Female	
Natural science	4 714	1 335	28.3
Engineering and technology	10 475	2 082	19.9
Medical science	4 319	1 988	46.0
Agricultural science	1 916	648	33.8
Social science	4 899	1 803	36.8
Humanities	6 463	3 117	48.2
Total	32 786	10 973	33.5

Source: KSH (2006a).

Figure 2.14. Women researchers by sector of employment, 2005



Source: OECD Science, Technology and Industry Scoreboard 2007.

2.5.2. Overall expenditure on education

With significant growth in expenditure in the past ten years, expenditure on education as a percentage of GDP is now only slightly below the OECD average of 5.8%. The increase of 50% in education expenditure since 1995 (compared with an OECD average increase of 42%) outpaced growth in GDP. As a result, education expenditure as a percentage of GDP increased from 5.3% in 1995 to 5.6% in 2004 (Table 2.8). The largest rise in expenditure has been in tertiary education (59%), mirroring a similar average pattern in OECD countries. The increases in primary and secondary education funding have been entirely publicly funded. As a result, the public funding share of primary and secondary education increased during this period by three percentage points.

To assess their potential impact on the quality of educational services, the resources invested in education need to be seen in relation to the number of students enrolled. On that measure, spending per student across all levels of education (excluding pre-primary education) is, at USD 4 326 (equivalent), well below the OECD average of USD 7 061. At the tertiary level, spending per student is USD 7 095 compared to an OECD average of USD 11 100. Hungary's comparative position improves somewhat when countries' relative wealth is taken into account. On this measure – expenditure per student, relative to GDP per capita – expenditure levels in Hungary in fact exceed the OECD average at the pre-primary, primary and tertiary levels and are only just below the OECD average at the secondary level.

Table 2.8. Expenditure on educational institutions as a percentage of GDP, by levels of education, 1995, 2000, 2004

From public and private sources, by year

	2004			2000			1995		
	Primary, secondary and post-secondary non-tertiary education	Tertiary education	Total all levels of education	Primary, secondary and post-secondary non-tertiary education	Tertiary education	Total all levels of education	Primary, secondary and post-secondary non-tertiary education	Tertiary education	Total all levels of education
France	4.1	1.3	**6.1**	m	m	**m**	m	m	**m**
Germany	3.5	1.1	**5.2**	m	m	**m**	3.7	1.1	**5.4**
Greece	2.2	1.1	**3.4**	2.3	0.7	**3.1**	1.8	0.5	**2.3**
Hungary	**3.5**	**1.1**	**5.6**	**2.9**	**1.1**	**4.9**	**3.5**	**1.0**	**5.3**
Italy	3.4	0.9	**4.9**	3.2	0.9	**4.8**	m	0.7	**m**
Japan	2.9	1.3	**4.8**	3.0	1.3	**4.8**	3.1	1.1	**4.7**
Korea	4.4	2.3	**7.2**	4.0	2.6	**7.1**	m	m	**m**
Mexico	4.3	1.3	**6.4**	3.8	1.1	**5.5**	4.0	1.1	**5.6**
Poland	3.8	1.5	**6.0**	3.9	1.1	**5.6**	m	m	**m**
Portugal	3.8	1.0	**5.4**	3.9	1.0	**5.4**	3.6	0.9	**5.0**
Spain	3.0	1.2	**4.7**	3.2	1.1	**4.8**	3.8	1.0	**5.3**
Turkey	3.1	1.0	**4.1**	2.4	1.0	**3.4**	1.7	0.7	**2.4**
United Kingdom	4.4	1.1	**5.9**	3.6	1.0	**5.0**	3.9	1.2	**5.5**
United States	4.1	2.9	**7.4**	3.9	2.7	**7.0**	3.9	2.4	**6.6**
OECD average	**3.8**	**1.4**	**5.8**	**~**	**~**	**~**	**~**	**~**	**~**

1. Expenditure from public sources only. 2. Reference year: 2005. m. Missing data.

Source: OECD, *Education at a Glance 2007*.

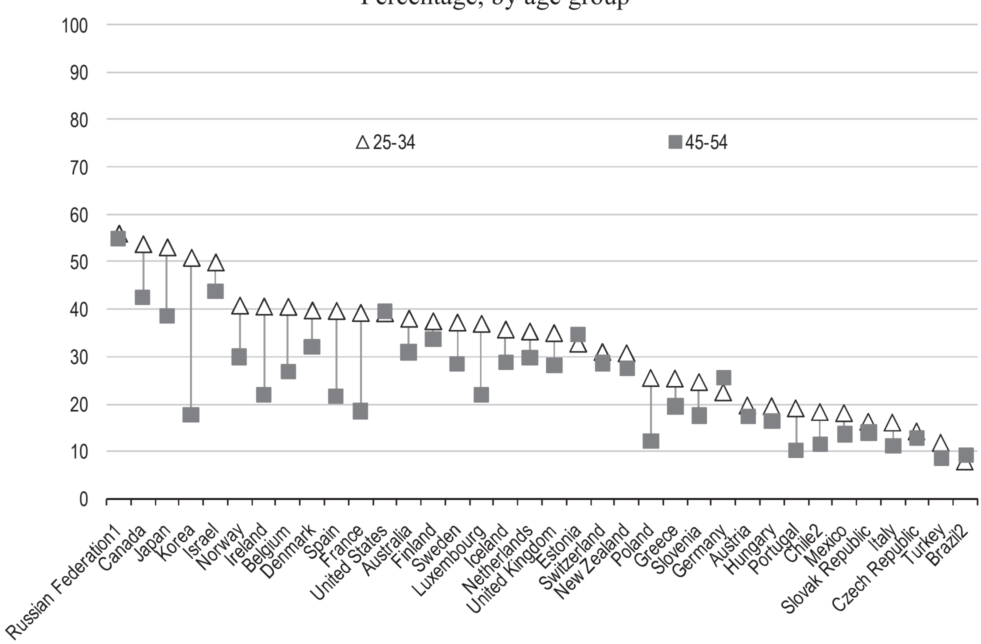
Spending levels alone are not a reliable indicator of education quality. Resources, particularly when in short supply, need to be spent efficiently. In compulsory education, the authorities recently took steps to improve quality, notably with the introduction of output measures of student and school performance as well as the teaching of ICT and language skills. However, the authorities should reconsider the current system of segregating secondary school students into vocational and academic streams, as this has a tendency to misallocate students. Furthermore, the division into vocational and academic streams is less useful for providing skills for modern labour markets.

2.5.3. Tertiary education

The level of tertiary attainment in Hungary is well below the OECD average. The proportion of the 25-to-64-year-old population in Hungary with tertiary qualifications is 17%, compared with the OECD average of 26%. Moreover, although tertiary attainment has increased, it has been at a slower pace than in most other OECD countries. The proportion of the younger population (25-34 years old) with tertiary qualifications is 20%; the equivalent figure for the older population (55-64 years old) is 15% (Figure 2.15).

Figure 2.15. Population that has attained at least tertiary education, 2005

Percentage, by age group

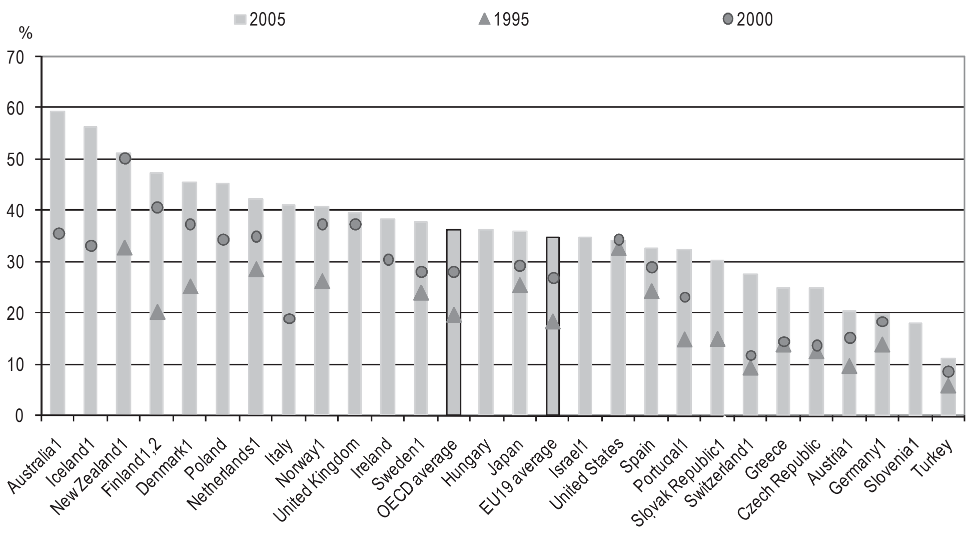


Countries are ranked in descending order of the percentage of 25-to-34 year olds who have attained tertiary education. 1. Reference year: 2003. 2. Reference year: 2004. *Source:* OECD, *Education at a Glance 2007*.

Current trends in tertiary enrolment may suggest that Hungary will make faster progress in the coming years, as student enrolments in tertiary education more than doubled between 1995 and 2004. This has translated into a sharp increase in tertiary graduation rates, with university-level graduation rates increasing from 29 to 36% between 2004 and 2005; they now match the OECD average (Figure 2.16). The more vocationally orientated tertiary-type B qualifications form a relatively small part of tertiary provision in Hungary but graduation rates have also increased in the latest figures to 4% of the typical age cohort.

Figure 2.16. Tertiary-type A graduation rates, 1995, 2000, 2005

Percentage of tertiary-type A graduates in the population at the typical age of graduation



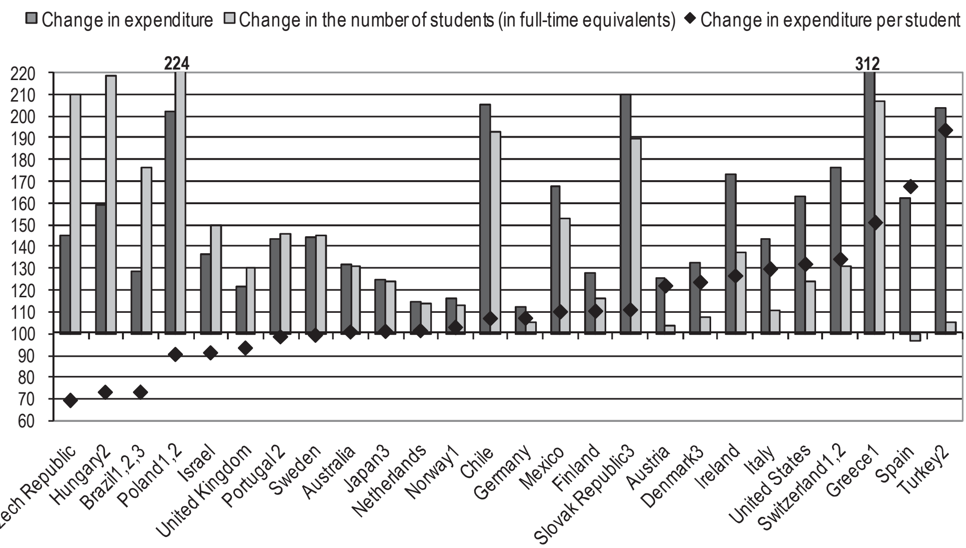
Countries are ranked in descending order of the graduation rates for tertiary-type A education in 2005.
1. Net graduation rate is calculated by summing the graduation rates by single year of age in 2005.
2. Reference year: 2004.
Source: OECD, *Education at a Glance 2007*.

The sharp increase in graduation rates has led to a 27% reduction in levels of expenditure per student, despite significant budgetary increases (Figure 2.17). Only the Czech Republic has fared worse among OECD countries for which data are available. The increases in expenditures have been funded slightly more from private sources (increase in funding of 69%) than public sources (increase in funding of 57%). Private funding originates more from other private entities (*i.e.* businesses, charities, non-profit organisations) than from households, which is unusual among OECD countries.

Moreover, households receive sizeable public subsidies, with some 16% of public funding of tertiary education devoted to expenditure on scholarships and grants. This is much higher than the OECD average of 10%. Over the last decade the number of publicly funded places has increased significantly, though growth has recently levelled off somewhat as the government has sought to consolidate public finances.

Figure 2.17. Changes in the number of students and changes in expenditure on educational institutions per student, by level of education, 1995, 2004

Index of change between 1995 and 2004 (1995=100, 2004 constant prices)



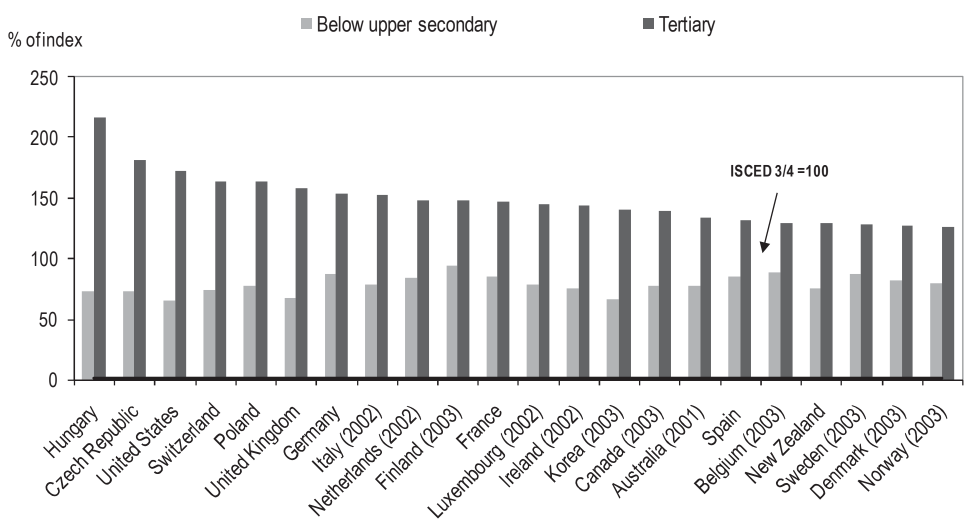
Countries are ranked in ascending order of change in expenditure on educational institutions per student.
1. Public expenditure only.
2. Public institutions only.
3. Some levels of education are included with others.
Source: OECD, *Education at a Glance 2007*.

Hungary operates a dual-track system whereby students are admitted to tertiary education on the basis of their entrance examination scores, with higher scoring students subsidised by state funds paid to the institution, and lower scoring students admitted as 'private' students who are required to pay full tuition fees. This raises serious questions about the equity of access to tertiary education in Hungary. A small specialised programme begun in September 2005 seeks to increase the number of disadvantaged and Roma students who are admitted to and supported in tertiary education. State-guaranteed loans are also available to students in tertiary education, although the amount available (USD 1 717) is relatively low and the interest rate charged (around 12%) is high compared with other OECD countries (where interest rates are typically 5% or less).

There may be a case for reconsidering the balance of cost sharing between public and private sources of funding for tertiary education, particularly in light of the sharp decline in expenditure per student, which would seem to indicate the strain on public financing imposed by rapid expansion. The earnings advantage of university-level graduates aged 30-44 years compared with persons holding upper secondary qualifications is 125%, the highest comparative advantage of all OECD countries (Figure 2.18). The earnings advantage is similar for all tertiary qualifications and trend data show that the earnings advantage has strengthened almost continuously since 1997, although there was a slight drop in the latest figures. Tertiary graduates in Hungary also have a much greater chance of finding a job, as 83% of tertiary graduates aged 25-64 in employment compared with only 70% of those with an upper secondary qualification. Graduates' high wage premium would seem to indicate ample scope for contributing to the costs of tertiary education. At the same time, to prevent a shift in funding towards private sources from limiting access by students from low-income families, such contributions would need to be assessed using a needs-based formula.

Figure 2.18. Relative earnings of the population with income from employment, 2004

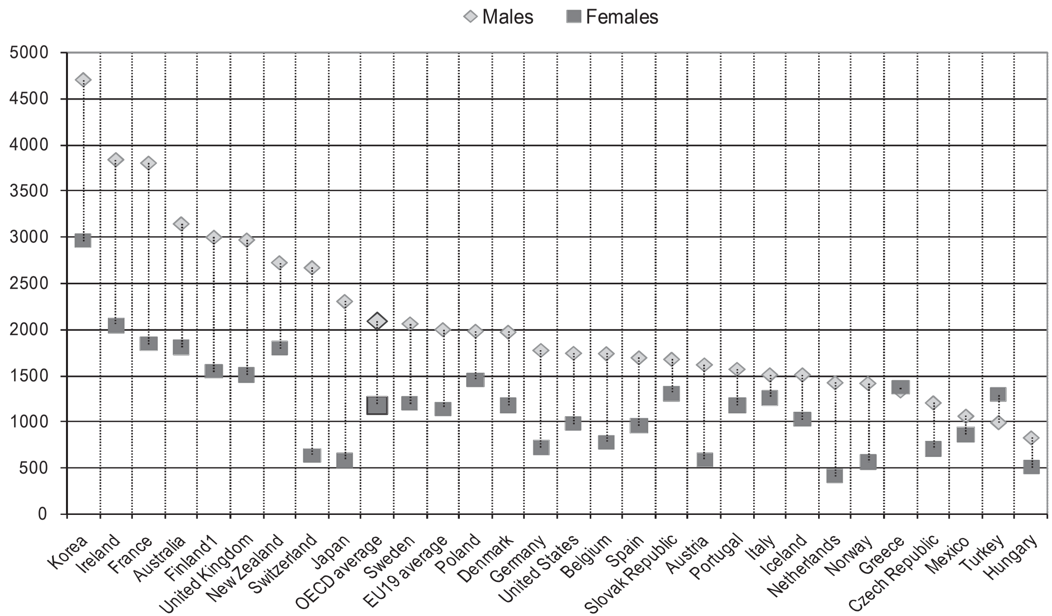
By level of education for 25-to-64-year-olds (upper-secondary and post-secondary non-tertiary education = 100)



Source: OECD Science, Technology and Industry Scoreboard 2007.

Figure 2.19. Number of tertiary science graduates per 100 000 employed 25-to-34-year-olds, 2005

Tertiary-type A, tertiary-type B and advanced research programmes, by gender

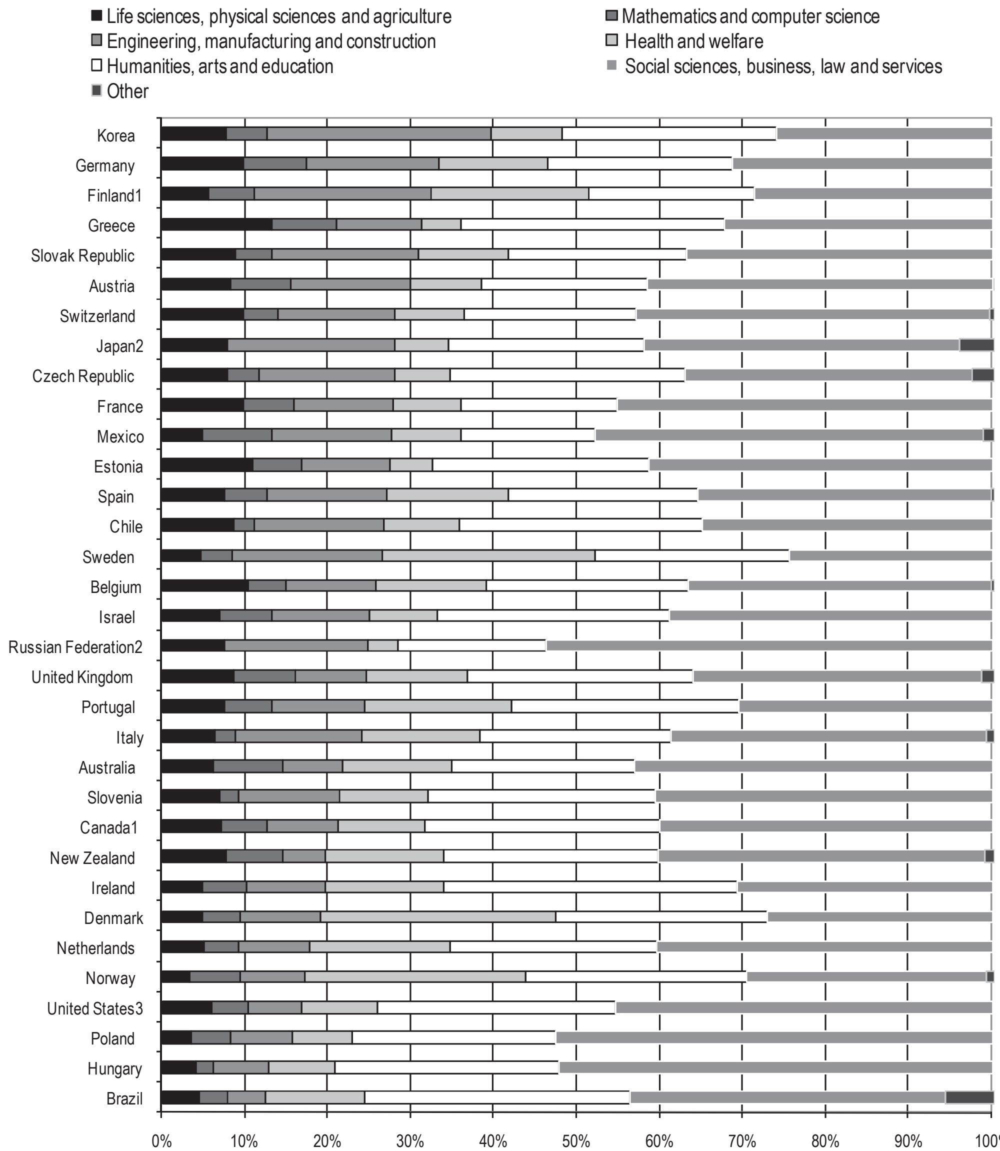


Science fields include life sciences; physical sciences; mathematics and statistics; computing; engineering and engineering trades; manufacturing and processing; architecture and building. Countries are ranked in descending order of the share of the number of male science graduates in the total number of male and female science graduates in tertiary programmes. 1. Reference year: 2004.

Source: OECD, *Education at a Glance 2007*.

Figure 2.20. Tertiary graduates, by field of education, 2005

Graduates with tertiary-type A and advanced research qualifications



Countries are ranked in descending order of the proportion of qualifications in life sciences, physical sciences and agriculture; mathematics and computer science; and engineering, manufacturing and construction.

1. Reference year: 2004.
2. Physical sciences, mathematics, statistics and computing are included in life sciences.
3. ISCED 5B programmes are included with ISCED 5A/6.

Source: OECD, *Education at a Glance 2007*.

2.5.4. Production of S&E graduates

Given the relatively low levels of active researchers in Hungary, not to mention their age profile, the education sector needs to produce more scientists and engineers. However, a weak spot in Hungary's innovation potential is the small share of tertiary education graduates in scientific and technological areas. As Figure 2.19 shows, relative to population, Hungary has fewer science graduates (695 per 100 000 of the employed population aged 25-34 years) than any other OECD country and less than half the rate for the OECD on average.

Even so, the current rate of production of science graduates would seem to be an improvement. There are more than six times as many science graduates among younger age groups than among older age groups (Table 2.9), a disparity that is more than twice the OECD average. Nevertheless, as Figure 2.20 shows, social sciences, business, law and services remain by far the most common subjects studied, accounting for more than half of the annual university graduate output.

Table 2.9. Ratio of 25-to-34-year-olds with ISCED 5A and 30-to-39-year-olds with ISCED 6 education to 55-to-64-year-olds

	Education	Arts and humanities	Social sciences, business and law	Science	Engineering	Agriculture	Health and welfare	Services	Total
Hungary	1.9	2.7	2.4	6.2	0.8	0.9	1.4	1.3	1.7
OECD average	1.0	2.2	3.5	3.0	1.9	2.2	1.9	3.1	2.3

Note: Science includes life sciences, mathematics and statistics, computer science and use.

Source: OECD, *Education at a Glance 2007*.

The OECD's Programme of International Student Assessment (PISA) shows Hungarian 15-year-olds to be average performers on the science scale (OECD, 2007e). Moreover, their interest in science and scientific careers is also around the OECD average. They would therefore seem to have an interest in science in secondary school. A likely explanation for the relative disinterest at tertiary level would seem to be job market prospects. Job prospects were not promising for scientists and engineers for most of the 1990s, although things have improved in recent years. But because the R&D sector is relatively small, it has sent correspondingly small signals to education providers and students compared to the much stronger signals sent by labour markets in some other areas, notably business-related fields. Furthermore, the severe lack of financial and marketing managers, as well as booming opportunities for lawyers, have made these specialisations more attractive. The low share of graduates with R&D-relevant degrees thus essentially reflects weak demand signals.

Graduation rates at doctoral level remain low at around half of the OECD average, while the proportion of S&E doctoral degrees is also one of the lowest, reflecting similar patterns at other tertiary degree levels (Figure 2.21). A recent study (Tamás *et al.*, 2005) investigating the potential demand for HRST for the coming decade identified a shortage of PhDs as the main bottleneck in the Hungarian science system. This shortage risks jeopardising FDI for higher value-added and knowledge-intensive activities. The study concludes with a call for the government to initiate the necessary changes in PhD training (both in quantity and quality) and to ease the inflows of PhD researchers from abroad.

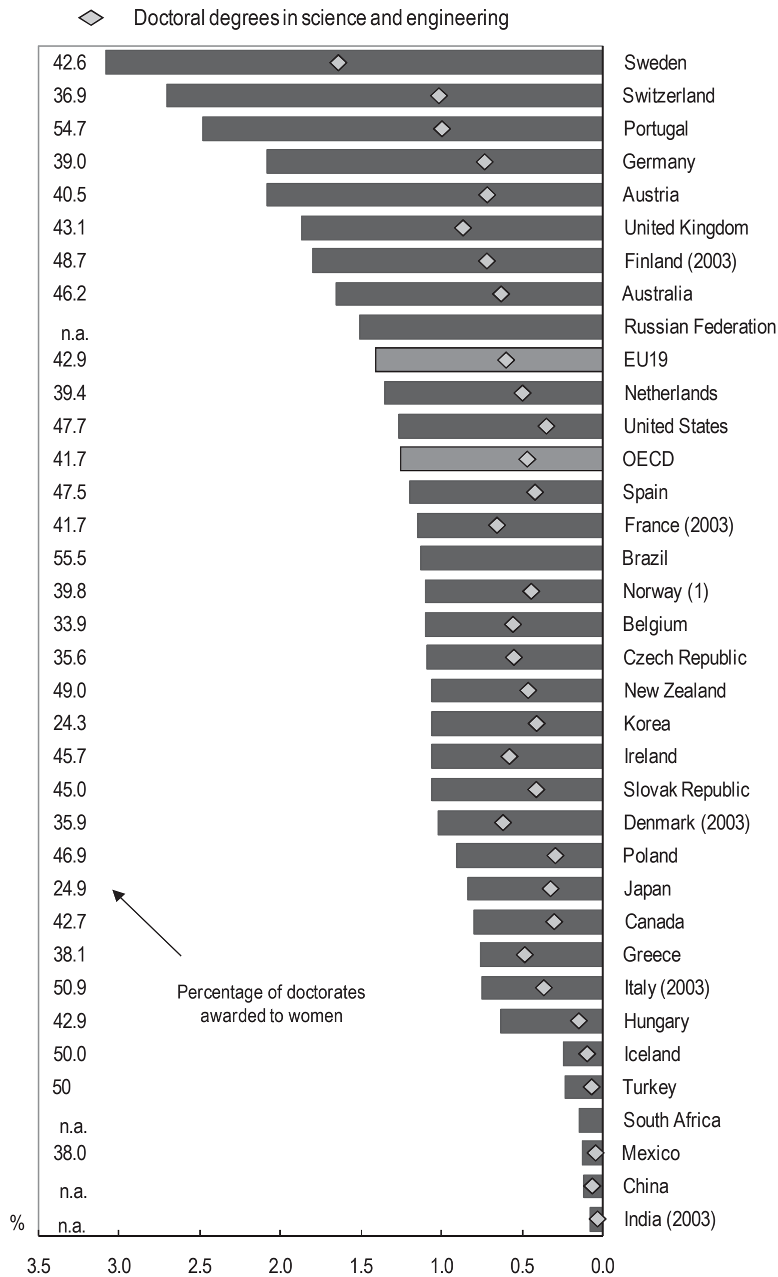
2.5.5. How well does supply match demand?

In recent years, the business community has been vociferous in arguing that an increasingly important obstacle to investment and innovation is the lack of educated people. The quantity of skilled workers is deemed insufficient for innovative businesses, while the unsatisfactory level of vocational training is seen to have hampered emerging industries and the introduction of new technologies in traditional industries. This skills shortage would seem to be confirmed by the high wage premiums earned by university graduates.

Though some demand signals reach the tertiary sector, there has long been criticism that the supply response is inadequate and that courses in tertiary education are too long, have insufficient vocational content and are too focused on specific subjects. The introduction of shorter, more vocationally oriented degrees as part of the Law on Higher Education was therefore welcome. The new three-year bachelor degree courses are broader-based than master's courses, have more vocational content and also involve compulsory work experience. On completing this new degree, students can take an additional year's study to complete a specialised master's course. Other elements of the new law should also strengthen signals to the education system. In particular, it makes it easier for students to transfer between universities during their studies, sets up a mechanism for feedback from the career experience of graduates to new admissions, and has established new governing structures.

Figure 2.21. Graduation rates at doctoral level, 2004

As a percentage of the relevant age cohort



Source: OECD Science, Technology and Industry Scoreboard 2007.

Market signals nevertheless need further strengthening. In particular, the government should again attempt to introduce more consultation between the tertiary sector and business on the content and mix of courses. Early drafts of the 2005 Innovation Act proposed setting up a new system in which tertiary education providers would have to regularly consult employers and respond better to industry demands for changes to the mix and content of courses. This proposal was, however, resisted by tertiary education representatives during the redrafting of the act on the grounds that the proposal would compromise the independence of educational bodies.

In addition, the tertiary education system should be under greater pressure to shift out of areas of excess supply. Understandably, it has been easier for the system to respond in areas of growing demand for courses, but its response has been sluggish when falling demand has meant downsizing university departments. This problem is exemplified by the relatively large number of students taking teaching qualifications: although the number of graduates has fallen considerably, supply continues to exceed demand and many graduates with teaching qualifications do not become professional teachers. Changes in the subject mix and improving the quality of degree courses could be facilitated by making greater use of tertiary education funding to encourage changes in the allocation of teaching resources. Currently, these transfers are based on per capita payments which vary across courses (roughly reflecting teaching costs) and are set by agreement between the universities and the government. Each year the government sets limits on how many per capita payments it will fund and these are very strictly defined (over 400 sub-limits are set).

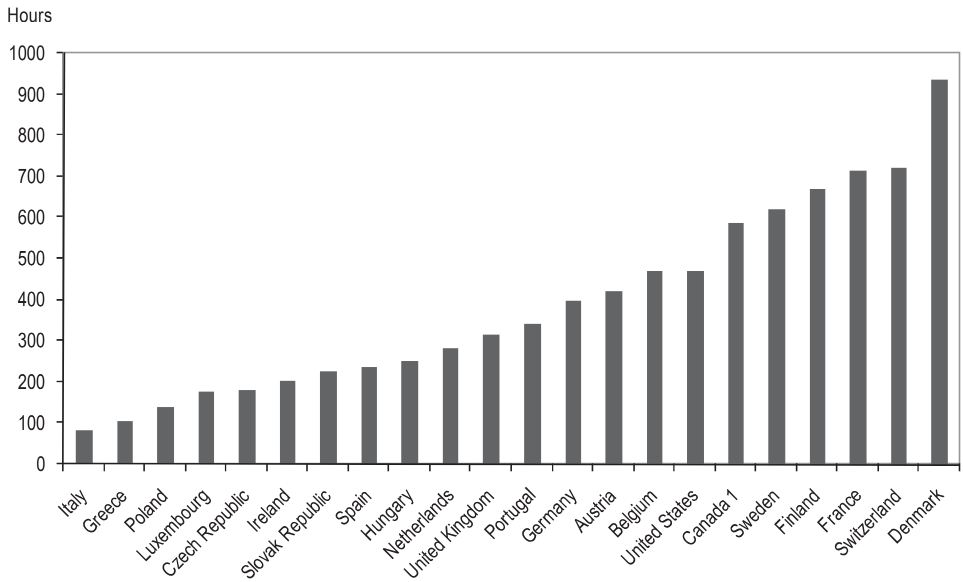
The incentive structure for students and universities could also be strengthened by the introduction of tuition fees for public university courses. The main economic argument for fees is that it would help better connect investment with return to university students and provide useful price signals for universities. Fee systems can also help fine-tune subsidies for tertiary education by designing mechanisms, such as government loans, to provide extra help to students from low-income households or extra support for certain types of courses. Despite these benefits, there would seem to be few prospects of introducing a fees system in the short term as it was recently rejected in a national referendum.

2.5.6. Lifelong learning

In Hungary, participation in job-related education and training is low compared with other OECD countries and particularly so for the less well educated. Only 4% of the population aged 25-64 years participates in non-formal job-related education and training during the year. Along with Greece and Italy, this is the lowest rate among OECD countries. In terms of the number of hours of such education and training an individual can expect to receive between the ages of 25 and 64, Hungary performs a little better (253 hours compared with the OECD average of 389 hours), indicating that those who do participate, do so reasonably intensively (Figure 2.22).

Figure 2.22. Expected hours in non-formal job-related training, 2003

Over a 40-year period, for 25 to 64-year-olds



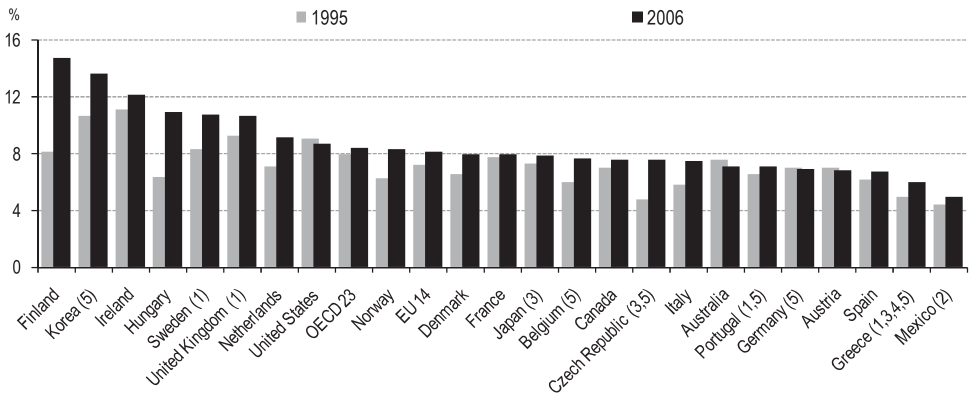
1. Reference year: 2002.
Countries are ranked in ascending order of expected hours in non-formal job-related education and training.
Source: OECD, *Education at a Glance 2007*.

2.6. ICT in the Hungarian economy

ICT manufacturing has been a major driver of economic growth and export performance over the last decade, and there are also signs of improvement in the sector's low R&D intensity, but IT diffusion and use remain among the weaknesses of the Hungarian innovation system. Comparatively low levels of computer skills and literacy, broadband penetration (most of all in rural areas) and Internet use are major hindrances and should be of concern to innovation policy.

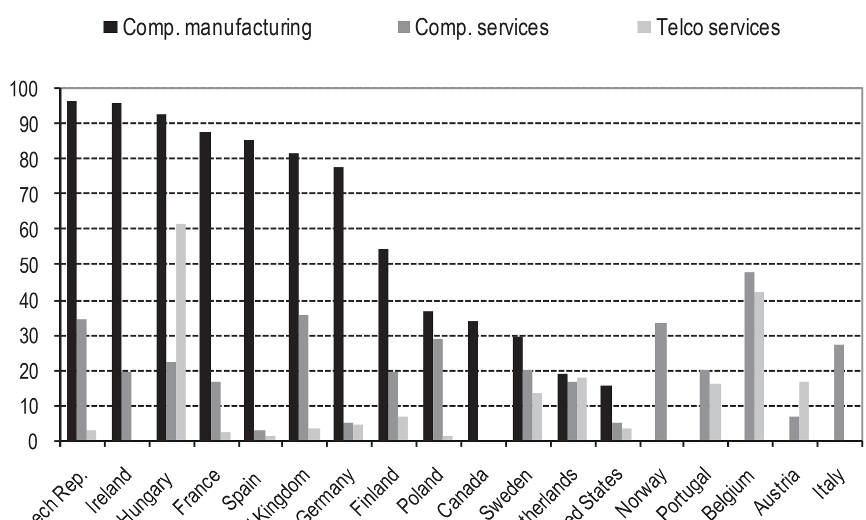
Figure 2.23. Share of ICT value added in business sector value added, 1995 and 2006

Percentages



1. 2005 instead of 2006. 2. 2004 instead of 2006. 3. ICT wholesale (5150) is not available. 4. Telecommunication services (642) included Postal services. 5. Rental of ICT goods (7123) is not available.
Source: OECD *Information Technology Outlook 2008*.

Figure 2.24. The share of foreign-controlled affiliates in turnover of the ICT sector,[1] 2002[2]

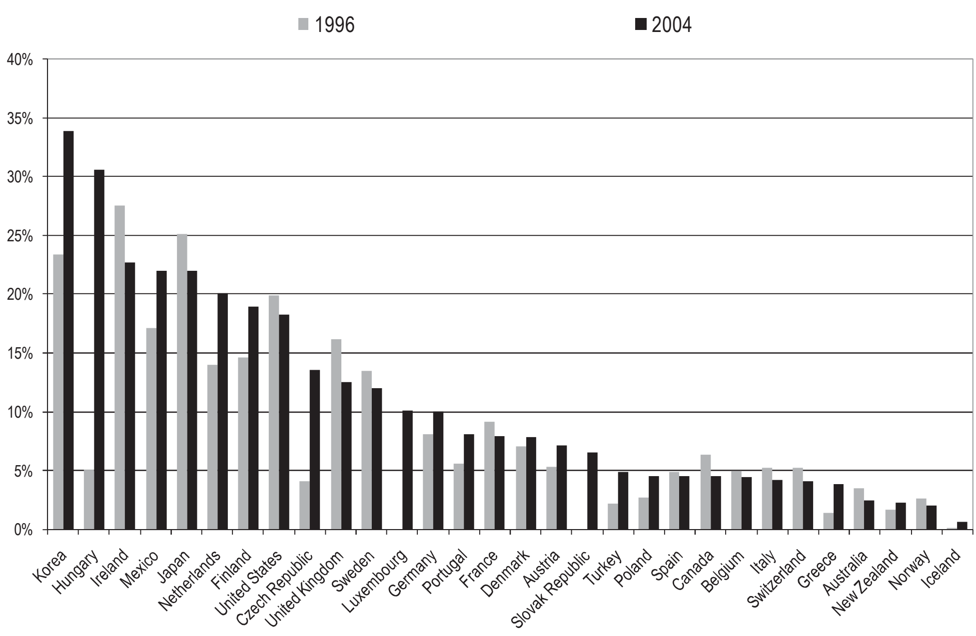


1. Computer manufacturing, ISIC 30; Computer and related services, ISIC 72; and Telecommunications services, ISIC 642. 2. *For computer manufacturing*: France, Ireland, Netherlands, Norway, Portugal, and Sweden, 2001; Hungary, Finland, Spain, and United Kingdom, 1999. *For computer and related services*: Austria, Finland, France, Italy, Germany, Netherlands, and Portugal, 2001; Sweden, 2000; Hungary, 1998; Ireland, Norway and United Kingdom, 1997. *For telecommunications services*: Austria, Finland, France, Germany, and the Netherlands, 2001; Czech Republic and Sweden, 2000; Hungary, 1998; Ireland and Italy, 1997.
Source: OECD Information Technology Outlook 2006.

2.6.1. The Hungarian ICT business sector

The ICT sector[46] in Hungary has been growing rapidly over the last decade and has become a major sector of the economy (see Figure 2.23). It accounts for some 11% of value added and more than 30% of total merchandise exports, figures that put Hungary among the most specialised countries in the production of ICT hardware (Figure 2.24). The basis for this strong position has been very high FDI inflows, reflecting the share of MNEs in the ICT sector, which is among the highest of all OECD countries. FDI was mostly attracted by cost advantages and the availability of a skilled labour force; it had very little to do with indigenous R&D capacities (ICEG, 2007). Though the picture has started to change – owing in part to efforts to establish ICT clusters (see Box 3.1 in Chapter 3) – R&D intensity is still low and very much concentrated in MNEs.

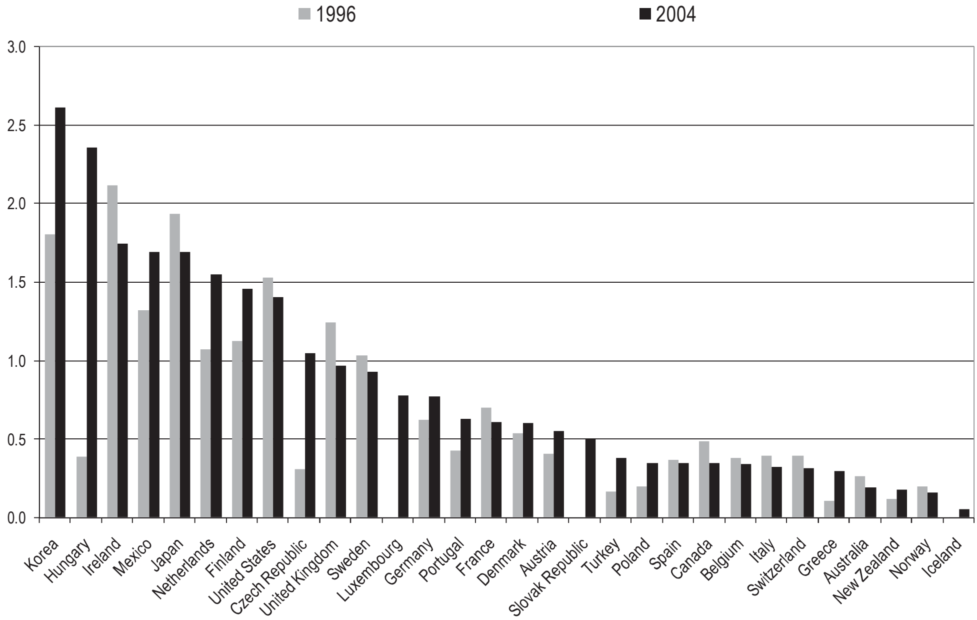
Figure 2.25. Share of ICT goods in total merchandise exports, 1996-2004



Source: OECD Information Technology Outlook 2006.

46. For a definition of the ICT sector, see OECD (2002).

Figure 2.26. Revealed comparative advantage in ICT goods, 1996-2004



Source: OECD *Information Technology Outlook 2006*.

Furthermore, in terms of export specialisation in ICT, Hungary is second only to Korea (Figure 2.25) and the export surplus stemming from the sector is significant (Figure 2.26). On the other hand, as the sector is strongly geared towards highly productive manufacturing of hardware (with software – once a strong point in the Hungarian ICT landscape – and services occupying a much smaller share in international comparison), the share in employment is less than in other OECD countries.

2.6.2. Diffusion and use of ICT

While production of ICT hardware is a major strength of the Hungarian economy, several indicators point at weaknesses in the diffusion and use of ICT. In rankings of the ITU and UNCTAD (2007), which combine several synthetic "information society" indicators, Hungary does not perform favourably on important dimensions such as availability of skills for the information society and diffusion (Table 2.10). While it is not surprising that Hungary trails small advanced western European countries such as Sweden, Denmark and the Netherlands, the substantial gap with other central and eastern European countries is worrying.

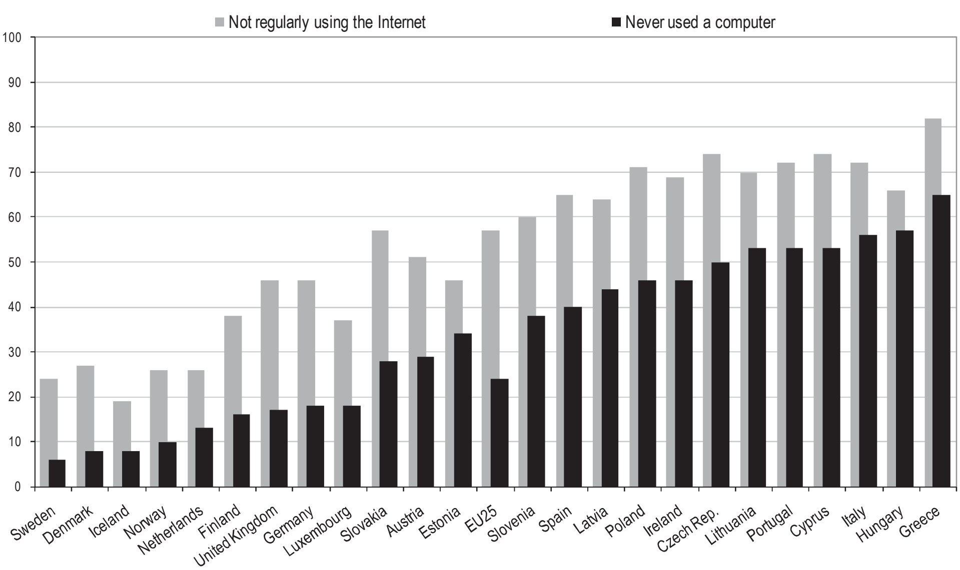
Table 2.10. Information society indicators

Rank	Country	Network index	Skills index	Diffusion index
1	Sweden	605.1	153.8	464.5
4	Netherlands	555.6	141.6	472.6
5	Demark	616.5	145.8	390.2
24	Estonia	339.6	137.2	346.2
30	Slovenia	261.8	146.0	332.2
33	Latvia	228.7	138.5	262.1
36	Czech Republic	295.8	125.0	231.5
37	Lithuania	245.9	140.3	219.2
39	Hungary	232.6	133.7	192.4
41	Slovak Republic	249.2	122.4	274.6
45	Poland	190.7	137.5	211.6

Sources: ITU and UNCTAD (2007).

Figure 2.27. Individuals not using computers or the Internet, 2005

As a percentage of the total number of individuals aged 16-74



Source: Eurostat (2006).

Weaknesses in skills and diffusion reinforce each other, as the large number of people who do not use either PCs or the Internet demonstrates. Though the gap has been closing somewhat in recent years owing to rapid growth,[47] Hungary still lags the EU27 average. While this is certainly also influenced by income and price levels, Hungary does not perform as well as other central and eastern European countries with similar levels of income per capita (see Figure 2.27).

The picture for e-skills is mixed: almost 40% of Hungarian employees are not computer literate, a figure twice the EU25 average. However, the share of those with a high level of computer literacy is high and on a par with the EU25 average.

Broadband penetration for citizens, a measure both of the infrastructure for ICT diffusion and of diffusion itself, was significantly below the EU27 average (11.6% and 18%, respectively) in October 2007 (DG INFSO, 2007). This is mainly due to much weaker supply in rural areas (around 2.3% as compared to 8% on average in the EU); in urban areas, the gap is narrower. Indicators of actual use of ICT and ICT-related services depict a considerable digital divide in Hungary. Compared to households and individuals, the share of companies with broadband penetration is higher and growing fast, but still trails EU27 averages by 7 percentage points.

The example of countries like Estonia has shown that a major impetus for IT diffusion can come from the provision of effective public services. E-government is an area in which there has been significant development in recent years and it has improved both the level of development and Hungary’s indicators in international comparison. The scope of services has increased considerably, the number of users has increased, and the online accessibility of public institutions has improved significantly. Full online availability has also increased in recent years: in 2004 only 15% of all measured services were available online, but in 2007 50% were. Even so, Hungary has only moved from the bottom of international rankings towards (but still below) the EU average. Progress in the use of online public services by companies and citizens is weaker than the level of availability, and the recent increase in the number of users was insufficient to diminish significantly the gap in company and citizen usage with the EU10 and the EU15 averages.

47. Perhaps also because of the spread of public Internet access points (ICEG, 2007).

Chapter 3

THE ROLE OF GOVERNMENT

3.1. The evolution of Hungary's science, technology and innovation policy[48]

Since the end of the communist era, Hungary has put much effort into developing a modern institutional framework for science, technology and innovation (STI) policy. Today, there is a solid legal basis for STI policy and most of the relevant elements exist (*e.g.* strategy documents, policy advisory and co-ordination bodies, specialised funding bodies). These changes have often taken place rapidly and in bursts of institutional change, re-organisation and re-orientation of policy, and have rarely been based on evidence relating to the functioning and performance of institutions or policy instruments. Hungary has made little use of the evaluations and assessments that inform, and to some extent guide, STI policy in other OECD countries. Thus, while Hungary has evolved towards an institutional setting comparable to those in other OECD countries, there are still issues to be resolved and room for improvement.

3.1.1. Building new foundations: STI policy in the period of change

As an immediate result of the end of communist rule, the collapse of traditional export markets and the consequent need to re-orient the economy, Hungary suffered a deep recession after 1989. GDP decreased by 7.7% in 1991, institutional structures collapsed, and R&D expenditure was significantly reduced. The enterprise sector cut back on research spending even more drastically than the national government. Many companies (especially large, formerly state-owned firms) went out of business, and surviving firms re-oriented their activity to the market and shed activities that were unpromising in the short or medium term.

48. This section draws on Báger *et al*. (2005), the *European Trend Chart on Innovation* (2001, 2002 and 2003), NKTH (2004) and Veres and Krisztics (2006).

In the early 1990s, nearly all specialised state-financed R&D programmes were abandoned and the previously dominant top-down funding system for R&D (identifying and financing R&D in strategic areas) was by and large replaced by a bottom-up approach and by applications for support for individual projects by research institutes and companies. This was complemented by institutional funding for the major public research institutions (essentially the universities and the Hungarian Academy of Sciences).

By the mid-1990s, economic imbalances began to jeopardise the stability of the economy. A strong forint and a rise in consumption led to a deteriorating trade balance: the balance of payments deficit exceeded 9% of GDP in 1994. In 1995, the Minister of Finance established a fiscal stabilisation programme (known as the "Bokros package"), which led to substantial reductions in public spending. This also affected public expenditure on R&D, which fell to an all-time low of 0.67% of GDP in 1996. Many public research institutes, the most important R&D-performing sector at the time, underwent a second wave of layoffs and closures.

The National Committee for Technological Development (OMFB), a government body responsible for financing (and also at times for steering) innovation and technology policy was in place throughout the 1990s. It was established to manage the Central Basic Programme for Research and Technological Development (KMÜFA), which mainly covered applied research. The OMFB's responsibilities included co-ordination of R&D strategy, international relations, and managing technology development funds and programmes. In 1997, the OMFB launched a major technology foresight exercise, at that time a pioneering venture in central and eastern Europe. It involved major stakeholders and covered important fields, but was only published widely in 2001 and had at best an indirect effect on policy.

3.1.2. The second half of the 1990s: towards a comprehensive STI policy system

Major changes took place in the second half of the 1990s and at the beginning of the new century, as growing political awareness of the importance of R&D and innovation for the country's further progress motivated changes in government policy: the formulation of the Széchenyi Plan, the first National Development Plan; changes in the institutional setting for R&D policy; and the creation of a new research funding system.

From 1998 to 2002 the government set new economic and science, technology and innovation priorities. The Ministry of Economy (since 2002, the Ministry of Economy and Transport) became again a key ministry for innovation policy along with the Ministry of Education and Culture, which was responsible for the universities and the Hungarian Academy of Sciences

(HAS). In 1999 the government also reorganised the Science and Technology Policy Council (TTPK) as a high level co-ordinating body for science, technology and innovation policy.

At that time, the Ministry of Economy advocated a more proactive role for the state in determining the future direction of the Hungarian economy. In 2000, the Széchenyi Plan was a first attempt towards an innovation strategy with a long-term view. It outlined broad goals for the development of the economy as a whole and for priority areas such as innovation. The objectives of innovation policy were to strengthen information and knowledge flows, to facilitate the acquisition of knowledge and skills by domestic human resources, to channel foreign direct investment (FDI) to high-technology sectors and to accelerate the computerisation of the economy. The government also published *Science and Technology Policy 2000*, as an integral part of the Széchenyi Plan, to summarise the approaches to shaping policies on the development of science and technology and outline planned actions.

3.1.3. After 2000 – Entering a new phase

Up to the recent slowdown, the beginning of the 2000s was characterised by robust growth of GDP and R&D intensity edging towards 1% of GDP. However, some imbalances have emerged in the macroeconomic and fiscal environment and a number of structural problems persist. They include a divide in the economy (sometimes referred to as "dual economy" characteristics), regional disparities and a low level of R&D and innovation activity in the business enterprise sector (see Chapters 1 and 2).

Against this background, and in preparation for Hungary's accession to the European Union, STI policy, institutions and funding underwent significant changes:

- *Development planning*. After the general election in May 2002, the new coalition government, faced with budgetary constraints, reviewed the Széchenyi Plan and cut back on some of the activities envisaged in it. As a consequence, a New National Development Plan (new NDP) was drawn up. It declared R&D and innovation a policy priority and put the goal of achieving a knowledge society/ economy at the centre. The most important objectives of the new NDP's innovation programme were to establish innovation-friendly regulation, to make Hungary an attractive location for R&D investment, to strengthen the protection of intellectual property rights (IPRs) and to finance innovation by small and medium-sized enterprises (SMEs). It called for measures to strengthen the links between science and industry, *e.g.* by developing technology transfer centres, the establishment of co-operative research centres, the improvement of innovative capacities in the business sector, the attraction of innovation headquarters, and improvement of the R&D infrastructure by upgrading laboratories.

- *Policy advisory bodies*. Policy advisory bodies were either newly established or redefined. During the 1990s, the Council of the National Committee for Technological Development (OMFB Council) made strategic decisions concerning the use of the Central Technological Development Fund: the types of technology policy schemes to be launched and how much funding to be allocated to specific schemes. In January 2000, the Council became an advisory body to the Minister of Education and lost its decision-making power. In 2003, it was re-established and renamed the Research and Technological Innovation Council (KTIT) under the Law on Research and Technological Innovation (Act XC of 2003). In April of the same year, the Science and Technology Policy Council (TTPK), the highest-level co-ordination and consultation body for science and technology policy (established under this name in 1999[49] following predecessor bodies first put in place in 1990) was reformed, and the Science and Technology Policy Advisory Board (TTTT) was established as an expert committee comprised of members of the research and business community to aid the TTPK.

- *R&D funding and specialised institutions*. Having been under the responsibility of a minister without portfolio (1990-94) and a division of the Ministry of Education and Culture (2000-03, though by and large with the same mandate), in January 2004 a new independent agency, the National Office of Research and Technology (NKTH) was established under the new law on Research and Technological Innovation, with similar tasks as OMBF had previously. The NKTH was made responsible for the government's technology policy and tasked to devise R&D and innovation programmes, manage bilateral and multilateral international R&D co-operation, and supervise the network of Hungarian science and technology attachés. Its main function is to manage the Research and Technological Innovation Fund established in January 2004 in order to ensure more stable financing of R&D. As of 2006, the NKTH has been supervised by the Minister of Economy and Transport who replaced the Minister of Education in this function. In January 2007, according to an amendment of the Law on the Research and Technological Innovation Fund, the Minister of Economy and Transport was entitled to take operational decisions regarding the use of the

49. *www.proinno-europe.eu/docs/reports/documents/Hungary_CR_September_2001.pdf*.

Fund; this implied a significant expansion of the minister's power. As of the beginning of 2008, responsibility for the allocation of the Fund was again moved to the President of NKTH. In May 2008 the new minister without portfolio in charge of science, research and innovation was tasked with supervising NKTH (see below).

- *Higher education institutions and Academy of Sciences*. In the higher education sector, the Law on Higher Education of 2005 links Hungary to the European Higher Education Area and adopts the objectives of the Bologna process. The law aims at making the management of higher education institutions (HEIs) more efficient by adding new bodies (senate, economic councils) to the management structure of HEIs and at making HEIs more responsive to the changing needs of the business sector. Recent amendments to the law have gone further in this direction, by introducing tuition fees (called "partial development contributions") in 2006 and giving HEIs the right to set up business entities to commercialise their research results. In addition, a reform of the Hungarian Academy of Sciences was initiated with a view to modernising its institutional setting and strengthening incentives to raise the quality of research.

- *Regional STI policy*. Owing to political centralisation and the concentration of capacities in the capital region, regional STI policy is not very developed. However, this has been changing in recent years with the establishment of various regional bodies, but well-functioning institutions and the capabilities required for policy formulation and implementation will be required. Accession to the EU and access to EU Structural and Cohesion Funds have acted as a catalyst for developing Hungary's regional STI policy.

When it acceded to the European Union in 2004, Hungary also gained access to EU Structural and Cohesion Funds, which emphasise R&D and innovation. The preparation for Hungary's first full participation (planning period 2007-13) was therefore a catalyst for more intense communications between science, technology and innovation stakeholders in preparing the necessary planning documents.

In 2007, the New Hungary Development Plan 2007-13 – Employment and Growth (NHDP) and the Mid-term Science, Technology and Innovation (STI) Policy Strategy, as well as an Action Plan, were approved:

- The NHDP is the framework document for allocating the financial resources provided by the EU Cohesion and Structural Funds and national contributions. The NHDP has a number of objectives in various areas, including economic development, transport development, social renewal, environment and energy, regional development and state reform. These are translated into operational programmes, among which the Economic Development Operational Programme (EDOP), approved by the European Commission in August 2007, aims at improving the competitiveness of the Hungarian economy and contains R&D and innovation-related targets. The other specific objectives are "complex development of corporate capacities" (with a focus on SMEs), "development of the business environment" and "facilitation of the access of SMEs to financial resources".

- The Mid-term Science, Technology and Innovation (STI) Policy Strategy[50] aims at transforming the Hungarian innovation system so as to make Hungary a country in which "knowledge and innovation are the driving engines of the economy" by 2013. To this end, it identifies strategic goals in four broad areas of innovation policy: *i)* strengthening companies' research, technological development and innovation (RTDI) activities; *ii)* building internationally competitive RTDI capacities and centres; *iii)* strengthening knowledge to support the competitiveness of the society; and *iv)* strengthening regions' RTDI capacities. Key technology areas and targeted industrial sectors have also been identified: information and communication technology (ICT); life sciences and biotechnology; materials science and nanotechnology; technologies of renewable energy resources; and environmental technologies. Targeted sectors include: the information technology and electronics industry; engineering and vehicle manufacturing; the pharmaceutical industry; chemical industry; food processing; and innovative services. The strategy sets out several indicator-based targets to be reached by 2010 and 2013. Notably, Hungary aims to achieve R&D intensity (the ratio of gross domestic expenditure on R&D [GERD] to GDP) of 1.4% by 2010 and 1.8% by 2013. Some of the target set in the Strategy may be very difficult to achieve (see section 3.4).

- Together, the NHDP and the Mid-term STI Policy Strategy address the main challenges facing the Hungarian innovation system and provide a sound orientation for STI policy in many respects. As they

50. The Law on the Research and Technological Innovation Fund of 2004 envisaged the formulation of an STI Strategy by the government by May 2005. The strategy was finally approved in March 2007, and the related Action Plan in August 2007.

set very ambitious goals, timely implementation will require state-of-the-art governance of the innovation system, including good interaction between central and regional government institutions and other actors. Previous experience and apparent delays in the implementation of the current Action Plan suggest that the governance of innovation policy and its implementation urgently require improvement.

3.2. Governance and the policy mix

Governance of innovation policy determines to a significant degree the effectiveness and efficiency of related policy measures. For this reason, many OECD countries – including Hungary – are currently undertaking efforts to improve their innovation policy governance. This section starts with a brief account of the new legislation and policy documents at both national and regional levels, which provides a legal and policy framework for innovation policy. Next, the institutional setting of innovation policy is presented and assessed with a view to its operation in practice. The main characteristics of the mix of instruments used is then discussed (a more detailed account of these instruments can be found in section 3.3). Finally, the use of tools for evidence-based policy making, such as monitoring, evaluation and stakeholder involvement in Hungarian innovation policy, is reviewed.

3.2.1. Institutional setting of Hungary's STI policy

The national level

Hungary has developed a diversified institutional landscape for innovation policy, with several ministries, advisory bodies and institutions responsible for policy delivery, including funding – in short, the elements of a typical innovation policy system in OECD countries. This section describes the situation at the national level, then turns to some important changes in regional innovation policy governance and concludes with some remarks about current or planned changes.

In the legislative branch, the main parliamentary committees involved in innovation policy are the Education and Science Committees, the Economics and Informatics Committee and the recently established Innovation and Research *ad hoc* Committee.

In the executive branch, the key ministries dealing with innovation policy used to be the Ministry of Education and Culture and the Ministry of Economy and Transport. The Ministry of Education and Culture is in charge of the formulation and implementation of education policies. It supervises the entire public education system from elementary schools to universities. It therefore has wide-ranging responsibilities, including maintaining a quantitatively and qualitatively adequate supply of human resources for science and technology (HRST). The Ministry of Economy and Transport has operated a number of innovation policy measures and supervised the government offices responsible for quality management, intellectual property, standardisation, metrology, energy and consumer protection. In May 2008 a new position was created as part of a government restructuration: a minister without a portfolio in charge of science, research and innovation. Only once in the past 18 years (from the end of 1990 to mid-1994) had STI policy been given such a strong position within the central government. The new minister is generally responsible for RTDI and for co-ordinating science policy. The appointment of the new minister, who is also in charge of supervising the National Office for Research and Technology (NKTH), is likely to lead to further change in the status of NKTH, but its direction is still not entirely certain at this stage. Currently, the minister has a small administrative office and he is assisted by a state secretary.

Some sectoral ministries, in particular the Ministry of Agriculture and Rural Development, the Ministry of Environment and Water, and the Ministry of Health, have some R&D competences, notably in mission-oriented research relevant to their field of responsibility

The Science and Technology Policy Council (TTPK) is the government's highest-level advisory and co-ordination body for science and technology affairs. It discusses policy documents, co-ordinates policy measures and facilitates their implementation. The prime minister presides and the vice chairs are two ministers (the Minister of Education and Culture and the Minister without portfolio in charge of science, research and innovation) and the president of the Academy of Sciences. Other ministers and stakeholder groups are represented as well. The Science, Technology Policy and Competitiveness Advisory Board (TTTT) is an expert committee on STI policy, with members from industry and academia. However, both of these bodies have been largely inactive since 2006 and have not had a role in major STI policy decisions, *e.g.* the formulation of the Mid-term STI Policy Strategy. The Higher Education and Research Council (FTT) advises the minister of Education and Culture.

The National Office for Research and Technology (NKTH) is in charge of implementing the government's STI policy. It is the most important funding body, mainly for funding of applied research and innovation. NKTH designs support programmes for R&D and innovation and manages international R&D co-operation. It submits its strategic proposals to the Research and Technological Innovation Council (KTIT).

The Hungarian Scientific Research Fund (OTKA) supports scientific research and the development of the research infrastructure, with a focus on basic research. It defines its allocation strategy independently, launches funding schemes and decides which research projects to support. Its annual budget has been decreasing in recent years.

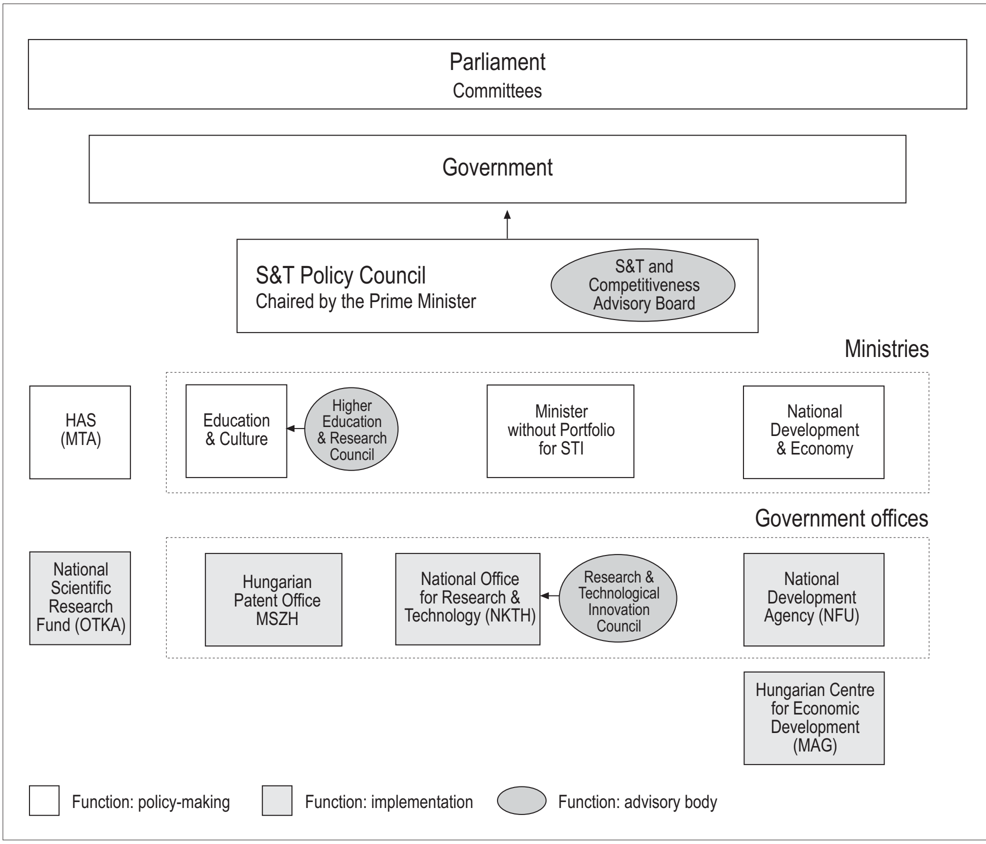
The Hungarian Academy of Sciences (HAS, or MTA in Hungarian) is a self-governing public body with a high degree of scientific, political and financial autonomy. It has multiple roles, both as a major performer of R&D and as an important part of the STI governance system. The president of the HAS regularly reports to the government and to the parliament on the state of science and technology in Hungary.

The National Development Agency (NFÜ) is tasked with mid- and long-term development and planning activities, including the preparation and implementation of strategic plans and operational programmes to make use of EU funds (currently under the National Strategic Reference Framework 2007-13). NFÜ is in charge of all but one of the managing authorities of the various operational programmes co-financed by the EU Cohesion and Structural Funds.

The main actors in the governance of Hungary's innovation system are presented in Figure 3.1.

The innovation policy system (the institutions responsible for strategic planning and decision making, policy co-ordination and implementation) has undergone a number of institutional changes since the 1990s. Each incoming government has restructured at least one major part of the system, and – as shown above in the outline of the evolution of Hungary's STI policy – some actors, notably the Science and Technology Policy Council (TPKK) and the NKTH, have seen their institutional positions change very frequently. Figure 3.2 shows these changes concerning the position of NKTH up to, but not including, the latest developments since May 2008. The political status of the highest-level consulting and co-ordination body, the TTPK has also changedrepeatedly. It was headed by a minister (1990-94, 2000-02) or by the prime minister (1994-98 and from 2002). Its operational unit (secretariat) was in a politically strong position only during the early 1990s. It held meetings frequently until 1998 (at least four times a year), but then met once a year on average; its last meeting was held in January 2006 (before the last parliamentary election).

Figure 3.1. Major actors of the Hungarian STI policy system

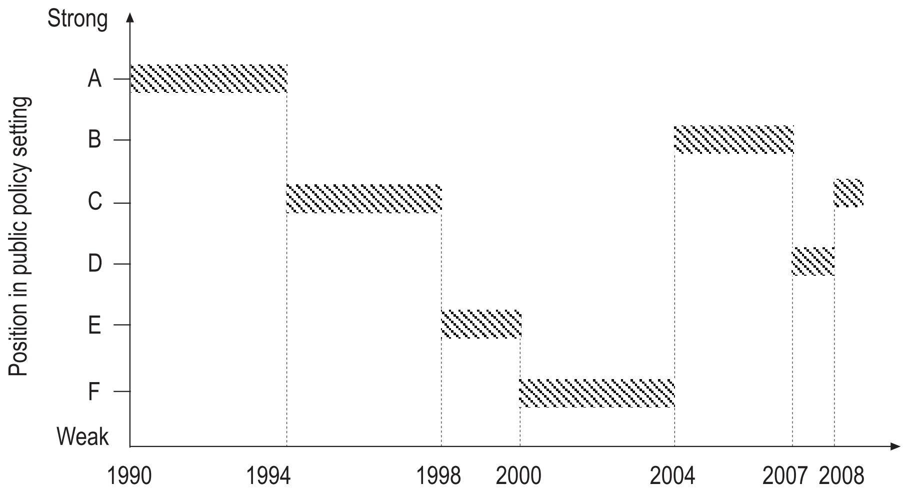


Status as of September 2008.

Source: Background Report, NKTH.

The frequency of these changes suggests that there is lack of a consensual, coherent view of how Hungary's innovation policy should be organised and governed. These changes are likely to send confusing signals to the potential or actual beneficiaries of innovation policy and to stakeholders of the Hungarian innovation system more generally. They have arguably had detrimental effects on the ability of actors to implement measures consistently and created much uncertainty among the potential and actual beneficiaries of the policy measures. This is likely to have decreased the effectiveness and efficiency of these measures considerably. Delayed decisions and tardy provision of promised funding unnecessarily complicate the planning of R&D projects, especially for businesses. In addition, the government itself has occasionally not lived up to promises made (most notably by not providing the foreseen co-funding for the Innovation Fund).

Figure 3.2. Changes in the institutional setting of the main Hungarian funding institution for innovation



	A	B	C	D	E	F
Status	Government office	Government office	Government office	Government office	Office under Ministry	Division of Ministry
Level of autonomy	Full	Full (with strong guarantees)	Full	Partial	Partial	No
Rank of the leader	Minister	State secretary	State secretary	State secretary	State secretary	Under secretary

Source: Background Report, NKTH.

The institutional positioning of the NKTH appears to have been less than optimal for some time. A number of other countries have gone in the direction of a clear separation of strategic political decision making in a responsible ministry and implementation through an independent agency (see Arnold, 2004). Austria (with the *Forschungsförderungsgesellschaft,* FFG), Finland (with TEKES) and Sweden (with VINNOVA) are examples of good practice in this area.

The regional level

In Hungary, central government authorities dominate innovation policy, and regional innovation policy has only recently gained some importance. This is partly due to the very uneven geographical distribution of R&D and innovation capacities, which are highly concentrated in the central region around Budapest, and to the fact that the administrative structure of Hungary does not readily lend itself to regional policy. The main regional administrative unit (the county, of which there are 19) is quite small and it is difficult to co-ordinate them. Another reason is the highly centralised regulatory framework under which public R&D institutions operate. Universities, which are the main R&D performers, are regulated by the Ministry of Education and Culture, and institutes of the Hungarian Academy of Sciences are governed by the HAS headquarters.

However, the importance of the regions has been increasing and is set to increase further, not least because of their role in EU Structural Funds, a major source of funding for innovation in the 2007-13 period. The countries' seven NUTS 2 regions receive development funds, of which a share is for innovation. Even so, the regions do not control most matters associated with innovation policy, which remains in the hands of the central government.

Important actors on the regional level are the president of the National Territorial and Regional Development Office (Secretary of State) and the Minister of Agriculture and Rural Development, who are responsible for regional development and cohesion. The Ministry of Economy and Transport, the National Development Office and the National Office for Research and Technology are also active at the regional level. At NKTH a vice-president oversees all NKTH activities related to regional innovation issues.

In response to the EU requirement for planning units at the regional level, regional development councils (RFT) were established. The regional development agencies (RFÜ), founded in 2004, act as the operational arm of the RFTs. In addition, all regions have established regional innovation agencies (RIÜ), which generally operate under the RFÜs (except in the central region). The regional innovation agencies in the seven Hungarian regions operate their own funding schemes for innovation promotion (the amount available autonomously is on average EUR 3-4 million a year per region).

Other actors active on a regional or local basis, such as the regional and local business support networks of the Hungarian Foundation for Enterprise Promotion (MVA), could play an important role in the implementation of regional innovation policies. Currently, MVA runs a network of 140 local enterprise agencies, set up jointly by local authorities, business associations and local chambers of commerce. Within this network, business incubators provide favourable conditions for micro and small enterprises. However, innovation policy in general is not yet one of the Foundation's main themes.

To sum up, while there have been steps towards greater regionalisation of innovation policy, more needs to be done, notably in raising the region's capabilities. So far, the regions serve mainly as statistical planning units and not as genuine actors in innovation policy. They depend heavily on the central government for both strategy and funding and, given the number of actors and the complexity of relations and interests, regional innovation strategies are difficult to co-ordinate (*e.g.* Borsi *et al*., 2007).

3.2.2. Policy mix

Hungary has a considerable number of instruments available at the national level for fostering science, technology and innovation. Indeed, the present innovation policy mix includes some 40 measures (for further details, see section 3.3). They address the objectives of the major STI policy documents of the past ten years through direct support for R&D and innovation. Most focus either on promoting business R&D and firms' innovation activities (20 schemes), or on fostering networking and co-operation (17 schemes, of which six are for international co-operation). Four schemes are dedicated to regional innovation and indicate a shift from a national toward a more regional focus.[51].

Taken together, the policy instruments address the major problems and challenges of the Hungarian innovation system. Quite often, they are modelled on successful measures in other OECD countries – for example, the co-operative research centres (KKK) and the regional knowledge centres (RKC) – but in some cases new methods have been tried (*e.g.* the Innovation Fund and its financing mechanism or the Innocsekk initiative). The number of instruments is likely to expand further in view of the increasing attention to the regional dimension of innovation policy and additional sources of funding, notably from EU sources.

Concerning the mix of measures, the following issues need to be addressed:

51. In the second half of the 1990s, the OMFB launched special funding schemes for regional innovation which were operated by the local chambers of commerce. They were later abandoned.

- Potential overlap of existing measures.
- Mix of generic and sector-specific measures.
- Mix of funding for applied and basic research.
- Articulation between national, regional and EU funding.
- Mix of direct and indirect support.

Potential overlap of existing measures

A number of instruments address the same policy objectives, so that there is some potential overlap. While this does not necessarily lead to redundancies (as target groups, concrete objectives, etc., may be different), there is a case for constant monitoring and review of the mix. So far, assessments that take a systemic view have not been carried out in Hungary.

The example of two of the most important programmes on industry-science collaboration illustrates the need to avoid overlaps: One of the first major schemes in this area established the co-operative research centres (KKK) involving firms, publicly financed public research organisations and higher education institutions. Under this programme, there were 19 centres in 2007. According to a recent evaluation, the KKK programme had a positive impact on the innovation activities of member or associated companies, the number of PhD students and the quality of education and training provided by the member universities, and the creation of new, technology-based (spin-off) companies. The programme thus seems to have met its objectives. Based on the evaluation recommendations, the scheme has been continued, partly as a new measure co-funded by the EU (with funding for newly established centres) and as a national initiative (providing continuing financial support for the already established centres).

However, another major initiative, the regional knowledge centres (RKC), launched in 2005, has similar objectives, although somewhat different requirements (a pre-condition was to set up new organisational units for academy–industry partnerships) and with strong public financial support (under the Pázmány Péter programme). This programme also led to the establishment of 19 centres (see Table 3.7).

There may be good reasons for fostering different forms (or a continuum) of industry-science co-operation with a set of different policy instruments. However, the rationale for this kind of multiplicity needs to be assessed carefully since there is a manifest danger of sending confusing signals to (potential and actual) programme participants and of diluting the impact of each programme. There is also a potential danger of overlap in the sense that programmes with the same main goal address the same target groups, albeit with somewhat different means. This shows the need for good co-ordination of and delineation between programmes.

The regional cluster initiatives are another obvious area of potential overlap. With the increasing importance of regional innovation policy, a considerable number of institutions are engaged in the formulation and implementation of regional cluster policies and related support schemes (see section 3.3). In the NHDP 2007-13, cluster development as a regional policy objective appears in both the Regional Operational Programme and the Economic Development Operational Programme, linked to the so-called "development poles". These poles address the problem of the uneven regional distribution of R&D and innovation capacities through integrated regional policies in areas of technological specialisation. The emergence of this new focus has been paralleled by growth in the organisational infrastructure (such as regional innovation offices), parts of which have been established very recently, and not always in a coherent manner. An even more recent framework for fostering linkages between actors is the new initiative for national technology platforms in areas of breakthrough technologies (see the following sub-section). While this will provide a basis for articulating Hungarian innovation policy with European policy, there is also a risk that the schemes promoting interaction may send blurred and sometimes conflicting signals to actors. The establishment of well-functioning governance and communication structures between the various initiatives is a challenging task.

NKTH has approached this problem by initiating a number of changes in the policy mix and in management practices. Similar or potentially overlapping measures have been grouped under a small number of headings, *e.g.* support for competitive technological innovation, improvement of the knowledge base, enhancement of international R&D co-operation. In order to increase predictability and transparency, eligibility and other criteria are to be guaranteed for three years.

Mix of generic and sector-specific measures

The relative weight of generic and technology-specific measures in Hungarian innovation policy has changed considerably over time. In the early 1990s, there were no technology priorities and measures were essentially generic/horizontal in nature (*e.g.* applied R&D with no technology priorities, academia-industry co-operation, international R&D co-operation, etc.) or addressed the transition towards a market economy. Legislation, IPR and institution building were the focus of policy attention. In the mid-1990s, after the immediate shock had been absorbed, two thematic (technology-based) programmes were launched (IKTA, for the application of ICT; and a biotechnology programme). When these programmes terminated, they were not followed up by new technology-specific actions. Since December 2004, however, new technology areas have been selected for support (*e.g.* mobile telecommunications, nanotechnology and biotechnology).

The sectoral orientation of innovation policy has been gaining in importance through the clusters and development poles and the newly established sectoral innovation technology platforms (see below). These platforms – of which 11 have been established so far – are supposed to bring together the stakeholders of the respective technology areas, following the model of the European technology platforms. Like their European counterparts, their task is to develop strategic roadmaps for the sector or technology, to inform policy and to advise on priority setting. Their organisational form will be defined mostly bottom-up, but their operations will be publicly funded. Some new platforms should be established in the near future.

This approach has its merits, notably with respect to the need to better align regional production and R&D capacities. However, policy implementation is a challenge, as it is necessary to co-ordinate a large number of national and regional initiatives. Policy also must ensure critical mass for the initiatives. At the same time, great care should be taken in order to avoid the pitfalls of outdated industrial policy approaches that limit competition and thus stifle innovation.

Box 3.1. Sector-specific policies: catching up in ICTs

ICTs have become an STI policy priority in Hungary as in other OECD countries. In recent years, developments in this area have been mixed (progress in some fields, but not in all). This calls for further policy actions.

Today, the Hungarian ICT sector is characterised by low R&D intensity in the sector's manufacturing firms, comparatively low broadband and Internet penetration rates (and relatively high costs) and the persistence of a digital divide (mostly between urban and rural areas). However, Hungary has quite a developed ICT market in terms of market size in relation to GDP, and has been an attractive location for multinational ICT companies which have invested in Hungary owing to cost advantages for production, but have also in recent years started to allocate R&D competences to their subsidiaries and to pursue R&D and innovation activities with Hungarian partners (*e.g.* Nokia, Ericsson, Siemens, Avaya, Motorola and Philips).

Increased interaction with Hungarian firms and research institutes can be traced at least in part back to dedicated programmes and initiatives, such as the Budapest University of Technology and Economics' Inter-University Centre for Telecommunication and Informatics, an offspring of the KKK programme. Recently launched cluster initiatives also have a strong ICT component. For example, ICT is the most important sector in the North Great Plain cluster initiative (which brings together some 50 enterprises, including T-systems, British Telecom and Wygomi Group). In the Jedlik Ányos programme, which supports long-term strategic research, a specific sub-programme is dedicated to ICT. In 2004, the Mobile Communications R&D and Innovation Centre was established as a test bed for future mobile communication technologies.

…/…

Box 3.1. Sector-specific policies: catching up in ICTs *(continued)*

Also, in the NHDP 2007-13 with its stronger focus on regional clusters and technology platforms, the thematic orientation of STI policy has become more pronounced, and ICT occupies a prominent place.

Yet, considerable weaknesses in policy and policy actions hamper the diffusion of ICT: In its 2007 report on e-government in Hungary, the OECD concluded that up to 2006 Hungary had experienced a phase of rapid catch-up in e-government readiness and performance, placing it among the better-performing countries of central and eastern Europe, but still below the EU average. However, progress has been slowing owing to factors which hamper progress in other STI policy areas as well (see OECD, 2007f, p. 229):

- Deficient e-government leadership, *e.g.* unclear and partly overlapping responsibilities and opaque accountability structures.
- Lack of budgetary concepts, *e.g.* no specific funding secured for e-government and budget provisions only on an *ad hoc* basis.
- Limited systematic monitoring and evaluation, *e.g.* no common public-sector approach to monitoring and evaluation.
- Fragmented cross-institutional collaboration frameworks, with substantial delays *e.g.* in the MEKIK (Hungarian Public Administration Interoperability Framework) project.

As a consequence, Hungary has slid from rank 27 to 30 in the UN's indicator for e-government readiness and is also not faring well in a number of other indicators related to public provision of ICT-based services. Thus, policy weaknesses in the field of e-government mirror difficulties in STI policy in general and have come to be a brake on Hungary's catching-up process in ICT. In this very important policy domain, better governance, stable funding, thorough monitoring and evaluation and efficient policy implementation are as needed as in STI policy in general.

Recent initiatives such as the Central Office for Administrative and Public Services (KEKKH) in 2007 or the adoption of the e-public administration 2010 strategy envisaged for summer 2008 are much needed steps in this direction as would be the completion of the implementation of MEKIK and other initiatives.

Sources: OECD (2007f); Veres (2007); European Commission (2008b).

Mix of funding for applied and basic research

The Hungarian Scientific Research Fund (OTKA) was established in 1991 to support (mainly basic) scientific research and to develop the research infrastructure and human resources. It is an independent agency, with full autonomy for defining its funding strategy, launching funding schemes and deciding on support for research projects. Owing to budgetary constraints, OTKA's annual budget has decreased to HUF 5.18 billion (about EUR 20.7 million) in 2007. By comparison, direct funding from the NKTH and the Structural Funds – which is overwhelmingly for applied research and development – is of the order of EUR 200 million each.

While this allocation pattern reflects Hungary's emphasis on strengthening the R&D and innovation capacities of business enterprises and to provide incentives for industry–science collaboration on projects of applied research, the relative scarcity of funding for basic research may have incited researchers applying for public funding to disguise basic research projects as applied research in order to tap into the substantially larger funds for the latter. Both HEIs and the Academy of Sciences have significant funding through the Research and Technological Innovation Fund. However, their shares can be expected to decrease in light of recent legislation aimed at increasing the share for business.

Thus, under present circumstances, some adjustment may be needed to secure enough competitive funding for high-quality basic research, *i.e.* a substantial increase in OTKA's budget. However, an expansion of financial resources for basic research needs to be complemented by better evaluation procedures at both the project and the institutional level.

Mix of direct and indirect support

Hungary's innovation policy uses both direct and indirect instruments to support R&D and innovation. Both types of public support have their specific advantages and disadvantages. Over time, and especially with the establishment of the Fund for Research and Technological Innovation, grants have become the dominant form of direct support for R&D, whereas previously, loans were favoured for close-to-market projects. In addition, there are several fiscal incentives for R&D and innovation. These include tax incentives for various forms of business R&D expenditure as well as tax exemptions for students performing R&D in related activities. These schemes are presented in more detail in section 3.3.

The main issue here is that little is known about the impact of the policy instruments currently in place. So far, programmes and funding schemes have been established, modified and discontinued on a more or less *ad hoc* basis, and not founded on systematic evaluation. Even less is known about the interaction of the various instruments. A rich and diversified toolkit of instruments has been put in place over the past years, and it is now time for a thorough assessment of the entire portfolio of programmes and instruments. It is likely that a system-wide assessment could produce the information necessary for improving the array of innovation policy instruments.

Mix of national, regional and EU funding

Two major sources of public resources for R&D and innovation could, in principle, provide a stable, long-term financial framework. The first is the Research and Technological Innovation Fund, through which NKTH is expected to allocate roughly EUR 200 million for R&D and innovation policy schemes in 2008. The second major source is EU funding. Co-funding from the European Regional Development Fund (ERDF) has been available since 1 May 2004. The NHDP 2007-13 will allocate on average EUR 138 million a year for R&D and innovation for competitiveness under the EDOP. In addition, the Social Infrastructure Operational Programme provides significant funding for research infrastructure, primarily at HEIs. Taken together, approximately EUR 200 million a year will be available for R&D and innovation activities from EU sources during the period to 2013.

The volume of European co-funding indicates the importance of EU innovation policy in Hungary. However, the impact of EU policy extends beyond funding, affecting policy orientation (shift towards regional innovation policy, thematic and technology priorities, etc.) and inducing the adoption of new practices (obligatory evaluation for all EU funding, which stimulates the diffusion of international good practices in monitoring and evaluation). These influences are likely to have a considerable impact. At the same time, there is a need to develop Hungarian capabilities in order to make the best possible use of EU funds and programmes and to develop and fund complementary policies for specific Hungarian priorities and policy goals. This requires close interaction among policy makers in innovation and regional policy and across a range of policy areas (education, support for SMEs, etc.).

3.2.3. Monitoring, evaluation and stakeholder involvement

Policy formulation in Hungary faces challenges similar to those in other countries in the region: a rapidly changing environment, internationalisation of the economy and greater social demand for better provision of public services It also faces the need to measure the impact of policy. This requires the systematic use of modern tools for monitoring and evaluating R&D and innovation policy measures.

Monitoring and evaluation

Some of the tools for evidence-based policy making – which include monitoring, benchmarking, evaluation, technology foresight, technology assessment, etc. – were used in Hungary relatively early. For example, Hungary was a pioneer among central and eastern European countries in conducting a foresight exercise in the late 1990s. However, such tools have not been systematically applied since and some have been used to a very limited extent.

Neither has monitoring been a standard practice at the project, programme or aggregate level. For example, the Mid-term STI Policy Strategy is the first document to set indicator-based targets against which to judge the attainment of goals. In 2007, the KTIT laid down a "monitoring strategy", according to which NKTH is tasked with in-depth monitoring of large or important programmes and projects, while financial and administrative criteria would be used to monitor those receiving smaller amounts of funding. The strategy was supported in a report by international experts on monitoring of STI measures.

While efforts were made in the mid-1990s to introduce systematic evaluations (two or three programmes were evaluated each year), evaluation of programmes or major projects has not been standard practice in Hungary's funding institutions. Evaluations carried out recently include:

- The first Hungarian Technology Foresight Programme (called TEP) was evaluated by an international panel of experts.
- The evaluation of the Co-operative Research Centre (KKK) programme.
- The *ex ante* and mid-term evaluation of the Economic Competitiveness Operational Programme (2004-06).
- Two (innovation-support-related) *ex ante* evaluations in connection with the Community Support Framework for 2007-13: a horizontal evaluation of the Operational Programmes of the New Development Plan and an evaluation of the EDOP as such.

As mentioned, no attempt has yet been made to assess comprehensively the current mix of instruments (both direct support and tax incentives). A thorough evaluation of the Research and Technological Innovation Fund – and the complex incentives it provides – would be extremely valuable in this context. External evaluations of programmes and funding schemes have been carried out only occasionally and on an *ad hoc* basis (*e.g.* the KKK programme). Anecdotal evidence suggests that some evaluations have been carried out internally. However, this does not compensate for the lack of external, publicly accessible evaluations.

Unlike other research institutions, the institutes belonging to the Hungarian Academy of Sciences publish detailed annual reports of their scientific, educational and society-related activity, and these reports are regularly evaluated by independent reviewers selected among the members of the Academy. However, evaluation of the Hungarian Academy of Sciences and its institutes appears insufficiently linked to funding criteria and the involvement of reviewers from abroad could be stepped up significantly.

The government has taken a number of initiatives to improve the situation. For example, the Law on Research and Technological Innovation of 2004 stipulates that all STI policy measures should be regularly evaluated by independent experts, with a view to achieving standards of international good practice. Meeting these standards would imply the systematic use of experts from abroad. Moreover, in 2005, the government passed a decree on the evaluation of R&D support projects and programmes. The increasing role of EU Structural Funds is likely to contribute to an improvement on current practice owing to the requirement that all policy measures financed by the European Union must be subject to *ex ante*, mid-term and *ex post* evaluations. As mentioned, the Mid-term STI Policy Strategy also sets indicator-based targets against which the attainment of objectives can be measured.[52]

In practice, and following a recommendation from NKTH based on its new monitoring and evaluation strategy (Arnold *et al*., 2007), KTIT has decided that evaluations will be carried out in the near future on the following programmes:

- Hungary's participation in the 6th Framework Programme.
- The Jedlik Ányos Programme.[53]
- The funding scheme for promoting R&D infrastructure.

Stakeholder involvement and policy dialogue

OECD experience shows that close involvement of major national innovation system stakeholders in strategy formulation and major STI policy decisions is beneficial: it can be instrumental in achieving a shared vision and in aligning the interests of major market and non-market actors in the innovation system. While practices differ significantly across OECD countries, there is evidence that countries with a strong record in innovation performance tend to build on trust or more generally on social capital built up over an extended period.

52. Whether these targets are operational and realistic is a different question which is not addressed here.

53. The call for tender for the evaluation of the Jedlik Ányos Programme was published in mid-November 2007.

In Hungary, there still seems to be relatively little stakeholder involvement in STI policy. Apart from the foresight exercise of the late 1990s, there have been few attempts such as the Innovation Forum in 2005 to stimulate public debate and stakeholder involvement in innovation policy. That forum was a series of public debates launched by NKTH to discuss promising fields for technological development (biotechnology, nanotechnology and information technology).

While broadly based policy dialogue plays a limited role in the formulation of Hungarian STI policy, there are instances of public debate. An example might be the discussions during the past few years of the role of the Academy of Sciences, its operation and the impact of basic research. These discussions have involved government, business, interest organisations and of course the HAS itself, and have been closely followed by both the scientific community and innovative companies. Many feel that the debate influenced the Academy's decision to launch an internal self-evaluation and its ongoing programme of reforms.

However, facilitating effective dialogue among a wide range of stakeholders and building platforms for such exercises is not yet standard practice in Hungarian innovation policy, as exemplified by discussions of the Revised Lisbon National Action Programme (which was open for comments to the general public just before its final approval) and by the new Mid-term STI Policy Strategy of 2007 and, in particular, its Action Plan, which have not been discussed with stakeholders.

The two high-level co-ordination and advisory bodies (TTPK and TTTT) could play an active role in stimulating broad-based public debate. Activation of these bodies is therefore warranted also from this perspective.

Statistical information for innovation policy

Both R&D and innovation-related data have been collected according to the OECD methodology since 1994. Hungary also participated in the two most recent Community Innovation Surveys (CIS 3 and CIS 4). This provides the basis for international benchmarking of Hungarian innovation performance (*e.g.* in the framework of the European Innovation Scoreboard). In terms of access to statistical information on individual institutions, programmes and projects, or to other relevant data, the situation appears less favourable. Shortcomings in this area need to be taken seriously since they present a potential obstacle to evidence-based policy making. Micro-level data are of particular importance for assessing the effectiveness and efficiency of individual policy measures.

In recent years several initiatives have sought to improve the situation. Based on its assessment of public R&D expenditures in 2004, the State Audit Office (ÁSz, 2004) made several recommendations that are of immediate relevance for policy (some were in fact taken on board when the government prepared the Law on Innovation). In 2006, the Science, Technology Policy and Competitiveness Advisory Board (TTTT) commissioned two reports: one to analyse the options to promote business R&D efforts and one to review methodological issues relating to the measurement of STI activities. Some of the recommendations have been incorporated in the STI Policy Strategy and its Action Plan. Both NKTH and the Ministry of Economy and Transport have also occasionally commissioned opinion polls and studies on a number of innovation-related issues.

Other potential data sources for STI policy analysis have not yet been tapped, either because of restrictions on access (*e.g.* tax-related data[54]) or because of the difficulties for merging different data sources. Public administrations also collect data which could be useful for STI policy analysis, but the databases are often narrowly focused on their primary use (management of funding schemes, accounting, project monitoring) and thus difficult to use. This situation will improve under a recent law on access to data for preparing decisions, which was approved by Parliament in June 2007.

However, the demand side is as important as the limitations on the supply side. Demand from policy makers for information and analysis for evidence-based policy making has, for various reasons, not been very strong in the past, not least because of frequent and often *ad hoc* changes in policy.

3.3. Funding of innovation

Over the past decades Hungary has developed a broad and differentiated set of instruments for public support for R&D and innovation. Following the general discussion of the mix of instruments in section 3.2.2, this section provides a more detailed account of the main funding instruments, their objectives, sources of funding, and role in the Hungarian innovation system.[55] It covers:

54. The easiest to use might be the tax returns of the Hungarian Tax Office (APEH), which contain data on the contribution to the Research and Technological Innovation Fund and on R&D tax allowance.

55. The analysis is mainly based on the policy reporting schemes operated by the European Union, the Trend Chart and ERAwatch databases. Additional sources are evaluation reports and recent policy studies.

- Co-funding by the European Union.
- The Research and Technological Innovation Fund (Innovation Fund).
- An overview of funding schemes at the national level.
- Innovation funding at the regional level.

As mentioned, two new sources of funding became available in 2004: co-funding from the EU and the Research and Technological Innovation Fund (with a novel funding mechanism). If appropriately used, they could sustain an elevated level of stable and predictable public support for innovation in the coming years.

3.3.1. Co-funding by the European Union

With EU accession in 2004, Hungary gained access to the Structural Funds, with an emphasis on R&D and innovation. Thus, the volume of EU funding and the institutional and procedural rules that accompany it (*e.g.* the obligation to conduct *ex ante* and *ex post* evaluations) influence Hungarian STI policy, including its orientations.

The New Hungary Development Plan 2007-13 (NHDP) – Employment and Growth is the framework document for allocating both the financial resources from the EU Cohesion and Structural Funds and the national contributions. In total, EUR 23.9 billion of EU development funds will be available for Hungary over the planning period, complemented by national co-financing and private capital. The NHDP has a number of objectives, including economic development, transport development, social renewal, environment and energy, regional development and state reform. The objectives of the National Strategic Reference Framework 2007-13 are translated into six thematic and territorial priorities and 15 operational programmes define the areas to which available funding is allocated.

The operational programmes include seven regional and eight "sectoral" programmes. The Economic Development Operational Programme (EDOP), approved by the European Commission in August 2007, is aimed at improving the competitiveness of the Hungarian economy. It has several specific objectives. One is to increase R&D and innovation capacity and co-operation. For this objective, EDOP funds of EUR 822 million (to be supplemented by a 15% national contribution) are envisaged over the current planning period. (Box 3.2 gives an overview of the EDOP priority areas in the area of science, technology and innovation.)

Box 3.2. EDOP STI priority areas

The Economic Development Operational Programme (EDOP) has the following STI priority areas:

- Promoting demand for R&D results.
- Developing R&D supply by providing the necessary human resources and infrastructure.
- Increasing the effectiveness of the research and innovation market by developing a network of bridging organisations, technology parks and incubators as well as technology transfer offices.
- Achieving a more effective utilisation of research results through enhanced co-operation between different domestic and foreign actors.
- Improving access to financial resources.

To address these objectives, the EDOP specifies so-called strategic priority axes:

- Priority axis 1: R&D and innovation for competitiveness;
- Priority axis 2: Complex development of enterprises (focused on SMEs);
- Priority axis 3: Improvement of modern business environment; and
- Priority axis 4: Financial instruments.

Priority axis 1 focuses on raising the level of domestic business R&D and innovation activities, on improving the utilisation of existing capacities and results, as well as on encouraging co-operation among R&D and innovation actors. This priority axis covers a wide range of activities, from support of corporate research projects to implementation of products or services, to the launch of new products and services, to the development of institutional and human resources related to R&D and innovation. Under the EDOP framework, the government – in co-operation with NKTH and the Hungarian Academy of Sciences – develops strategic areas for projects to address the EDOP's priorities. The resulting flagship projects (see Table 3.1) are part of the EDOP Action Plan for 2007-08. These measures are among the largest in terms of volume of funding in the Hungarian portfolio of public support instruments, and there is strong emphasis on R&D and innovation in SMEs and on cluster-oriented policies.

Table 3.1. Main EDOP strategy schemes and measures for the period 2007-08

Name of strategy	Measure no.	Name of measure	Overall budget (HUF billions)	Amount of funding	Number of targeted projects
The promotion of market-oriented R&D and the encouragement of research and technological co-operation	2007-1.1.1	Market-oriented co-operative RTD activities	13.0	Max 65%	130
	2007-1.1.2	Strengthening and developing research and development centres	9.0	Max 50%	20
Support of innovation clusters	2007-1.2.1	Support of the Polus innovation cluster	15.2	Max 70%	10
	2007-1.2.2	Promotion of innovation and technology parks	21.0	Max 50%	6
Encouragement of the independent innovation and R&D activities of the enterprises	2007-1.3.1	Support of innovation and research activities of SMEs	27.8	Max 50%	350
	2007-1.3.2	Increase in corporate R&D and innovation capacity	5.9	Max 40%	8
	2007-1.3.3	Support for technology-intensive start-ups	1.2	Max 80%	40

Source: Government of the Republic of Hungary (2007), Economic Development Operational Programme, CCI number: 2007HU161PO001, Version: GOP_070702_EN.doc.

3.3.2. The Research and Technological Innovation Fund

The main goal of the Innovation Fund[56] was to create stable conditions for funding private R&D and to establish a mechanism for project funding on a transparent and competitive basis. The body tasked with strategy formulation is the Research and Technological Innovation Council, which is mainly comprised of (non-governmental) representatives of the business and scientific communities. The Council defines the funding programmes and instruments and the related calls for proposals. These instruments are aimed to strengthen:

56. It succeeded the Technological Development and the National Research and Development programmes (KMFA and NKFP).

- R&D investments and innovation activities in the business sector (support for the development of new products, processes or services).
- Science-industry linkages through co-operation between universities and PROs and industry.
- Innovation capacities of the regions.[57]

The Innovation Fund has two main sources of revenue: the central government budget and the "innovation contribution" paid by medium-sized and large enterprises. This contribution is 0.3% of their adjusted net turnover. This contribution is reduced by the value of in-house R&D expenditure, as well as expenditure on R&D commissioned by a public or non-profit research organisation. Thus, the Innovation Fund seeks to re-allocate resources towards innovative activities, and to provide more stable funding over time. By law, funds must be allocated on the basis of open competition, and their use should be transparent and subject to monitoring.[58] Companies' contributions to the Fund amounted to about HUF 23 billion (EUR 92 million) in 2006.[59]

The law requires private contributions to be matched by a public contribution in the amount of the contribution by business two years prior to the budget year (based on Tax Office data). Although the Innovation Fund is by law independent, it has not been allowed to carry forward unspent funds. This can substantially reduce available funds. At the end of 2006 HUF 30.7 billion was forfeited.

The law on the Innovation Fund has been amended several times (Egyed *et al*., 2007). The amendments relate to:

- Budgetary constraints that make it difficult for the government to match the private contributions as envisaged; hence, the application of the rule determining the government's financial contribution was shifted from 2006 to 2007 (Budget Law of 2006).[60]
- The balance between basic and applied research. The Innovation Fund is supposed to support primarily applied R&D by business

57. A dedicated share (25%) of the Fund's money is earmarked to support R&D and innovation in the regions.

58. The innovation contribution has been adjusted in several respects: in 2004, the contribution was 0.2% and it was raised to 0.3% in 2006. In 2004, the rate for micro and small companies was 0.05%; they have been exempted since 2005.

59. Preliminary figure.

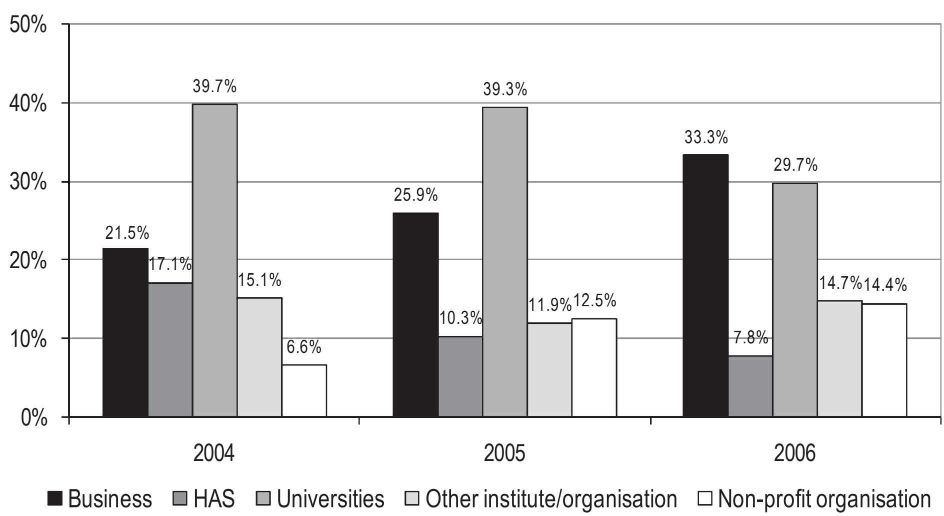
60. This provided a legal basis for a lower government contribution in 2006 (HUF 12.3 billion instead of the originally obligatory HUF 15.9 billion – the business contribution to the Fund in 2004). In 2007 the government fulfilled its commitments.

enterprises. Yet in the first years a considerable part of the funding went to public research organisations. Therefore, the Budget Law of 2007 earmarked 40% of all available funds to business in 2007, 50% in 2008 and 60% in 2009.[61]

- Eligibility has been extended to cover the social sciences, the cost of the country's S&T diplomatic network and the cost of the government's main advisory body.

In 2004, the first year of the operation of the Innovation Fund, 39.7% of the allocated funds went to universities, 17.1% to the Academy of Sciences and only 21.5% to business enterprises. However, the allocation of support has since changed significantly. By 2006 the business sector was the recipient of one-third of the total, while the shares of the universities and the HAS dropped to 29.7 and 7.8%, respectively. Taken together, public research organisations still received more than half of the Fund's support volume.

Figure 3.3. Support received from the Innovation Fund by type of institution, 2004-06



Source: NKTH (2006).

61. According to the most recent information this target will be reached in 2007, largely owing to the successful implementation of regional innovation promotion programmes.

Table 3.2. Support received from the Innovation Fund by type of institution, 2004-06

(HUF millions)

		2004	2005	2006
Non-profit organisations		1 478.0	3 458.5	3 825.4
Companies		4 819.4	7 175.1	8 826.4
All public research organisations		16 164.8	17 035.0	13 832.4
of which:	*HAS*	*3 844.8*	*2 851.9*	*2.065.9*
	Universities	*8 923.5*	*10 881.2*	*7. 868.5*
	Others	*3 396.5*	*3 302.1*	*3.898 0*
Total		22 462.3	27 668.6	26 484.3

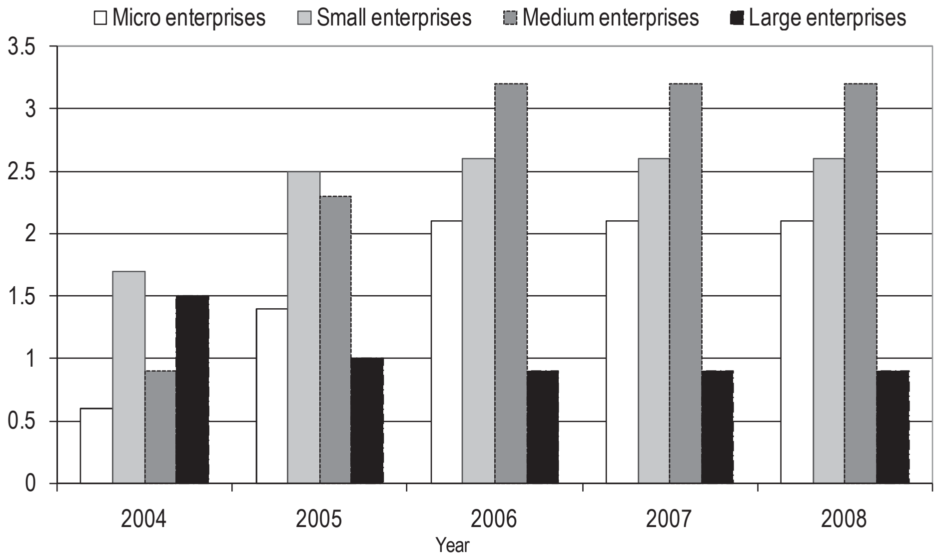
Source: NKTH (2006).

Of the HUF 8 825 million allocated to the business enterprise sector in 2006, HUF 7 215 million (80%) went to SMEs (564 in total), and HUF 1 611 million to large companies. This pattern of distribution is consistent with the fact that nearly every programme supports SMEs, and some exclusively address SMEs (the regional innovation programmes and the Irinyi János and Kózma László programmes which support innovation projects, especially innovation-related services for SMEs). Creating critical mass and increasing the absorptive capacity of SMEs are important objectives.[62] Micro-enterprises and medium-sized enterprises were able to achieve an impressive increase in both the volume and the share of total support from the Innovation Fund (Figure 3.4). The gain by medium-sized enterprises, whose innovation performance appears to have been a weakness of the Hungarian innovation system, is a promising sign. Despite the merits of a strong focus on support for SMEs, the extraordinarily low share of large enterprises (just about a tenth of the total, see Table 3.3) – unless compensated elsewhere – requires careful consideration.

62. Several "best practice" examples of successful innovation projects can be found in companies such as AnaLogic Kft., Genetic Immunity, Graphisoft Rt., Holografika Kft., or Solvo Rt.

Figure 3.4. Support from the Innovation fund by firm size, 2004, 2005, 2006 (%)

In billion HUF



Source: NKTH (2006).

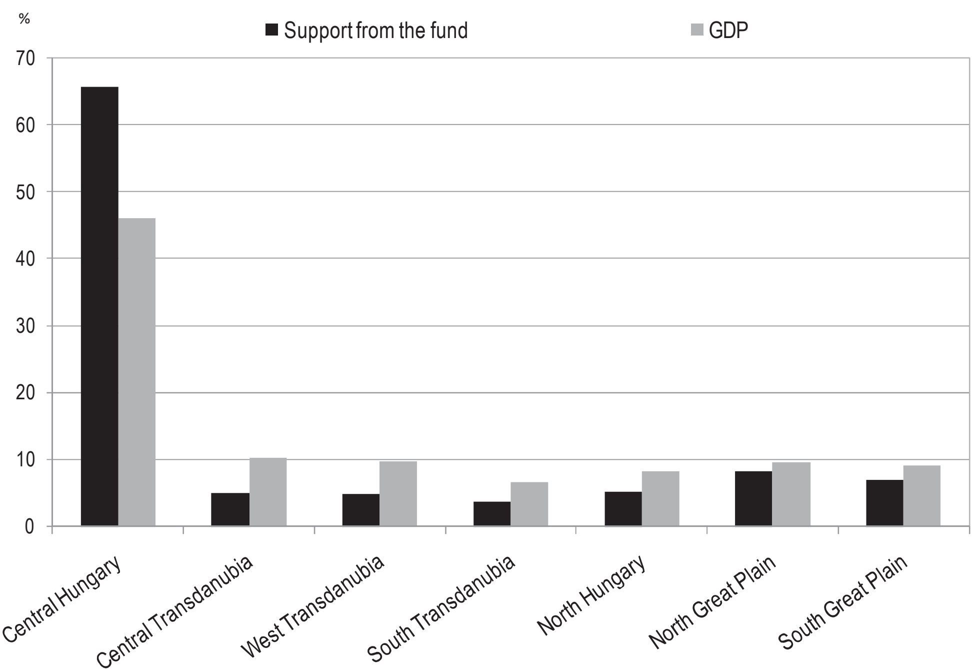
Table 3.3. Innovation Fund: support by firm size, 2004, 2005, 2006 (HUF billions)

Size category	2004	2005	2006
Micro-enterprises	0.6	1.4	2.1
Small enterprises	1.7	2.5	2.6
Medium-sized enterprises	0.9	2.3	3.2
Large enterprises	1.5	1.0	0.9
Total	**4.7**	**7.2**	**8.8**

Source: NKTH (2006).

It is a legal requirement that at least 25% of the Innovation Fund's allocations should go to regional innovation activities. This provision is meant to address the uneven distribution of R&D activities across the country. The central Hungarian region, which includes Budapest, receives most of the support granted by the Fund. The share of the support to the central Hungarian region is even higher than the region's share of GDP (Figure 3.5). This is not surprising, as much of the country's R&D capacity is located in central Hungary.

Figure 3.5. Support from the Innovation Fund by region, 2005



Source: NKTH (2006).

It remains to be seen whether the Fund is achieving its main objectives, including via an ongoing adjustment of its instruments, to strike a better balance between basic and applied research and between business enterprises and public research organisations as beneficiaries. There are some indications that it has not yet been entirely successful in achieving other major goals, notably to ensure greater stability in funding and greater transparency. This is mainly due to the modifications with respect to the contribution of government, the low degree of predictability of calls for proposals and the impossibility to carry forward unspent sums. A comprehensive assessment of its impacts will require a full evaluation; only a few programmes have been evaluated so far.

The funding mechanism of the Innovation Fund provides a powerful incentive to business enterprises either to perform R&D themselves or to purchase R&D services (in order to avoid paying the innovation contribution) since there is no (or little) opportunity cost involved (the innovation contribution would have to be paid anyway). Some firms – especially those that do not have their own R&D capabilities or see no need for them – may find it attractive to commission some R&D from public research organisations even if the return on the investment is very low. This may distort the market for R&D services. On the other hand, it may be argued that engagement of business enterprises with universities or public research organisations may induce a long-term change in behaviour and sustained and sound relations between them. However, it will have to be seen whether the Innovation Fund is the most efficient way to achieve this.

The 2005 *Economic Survey of Hungary* (OECD, 2005) discussed the Research and Technological Innovation Fund in some detail and called for an impact assessment of the "offset option" that is an essential part of this instrument. The questions raised above should be addressed in such an assessment, which has not yet been carried out. Other issues are the interaction with other instruments of public support for R&D, notably the existing tax incentives.

3.3.3. Funding schemes at the national level

As mentioned above, Hungary's system of direct support for R&D and innovation at the national level consists of about 40 measures, most of which focus either on promoting business R&D and firms' innovation activities (20) or on fostering networking and co-operation (17, of which six for international co-operation). Four are dedicated to regional innovation. Over time, and especially with the advent of the Innovation Fund, there has been a shift towards the use of grants (loans were previously used to support close-to-market R&D and innovation projects).

Given the low level of business R&D expenditure, especially among SMEs, stimulation of business R&D and innovation activities is one of the main challenges for Hungarian innovation policy, and most measures address this issue. The Hungarian taxation system also provides incentives for promoting different responses to the challenges facing the country's national innovation system (NIS).

Table 3.4 summarises the STI funding schemes. In addition, are several other schemes support R&D and innovation. The Hungarian Scientific Research Fund (OTKA) provides financial support for basic research, international co-operation, research infrastructure development and fellowships to young scientists. OTKA supports Hungarian researchers in the life sciences, the natural sciences and engineering, and the social sciences, with a distribution of roughly 40/40/20. Universities are the main beneficiaries with a share of some 60 to 65%, while HAS institutes account for 25 to 30% of OTKA's funding. Companies are also eligible for funding by OTKA, but the volume of support and the number of projects are small. OTKA's annual budget has been decreasing steadily, even in nominal terms, in recent years, from HUF 5.85 billion (about EUR 23.4 million) in 2005, to HUF 63 billion (about EUR 22.5 million) in 2006 and to HUF 5.18 billion (about EUR 20.7 million) in 2007.

In addition to these direct support schemes there are also fiscal incentives for R&D and innovation. As in the case of direct measures, it is hard to assess their impact, owing to the lack of the necessary data. These fiscal measures are:

- The deductibility of R&D expenditure from the contribution to the Innovation Fund (discussed above).
- Companies can deduct 200% of their R&D expenditures from their taxable income.[63] A 300% tax allowance is applicable if a company laboratory is located at a university or public research institution.
- Companies are eligible for a tax allowance based on the wages of researchers working in basic or applied R&D projects (maximum 10% of total wages).

63. Since R&D expenditure is recognised as normal business expenditure this implies that taxable income is reduced by an additional 100% of this expenditure.

- Students are exempt from paying personal income tax on their student salaries[64] (up to the level of the official minimum wage) if these are earned by performing activities in the fields of education, research or other services directly related to R&D (such as employment as librarians, laboratory assistants, or demonstrators).
- From January 2003 there is also an option for tax-free investment reserves up to HUF 500 million, accelerated amortisation of ICT investments, 70% tax relief for R&D donations and faster tax reimbursement, etc. These measures contribute to making the framework conditions more favourable to investment in innovation.

Table 3.4. STI funding schemes (October 2007)

Measure (HU_Trend Chart Id. #)	Objectives of STI policy					
	1. Increase the share of innovative firms	2. Networking and collaboration capacity building	2.2. Promoting international co-operation.	3. Human resource development	3. Facilitating regional innovation system	5. Developing R&D infrastructure
Application-oriented co-operative RTDI (HU_1)	X	X				
Social conditions of RTDI - MEC (HU_13)		X	X			
Participation of SMEs in FP6 (HU_22)	X	X	X			
'Jedlik Ányos' Programme (HU_24)	X	X		X		
RTDI infrastructure of public organisations (HU_51)						X
RTDI co-operation (HU_55)		X				
Support to new firms - start-ups, spin-offs (HU_58)	X					
Development of corporate research centres (HU_69)	X					X
SME RTDI activities (HU_73)	X					
Agri-food RTDI projects - GAK (HU_74)	X					
200% of R&D expenditures deductible (HU_84)	X					
Employment of PhD, MSc or MBA students (HU_85)				X		
'Pázmány Péter' Programme (HU_87)		X		X	X	
'Déri Miksa' Programme (HU_88)	X	X	X			

64. Student salaries are defined as revenues received by full-time students enrolled in undergraduate or graduate courses at accredited tertiary education institutions; and who are paid by those institutions or by companies whose premises are located on property owned by a tertiary education institution or are owned by a tertiary education institution.

Table 3.4. STI funding schemes (October 2007) *(continued)*

Measure (HU_Trend Chart Id. #)	Objectives of STI policy: 1. Increase the share of innovative firms	2. Networking and collaboration capacity building	2.2. Promoting international co-operation.	3. Human resource development	3. Facilitating regional innovation system	5. Developing R&D infrastructure
Innovative Education Support System (HU_89)				X		
Information infrastructure for R&D - KFIIF (HU_90)					X	
Co-operative Research Centres - KKK II. (HU_91)	X	X		X		X
Mobile Communications RTDI Centre (HU_92)	X					
Regional Innovation Agencies - RIÜ (HU_93)					X	
Large international R&D projects - NAP2005 (HU_94)		X	X			
Innocsekk - innovation voucher (HU_96)	X				X	
'Asbóth Oszkár' Programme (HU_97)		X	X			
Large R&D centres - NAP Nano (HU_98)		X	X			
'Irinyi János' Programme (HU_99)	X					
Establishing model incubator for biotech (HU_100)	X	X				
IPR protection for SMEs abroad (HU_103)	X					
'Baross Gábor' Programme (HU_104)						
'Baross Gábor' Programme II. (HU_105)	X	X				
'Kozma László' Programme (HU_106)	X	X		X		
RTDI in supplier networks - INTEG2006 (HU_107)		X				
'Teller Ede' Programme - NAP BIO 2006 (HU_108)						
RTDI management - INNOTETT_06 (HU_110)	X	X				

Note: Programmes in **bold** have been or are financed by EU Structural Funds.

Source: Trend Chart/ERAWATCH October 2007.

Table 3.5 summarises the major measures for providing direct support to R&D and innovation activities in Hungary.

Table 3.5. Direct measures in support of business RTDI activities in Hungary by STI policy objectives

Policy objective	Funding scheme (short description)	Allocated budget (EUR millions)	Note
Supporting the development of new products, processes or services	**Application-oriented R&D projects Trend Chart: HU_1**	**28.0**	**2004-2006**
	Innovation & research activities of SMEs – HU_73: R&D, absorptive capacity and academy-industry link building	**18.44**	**2004-2006**
Strengthening the adaptation and utilisation of R&D results and the establishment of new technology-based firms	**Support to new, technology and knowledge-intensive micro-enterprises and spin-off companies – HU_58**	**6.6**	**2004-2006**
	Baross Gábor Programme, Supporting technological innovation in the South-Plain region – HU_104 : Spin-off orientation	2.0	2006-2007
	5LET 2005 (sub-programme of the Irinyi János Programme) - HU_99: Individual inventors promotion in commercialisation of their R&D results and technology ideas	5.6	2006-2008
Innovation services to firms and service capacity building	Innocsekk – HU_96: Voucher to micro and small enterprises for ordering innovation services	20.0	2005
	IPR protection for SMEs abroad – HU_103	0.24	2006-2009
	Baross Gábor Programme, Supporting regional innovation networks – HU_105	19.2	2006
	Establishing a model incubator centre for biotechnology (BIOINKUB) – HU_100	4.0	2005-2007
Improving the quality of corporate research infrastructure	**Development of corporate research infrastructure related to the creation of new RTD jobs – HU_69**	**8.4**	**2004-2006**
Strengthening the technology base of industry	Agri-food RTDI projects	10.0 12.0	2004 2005
	Mobile Communications R&D and Innovation Centre – HU_92	8.0	2005-2008
	Setting up a Nanotechnology Research Laboratory – HU_98	7.2	2006-2009
Human resources development in business	Kozma László Programme – HU_106: Support for the employment of researchers	3.2	

Note: Programmes in **bold** have been or are financed by the EU Structural Funds.

Source: Trend Chart/ERAWATCH October 2007.

Table 3.6. Direct measures in promoting the networking capabilities of firms in Hungary

Policy objective	Funding scheme	Allocated budget (EUR millions)	Period covered
Network building and co-operation	Co-operative Research Centres – Trend Chart HU_91	8.0	
	Pázmány Péter Programme: Regional Knowledge Centres at Universities – HU_87	36.0 23.0 10.0	2004 2005 2006
	Technological innovation in supplier networks – HU_107: to enhance the innovation capabilities of SMEs in order to prepare them to establish long-term supplier relationships with medium-sized or large enterprises, called integrators	6.9	2006-08
	Asbóth Oszkár Innovation Programme for Cutting-edge Industries – HU_97: to accelerate the evolution of the cutting-edge industries in health, biotech and agriculture-based renewable energy-resources by promoting the establishment of technology platforms and innovation clusters.	26.0	2005-09
	Jedlik Ányos Programme – HU_24	44.0	
	S&T co-operation of businesses and publicly financed research units HU_55	**12.0**	**2004-06**
	Several other schemes, listed in Table 3.4, among others, aim to strengthen industry-academy links as well (HU_1, HU_105 and HU_106)		
International co-operation	Participation of SMEs in EU 6th Framework Programme – HU_22		
	Déri Miksa Programme – HU_88: to strengthen firms' participation in EUREKA projects; to improve academia-industry co-operation and the options of Hungarian exploitation of research results achieved by participating in EU R&D projects	4.0	2004-06
	Large international R&D projects – HU_94: to support large, interdisciplinary R&D projects, conducted by bi- or multilateral co-operation, including NoEs or IPs financed by the EU RTD FP	9.6	2005-07

Note: Programmes in **bold** have been or are financed by the EU Structural Funds.

Source: Trend Chart/ERAWATCH October 2007.

Schemes to promote collaboration and public-private partnerships (PPPs)

Weak links among actors, in particular among enterprises and higher education institutions and public research organisations, are generally perceived as another major weakness of the Hungarian innovation system. From the mid-1990s, policies have sought to promote networking by both large firms and SMEs. Table 3.6 lists the current measures.

The Co-operative Research Centres (KKK) programme has been positively evaluated and continues in a modified form. In addition, regional knowledge centres have been established at universities (under the Pázmány Péter programme) to set up new organisational units for strengthening academy-industry links and co-operation. As the goals of these programmes seem very similar, there is the danger of overlap or duplication.

As part of NKTH's monitoring exercise for strategy setting, two other schemes – the Asbóth and Pázmány Programmes – have also been subject of pilot assessment (Arnold *et al*., 2007). According to the report, industrial exploitation of university capabilities is weak and universities still lack experience in addressing industry needs, which provides justification for such programmes.

In October 2007 NKTH launched a new support scheme, the technology platforms. Its objectives are similar to those set up by the European Commission in the 6^{th} Framework Programme for RTDI. Companies are invited to combine their efforts to identify strategic sector-specific RTDI objectives and action plans. Public support is provided to establish the platform and start the strategy formulation process. According to the NKTH, 11 platforms have been established so far (including biotechnology, nano-technology, pharmaceuticals, humanities, fisheries, food and automotive technologies, etc.), with total public support of EUR 1.6 million (100% public funding in the form of grants). A new round has recently been launched in order to broaden the scope of technologies covered.

Here again, it important to be aware of the possibility of overlaps and redundancies between programmes and efforts should be made to examine the programmes carefully and clearly delineate them.

3.3.4. Innovation funding at the regional level

The regional level has gained considerably in importance in Hungarian STI policy, especially following the 2004 Law on Research and Technological Innovation. Schemes with a specifically regional focus financed by the Research and Technological Innovation Fund were announced in October 2004 and launched in 2005. The three most important programmes are: the establishment of the regional innovation agencies, the Baross Gábor programme, and the Pázmány Péter programme. Another initiative, Innocsekk, was launched in 2005 to back demand for innovation-related services by providing a voucher to micro and small enterprises in need of such services. These centrally devised innovation policy schemes have sometimes predominantly regional STI policy targets. In some cases, the content of these schemes is designed jointly with the regional development councils and regional development agencies. Finally, cluster-oriented policies are gaining in importance in Hungarian (regional) innovation policy.

Supported by a specific national scheme, seven regional innovation agencies (RIÜs) serve as a bridge between government agencies and independent regional innovation organisations. Their activities are based on the regional innovation strategies and are expected to facilitate regional innovation processes, co-ordinate technological innovation networks, and provide innovation-related services. They operate as networks, based on partnership among interested partners. These agencies work to improve co-operation between the different organisations, co-ordinate funds available for innovation, generate additional funding, and promote the creation of national and international innovation networks.

The RIÜs have three main sources of funding for RTDI projects: contributions from the central government budget, 25% of the Research and Technological Innovation Fund to be spent on promoting RTDI activities at the regional level, and co-financing from the EU. They receive funding from the central level for the first three years of their operations, after which regional players are expected to take over. Experience with similar innovation bridging organisation indicates that a legally independent organisation could perform such activities much more efficiently than a network. In that case, the RIÜ would be a service and bridging institution that creates new regional programmes.

Regional innovation strategies are seen as important pillars for the successful achievement of regional development objectives. They have now been devised for all seven regions. The regional development councils (RFTs) and regional development agencies (RFÜs) devise and implement regional development strategies, which include a chapter on innovation issues with three main objectives:

- To build institutions which are still lacking in the regional innovation system and to reinforce existing institutions and organise them into a network.
- To improve the innovation performance of enterprises with the help of specialised programmes.
- To provide support for high value-added, knowledge-based activities.

The RIÜ run their own funding schemes for innovation promotion (each has an average of EUR 3 to 4 million a year). They formulate their programmes according to the specific needs and priorities of their regions in the framework of the Baross Gábor programme.

The Baross Gábor programme to support regional innovation networks was devised at national level, but addresses the challenges of the different regions. It is composed of seven rather different regional goals, each tailored to the needs of the respective region. The planning process is driven by the RIÜs. The main targeted themes differ according to the regions but cover the following main topics: support for transfer and service innovation; support for product and service innovation; creation of regional innovation clusters; support for SMEs and spin-off companies; development of R&D and innovation infrastructures.

The Pázmány Péter programme funds the creation of the so-called regional knowledge centres. It aims to establish professional and regional centres of excellence in co-operation with companies and other research organisations in order to transform R&D results into marketable new products and technologies. In 2004, the NKTH announced a first call for proposals. After the first call for proposals, in 2005 and 2006 new regional knowledge centres were established country-wide.

An evaluation of the programme in 2006 concluded that it achieved major objectives and that resources had been used quite efficiently. In the first two years of its operation, the programme involved more than 800 researchers. Both scientific and commercial output seems to have been rather good (900 publications, 33 PhD dissertations, 57 new products, 11 patents and 13 newly establish companies).

The Innocsekk programme takes a regional approach to innovation by SMEs. It allows companies – through a voucher – to acquire the business, innovation and R&D services needed for their innovation processes. It supports innovative activities of micro and small enterprises, by promoting the use (and thus the demand for) innovation-related services. The voucher entitles them to a variety of innovation-related services relating to R&D, incubation, technological prototyping, measurement and quality control, project management, innovation marketing and intellectual property rights, purchase of licences, and technology transfer. Applications are submitted to the RIÜs which operate as local points of expertise and help enterprises with the tendering. Final funding decisions are made by NKTH three or four times a year.

The first three years of the programme's operation show that it was able to reach many SMEs that had not previously applied for support from the Innovation Fund. By mapping innovation actors in the region, the programme also helped to identify R&D providers, bridging institutions, and consultants able to provide effective services. Originally, the Innocsekk programme was to last until the end of 2007. However owing to great interest among firms, the resources allocated for the programme (some EUR 20 million) were used up earlier, and the NKTH suspended the programme in October 2006. However, the programme will continue in 2008, with some modifications based on feedback from the final evaluation in November 2007, under the EDOP.

As a result of these developments in regional innovation policies and programmes, the weight of the regions in innovation policy has increased. However, adequate articulation of the different levels of policy remains an issue. The new measures described above have predominantly been defined and launched by the central government. So far there are few policy measures taken at the regional level to address the specific challenges faced by the region concerned. However, NKTH is preparing a new set of measures relating to the priorities identified by the seven regional development councils. The North Great Plain Region exemplifies recent regional efforts to achieve a more decentralised governance system (see Box 3.3).

Box 3.3. The North Great Plain Region

The North Great Plain Region, situated along Hungary's eastern border, includes three counties (Hajdú-Bihar, Jász-Nagykun-Szolnok és Szabolcs-Szatmár-Bereg). It is favourably situated on the east-west transport corridor. Research and development, generally closely related to the higher education sector, is one of the region's strengths. It ranks second in terms of R&D intensity, third in terms of R&D expenditure per inhabitant, and fourth in terms of the share of R&D employees in total employment. By domestic standards, it has a very strong research base. It has the University of Debrecen – one of the country's largest regional higher education centres – and colleges in Debrecen, Nyíregyháza, Szolnok, Hajdúböszörmény, Jászberény and Mezõtúr. However, there are no well-established networks connecting business and academia that could facilitate the utilisation of research results of these knowledge institutions and their translation into innovations.

The science base of the region builds on the University of Debrecen and on the Institute of Nuclear Research of the Hungarian Academy of Sciences. The region's main research topics are food technology, agro-ecology and life sciences. After the first call for proposals under the Pázmány Péter programme, two new regional knowledge centres were established: the Food-Energy regional knowledge centre in Nyiregyhaza and the Genomnanotech centre in Debrecen.

The region has innovative health, agricultural and information technology industries. Priorities include strengthening the research base in agricultural, thermal and life sciences, which already have a significant research potential, as well as placing more emphasis on areas with an increasing share in the global economy (pharmaceutical industry, genomics and diagnostic development, nano-technology, functional food, renewable energy sources), as well as IT development. It also has much to offer in terms of tourist attractions. A potential natural resource and the most valuable asset of the tourism industry are mineral and thermal water reserves.

…/…

Box 3.3. The North Great Plain Region *(continued)*

In 2006, the region drew up a regional innovation strategy which stresses the importance of technology and knowledge diffusion, and the continuous regeneration of technological innovation. Based on developments in the European Union and the endowment of the North Great Plain Region, its overall aim is to support market-based innovations focused on the region's endowments, notably in the health, agricultural and IT industry, and to encourage their diffusion.

The North Great Plain Regional Development Council is the highest-level decision-making body in the region. It prepares the region's financial plans and takes part in allocation decisions regarding the various national and EU funds. The Council founded the North Great Plain Regional Development Agency, with headquarter in Debrecen, which began operations on 1 July 1999. Its main tasks are to ensure that the work of the Regional Development Council is carried out and to realise the objectives of the Regional Development Programme. In addition, it plays an important role in the establishment of the regional Future Prospects initiative and aims to involve as many people as possible from the region. In the course of its activity, the agency established co-operative relations with regional, national and international organisations, launched many new initiatives, co-ordinated the drafting of the regional programme documents, co-ordinated the National Strategic Frame of Reference at regional level, and prepared the independent regional operational programme.

Partly financed by NKTH via the Research and Technological Innovation Fund, the Észak-Alföldi Regional Innovation Agency (INNOVA) was set up in 2005 by the North Great Plain Regional Development Agency (as lead partner) and three regional innovation and technology transfer centres: The foundation of INNOVA was also supported by several economic development organisations. INNOVA forms a regional and trans-regional innovation network, harmonises regional innovation processes among innovation service providers, the university knowledge centres and innovative enterprises. It assists in the implementation of innovation initiatives (Baross Gábor Regional Programme Package, Innocsekk, 6th EU Framework Programme), publishes calls for proposals and manages and finances innovation programmes carried out by SMEs and knowledge centres.

In the last three years INNOVA has taken centre stage in regional innovation processes. It conducted a survey to identify the innovation activities of enterprises operating in the region, their connection with and knowledge about the Agency and about available innovation support programmes. According to survey results four out of five companies in the region face considerable barriers to innovation. In 58% of cases the shortage of finance is the main barrier; other important barriers are an unfavourable economic environment and capacity-related barriers (mentioned by more than 20%). Programmes such as Innocsekk and the Baross Gábor programme are well received and seen as helping to overcome these hurdles. From 2006, the Regional Innovation Agency helped to implement three cluster initiatives. The most important is the ICT cluster, which now counts more than 50 SMEs and MNEs. T-systems, British Telecom and Wygomi Group are among the most important members of the cluster.

To ensure continuity of activities beyond the three years of national funding after which the regional players are expected to take over the financing of RIÜ activities, INNOVA Észak-Alföldi Regional Innovation Agency Ltd. was founded by six regional organisations: the North Great Plain Regional Development Council, the University of Debrecen, the College of Nyiregyhaza, the College of Szolnok, the North Great Plane Regional Presidency of the Hungarian Association of Innovation and the Northeast Hungary Regional Development Agency.

Source: INNOVA Észak-Alfold Regional Development and Innovation Agency (2007).

Table 3.7. New Regional University Knowledge Centres

Supported Knowledge Centre	Region	Year
Research and Development in the Foodchain Regional Knowledge Centre, Budapest	Central Hungary	2004
Cellcommunication Knowledge Centre, Budapest	Central Hungary	2004
Transportation Informatics and Telematics Knowledge Centre, Budapest	Central Hungary	2004
IT Innovation and Knowledge Centre, Budapest	Central Hungary	2005
E-Science University Knowledge Centre, Budapest	Central Hungary	2005
Regional Knowledge Centre for Environmental Industry Based on Natural Resources, Gödőllő	Central Hungary	2005
Szentágothai János Medical Knowledge Centre, Budapest	Central Hungary	2006
Advanced Vehicles and Vehicle Control Knowledge Centre, Budapest	Central Hungary	2006
Information Security and Environment Security Knowledgde Centre, Veszrpém	Central Transdanubia	2004
Regional Knowledge Centre for Material Science and Technology, Dunaújváros	Central Transdanubia	2004
FOOD-ENERG Regional Knowledge Centre, Nyiregyháza	North Great Plain	2004
GENOMNANOTECH Regional Knowledge Centre, Debrecen	North Great Plain	2006
EGERFOOD – Regional Knowledge Centre, Eger	North Hungary	2005
Regional Knowledge Centre for Knowledge Intensive Mechatronical and Logistical Systems, Miskolc	North Hungary	2006
Environmentaland Nanotechnology Regional Knowledge Centre, Szeged	South Great Plain	2005
Neurobiological Regional Knowledge Centre, Szeged	South Great Plain	2006
MEDIPOLIS Regional Knowledge Centre, Pécs	South Transdanubia	2005
Regional Knowledge Centre for Vehicle Industry, Győr	West Transdanubia	2005
Regional Knowledge Centre for Forest and Wood Utilization	West Transdanubia	2006

Source: NKTH.

The cluster concept currently has a prominent role in regional policy and has been applied in economic policy since the late 1990s. It was applied in the Széchenyi Plan, in which a regional clusters sub-programme provided financial assistance for the establishment and development of cluster management and for their operations and services. This sub-programme followed a top-down approach to try to encourage cluster formation. Between January 2001 and December 2002 19 cluster initiatives received support of up to EUR 100 000 per application under this grant scheme.

Table 3.8. Innocsekk support by regions

Region	Number of proposals	Eligible proposals	Success rate (%)	Value of vouchers (HUF millions)
Central Hungary	223	65	29.1	1 209
Central Transdanubia	80	30	37.5	487
North Great Plain	124	32	25.8	463
North Hungary	76	44	57.9	805
South Great Plain	112	26	23.2	542
South Transdanubia	117	40	34.2	657
West Transdanubia	73	18	24.7	327
Total	805	255		4 490

Source: INNOVA 2007.

When the Széchenyi Plan was discontinued in 2002, the Ministry of Economy and Transport kept the promotion of clusters on the agenda.[65] During the period 2005-06 23 cluster organisations received HUF 447 million in financial support in the framework of the Economic Competitiveness Operational Programme. The sectors supported were: textile, automotive, fruit processing, food industry, thermal energy and water, tourism, construction, crafts, manufacture of precision instruments, and electronics. The current Mid-term STI Policy Strategy also seeks to develop and strengthen various forms of clusters, albeit in rather general terms. Funding will mainly be through the New Hungary Development Plan. The Research

65. More specifically, the cluster-related investment programme of the Széchenyi Plan (Establishment of Regional Clusters) became part of the Economic Competitiveness Operational Programme between 2004 and 2006, as its priority 1.1.3,:Establishment and reinforcement of first tier suppliers, and its sub-programme B: Supporting the development of services for clusters.

and Technological Innovation Fund and other national sources do not focus on clusters.

Up to now, the R&D and innovation dimension of cluster development has been little emphasised. One exception is the Asbóth Oszkár programme of NKTH which financed two large cluster projects. Recently, however, RTDI have received greater attention in cluster-oriented policies. RTDI-oriented cluster policies are explicitly named in the Economic Development Operational Programme of the New Hungary Development plan 2007-13 (1.2. Supporting Innovation Clusters), and are part of the 2007-08 Action Plan of the EDOP. The measure aims to strengthen accredited innovation pole clusters based on existing RTDI infrastructure, with concentrated, market-based competence centres (incubators, innovation and technological parks) offering tailor-made RTDI services and providing the necessary research and ICT infrastructure for members of the clusters. A proposed scheme, called Construction 1.2.1: Supporting Innovation and Technology Parks allocates approximately EUR 109 million for this purpose, with projects starting in 2008.

Objective II of the Mid-term STI Policy Strategy (Building internationally competitive RTDI capacities and centres) aims at establishing strong, competitive knowledge centres with business participation and innovation clusters through accelerated modernisation of the research infrastructure. Six so-called development poles have been defined with specific priority fields of science, and sectors of industry. These poles and their technological/industrial focus are:

- Debrecen – pharmaceutical industry and agricultural innovation.
- Miskolc – nanotechnology, chemical industry, mechatronics and renewable, alternative energies (‘Technopolis’).
- Szeged – health and environmental industry and agricultural biotechnology (‘Biopolis’).
- Pécs – cultural and environmental industry.
- Győr – car manufacturing, manufacture of machinery and renewable energies (Autopolis).
- Székesfehérvár and Veszprém – ICT, mechatronics, logistics and environmental industry.

Moreover, the concept of clusters is apparently based on a regional approach: Objective IV (Strengthening the regions’ RTDI capacity) explicitly states that strong, co-operation clusters and networks of innovative SMEs and innovation actors should be established in the regions.

Thus, the regional dimension of Hungarian technology and innovation policy has strengthened markedly in recent years. This is reflected in the increasing number of relevant instruments, the emphasis on the clusters concept, often with a strong regional aspect, the volume of related funding (through the EU Structural and Cohesion Funds) and in planning documents such as the EDOP. The emphasis on the regional dimension will continue to play a prominent role in the future. This can be seen as a step in the right direction, given the level of regional disparities and the need to better align innovation policies with local conditions. Yet, it is necessary to ensure the efficient development and delivery of regional innovation policy by establishing an interaction between national and regional institutions that avoids overlaps and gaps in responsibilities and aims at a "one-stop-shop" solution. The policy measures that address the regional level also need to be assessed thoroughly with respect to their impact.

3.4. Strategic tasks of innovation policy: a functional assessment

Over the past two decades, Hungary has re-invented itself as a competitive, market-oriented, economy that is a member of the European Union and fully integrated in the global economy. New specialisation patterns have emerged, accompanied by rapid growth in exports of manufactured goods, including high-technology and increasingly skill-intensive goods. Despite robust growth over more than a decade, Hungary still has a long way to go to catch up fully with the advanced OECD as productivity and GDP per capita is lagging.

Despite high productivity growth, Hungary's innovation performance has remained well below its potential. Innovation – notably innovation based on own R&D and technology development – is not yet a main driver of economic growth. Turning innovation into a more powerful engine of growth in productivity and GDP per capita requires more determined strides towards a knowledge-based economy and a spur to innovation throughout the economy. Higher innovation performance would also help to better seize the opportunities arising from technological change and globalisation and to respond successfully to challenges to Hungary's future development by adjusting better to powerful new competition, notably from emerging economies.

Hungary is at a crossroads. It has created a set of conditions for embarking on a more innovation-driven growth path. It can capitalise on the institutional and framework conditions that were put in place over the past two decades. There are major elements of its education and science system that are an asset. There are other factors that could facilitate progress towards a more innovation-based economy that are at least partly exogenous, such as increased inflows of new funding from EU Structural and Cohesion Funds which put stronger emphasis on R&D and innovation than in the past. However, increased efforts are required to make full use of these opportunities.

Government policy can – and indeed should strive to – play a decisive role in fostering innovative performance by improving framework conditions so as to make them more conducive to innovation – which involves a sufficient degree of predictability and sustainability of policy itself – and by adopting policy measures to overcome specific market or systemic failures that hinder innovation. This report shows that in order to successfully tackle the main challenges and seize the newly emerging opportunities, Hungarian policy makers need to increase their efforts to improve the performance of the innovation system in several dimensions.

Taking a comprehensive view, this section assesses the extent to which Hungary's STI policy has succeeded so far in performing the following tasks:

- Improving the governance of the innovation system.
- Fostering innovation in the business sector.
- Strengthening the links in the innovation system.
- Fostering critical mass, excellence and relevance of public research.
- Maximising benefits from the internationalisation of R&D.
- Strengthening the human resource base for STI and innovation.

This assessment will be instrumental in deriving conclusions and policy recommendations.

3.4.1. Improving the governance of the innovation system

Hungary has succeeded in putting in place the major elements that characterise the system of formulating and delivering STI policy in many OECD countries. Its STI policy now rests on a solid legal basis (laws on Innovation, the Innovation Fund, Higher Education, etc.). High-level co-ordination and advisory bodies (the TTPK chaired by the prime minister, and the TTTT) and a diversified set of programmes and instruments designed to support R&D and innovation have been set up. Funding schemes are managed by specialised institutions (which are either a government body such as NKTH or an independent agency such as OTKA in the case of basic research).

Thus considerable efforts to establish better governance of the innovation system have been made. Nevertheless, in some important aspects, the governance system has shown major shortcomings, for example:

- For extended periods of time STI was not represented at the highest level of policy and therefore not very well integrated in overall policy making.
- The institutional position of NKTH, the main institution for STI policy implementation, was clearly less than optimal for some time: it did not report directly to a government minister and policy formulation and implementation were not clearly separated, as is favoured by good practice in other OECD countries.
- The high-level advisory and co-ordination bodies did not live up to expectations. They met infrequently and/or were insufficiently involved in major policy decisions. Consequently, horizontal policy co-ordination of innovation policy and other relevant policy areas (such as education, employment, competition, public procurement, environment, etc.) has been rather weak.
- There was too little and insufficiently broad-based involvement of stakeholders in the preparation of major policy decisions.

However, a snapshot of the governance system at a given moment cannot give a comprehensive assessment of a country's STI policy. Beyond its static properties, the dynamics of the governance system – and how it is adapted and changed over time – are also of key importance for its performance. This is precisely an area in which Hungary's situation has very specific features.[66] Its innovation policy governance system has undergone numerous changes in recent years at the highest policy-making level, at the level of co-ordinating bodies and at the level of implementing bodies:

- There have been frequent changes in the status, mandates and operation of key institutions of the innovation policy system. These are likely to have reduced the effectiveness and efficiency of efforts to stimulate innovation activity. NKTH, like other institutions, has undergone a number of reorganisations and changes in status, and the operation of the Research and Technological Innovation Fund was partly hampered by uncertainties about effectively available funds, etc.

66. However, unpredictability is not only characteristic of STI policy; in a recent OECD analysis of Hungary covering a range of policy areas this has emerged as a constant across a number of areas (OECD, 2008a).

- Moreover, each incoming government has implemented changes following decisions which were often *ad hoc* rather than evidence-based (*i.e.* based on a thorough assessment and evaluation of the institutions and instruments in question).
- Thus, STI policy has lacked predictability and coherence. This instability affects companies' ability to plan R&D and innovation projects, and has also reduced the transparency and accountability of policy delivery institutions and prevented policy learning.
- Amidst somewhat turbulent developments in large parts of the system there are also areas of relative calm, and even some signs of inertia. Reform has been relatively slow in some important parts of the innovation system (*e.g.* the reform of the Academy of Sciences).

So far STI policy has not become a stable platform for developing a more consensual and consistent approach, although as an essentially growth-enhancing policy it may have the potential to do so. A move towards a more evidence-based approach to policy making could help to set in motion a virtuous circle of building trust and social capital more generally, which in turn could facilitate the necessary adaptations of the STI governance system.

Owing to a lack of demand, Hungary has somewhat fallen behind in developing and systematically applying modern management tools (such as monitoring, evaluation, foresight, etc.). Changes are now imminent, owing in particular to EU requirements. However, monitoring and evaluation should not be conducted simply as administrative or accounting exercises but as genuine tools to inform STI policy decision making. An evidence-based policy approach would create sophisticated demand for these tools.

The main challenges thus seem to be to provide a more stable institutional and policy framework based on good practice, to move towards evidence-based policy making and thus make policy more transparent and accountable, to increase the efficiency of the portfolio of measures, and to speed up institutional reforms in areas in which it has been slow.

As part of its STI strategy, the Hungarian government has set as an explicit goal to achieve R&D intensity of 1.8% by 2013 (Table 3.9 and Figure 3.6). However, a trend projection of R&D expenditure (Table 3.10) indicates that, like other EU countries which have set targets of this kind, Hungary is currently not on a trajectory that would allow it to reach its R&D target: the column 2010 LT shows estimated R&D intensities for 2010, based on the long-term trend of R&D expenditures since 1995, while column 2010 ST shows the R&D intensity for 2010 based on the trend of the three latest available years. Applying the long-term trend, Hungary would approach an R&D intensity of 1.1% in 2010. The short-term trend, which takes into account the recent pick-up in R&D intensity, leads to a slightly better outcome for R&D intensity in 2010 but it is still off the 1.4% mark, and achieving the 1.8% target by 2013 would be even more difficult.

Increased financial resources for measures to boost investment in R&D and innovation from the European Union during the new planning period (to 2013) could, in principle, facilitate reaching the targets. However, to achieve efficient use and maximum leverage, a clear strategic orientation will be required, along with well-functioning governance mechanisms in STI policy, strong commitment, and the adoption of good practices in implementation – conditions which the preceding analysis has shown are not yet completely fulfilled.

3.4.2. Fostering innovation in the business sector

The comparatively low level of business sector innovative activity, including R&D, is a key weakness of the Hungarian innovation system. Hungarian STI policy has therefore been right to identify increasing the level of R&D and innovation activities among Hungarian enterprises, especially SMEs, as a priority task in major recent policy and strategy documents. In addition to improved framework conditions, achieving this goal requires financial support for R&D and innovation in enterprises to correct for market failures that lead to underinvestment in R&D and innovation in business firms.

The population of firms covers a wide spectrum, and Hungarian firms are more varied than firms elsewhere. There is a large segment of inward-looking SMEs characterised by low productivity and innovation capabilities, a promising but still small group of technology-based start-ups, subsidiaries of highly productive, primarily foreign-owned MNEs with sizable R&D activity within and outside Hungary, as well as many enterprises that fall outside these categories. Evidently, the needs of these firms vary enormously. Innovation policy needs to take full account of these differences through a differentiated set of support instruments and measures. STI policy must be broad-based, and not just reduced to R&D, while at the same time the R&D core of innovation should not be neglected.

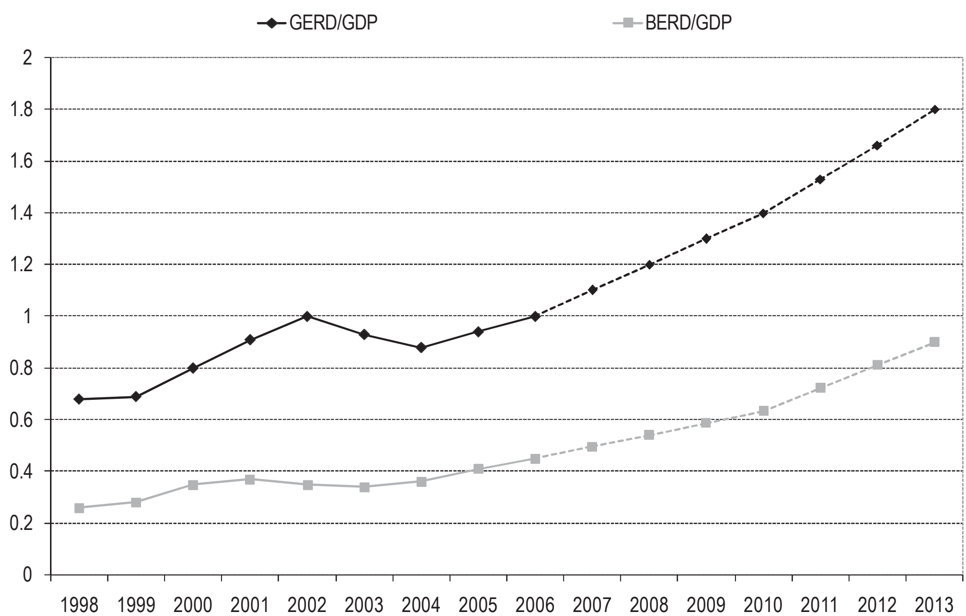
Table 3.9. Indicators and quantitative targets of the Mid-term STI Policy Strategy

		2006	2010	2013
R&D expenditure	GERD/GDP (%)	1.0	1.4	1.8
	BERD/GDP (%)	0.45	0.63	0.9
	BERD/GERD (%)	44.8	45.0	50
Summary Innovation Index (EIS)		66% of EU25		EU25
Share of S&E graduates (%)		5.1	5.5	6
Share of new to markets products (%)		4.2	5%	6
EPO patents per 1 million inhabitants		19	24	28
Early-stage venture capital/GDP (%)		0.002	0.005	0.006

GDP = gross domestic product; GERD = gross domestic expenditure on R&D; BERD = business enterprise expenditure on R&D; S&E=- science and engineering; EPO = European Patent Office.

Source: Mid-term STI Policy Strategy.

Figure 3.6. Past R&D intensity and targets of the STI Policy Strategy



Source: KSH, Research and Development (various years); targets from the Mid-term STI Policy Strategy.

Table 3.10. Extrapolation of R&D intensities, 2010

	R&D intensity (%)		
	2006	2010 long term	2010 short term
Austria	2.5	2.8	2.9
Belgium	1.9	2.0	1.8
Czech Republic	1.5	1.6	2.1
Denmark	2.4	2.9	2.3
Finland	3.5	4.1	3.5
France	2.1	2.1	2.1
Germany	2.5	2.7	2.5
Greece	0.5	0.6	0.5
Hungary	**1.0**	**1.1**	**1.2**
Iceland	1.3	1.2	1.5
Italy[1]	1.1	1.2	1.1
Luxemburg[1]	1.6	1.6	1.4
Netherlands[1]	1.7	1.6	1.5
Poland	0.6	0.5	0.6
Portugal[1]	0.8	1.0	1.0
Romania	0.5	0.2	0.6
Slovak Republic	0.5	0.2	0.5
Slovenia	1.5	1.5	1.4
Spain[1]	1.1	1.3	1.4
Sweden	3.8	4.3	4.1
United Kingdom[1]	1.8	1.7	2.0
EU27[1]	1.7	1.8	1.8

1. R&D data for 2005.

Source: Schibany and Streicher (2008).

New sources of public support for R&D and innovation in business enterprises have been created in the recent past, especially since the launch of the Research and Technological Innovation Fund in 2004; but this may still be insufficient to induce the growth in business R&D that is necessary to achieve a target of R&D intensity of 1.8% by 2013. Business R&D expenditure has picked up since 2004 but it is not certain if this is a persistent trend. Hungary has the opportunity, however, to leverage national resources devoted to support for R&D and innovation by increased EU funding.

Hungarian STI policy has been right to place special emphasis on support of the SME sector. As shown in this report, many public support instruments target SMEs, such as measures to facilitate the diffusion of new technologies, especially ICT, which is known to play an important role in boosting productivity growth. Despite considerable efforts, *e.g.* international openness and the liberalisation of the telecommunications industry, policy has not yet succeeded in sufficiently closing the gap in the uptake of ICT with more advanced countries.

Despite Hungary's considerable efforts, much remains to be done to foster innovative and complementary (management, marketing, etc.) capabilities of SMEs, to strengthen their ability to absorb knowledge and technology, and to link them with innovative networks. Collaboration between business enterprises and between enterprises and public research organisations, including in regional clusters, has received much policy attention in recent times. However, as this report shows, much needs to be done to make these co-operative arrangements work effectively. The expansion of schemes to promote innovation increases the need for good design and the need to safeguard against opportunistic behaviour by beneficiaries of these measures.

Some aspects and trade-offs have yet to be taken sufficiently into account. For examples, excessive support for SMEs (or certain types of SMEs) may actually discourage their growth. This is an important issue as Hungary lacks a strong segment of medium-sized innovative firms. Furthermore, an area that may not have received the policy attention it requires is innovation in services – an area that has become increasingly important in all OECD member countries.

As in other countries, policy typically addresses one by one the problems identified in the innovation system. New measures have been introduced while existing ones have remained in place. As a result, the portfolio of instruments is not optimal, and it deviates even more from an optimal state as new instruments interact with existing ones and the environment changes. For example, the impact of tax incentives for R&D

can be expected to change with general changes in the tax regime, the treatment of certain sub-groups of firms (*e.g.* phasing out of tax holidays for FDI ventures of MNEs) or the introduction of new direct support instruments.

A clearer overview of the impact of individual instruments and the system of instruments as a whole would be an invaluable aid to policy making. A comprehensive assessment would have to include direct support as well as tax incentives for R&D and innovation. An indispensable element of such an effort would be an evaluation of the Research and Technological Innovation Fund, including the impact of the innovation contribution on the behaviour of business enterprises, and finally on the amount, quality and allocation of the R&D actually performed. The impact of attempts to raise the share of business R&D through administrative caps (*e.g.* on the share of public research organisations) needs to be monitored.

Besides direct support, a number of tax incentives related to R&D and innovation address a variety of objectives (raising business R&D expenditure generally, providing a bonus to co-operative research, and stimulating development/use of human resources (such as tax-free employment of PhD, MSc or MBA students). Along with direct instruments of public support, an evaluation of fiscal incentives, notably the R&D allowance, would have to be part of an overall assessment of the policy mix.

Given the needs of the Hungarian business sector and the importance of customising support measures, policy has taken a commendable stance in not letting EU funding crowd out national funding of R&D and innovation. However, maintaining the level of national funding for R&D and innovation will only be justified if all the conditions for efficient use of these funds are met.

3.4.3. Strengthening the links in the innovation system

The levels of R&D performed by both higher education institutions and public research organisations funded by business enterprises compares favourably to the situation in other OECD countries. However, this is not necessarily indicative of strong industry-public sector research linkages, since it may be in part induced by the innovation contribution, the levy introduced to fund the Research and Technological Innovation Fund. Indeed, complementary evidence suggests the opposite to be the case, with innovation links between firms and other national actors weak when compared to the EU average. While there are notable links between *innovative* firms – whether home-grown technology-based SMEs or subsidiaries of MNEs – and the public research base, particularly universities, the issue for Hungary is that such firms are not very numerous and tend to concentrate in a few regions. In addition, these do not necessarily align with the regional distribution of public research organisations across Hungary, particularly in the case of West Transdanubia. The vast majority of Hungarian enterprises (especially SMEs) typically tend to have little capacity to absorb knowledge emanating from the public sector research base. Accordingly, PROs have yet to become the innovation centres of their regions, although this also reflects in part their own slow adaptation to the requirements of a knowledge-based economy.

Since the mid-1990s the government has been addressing these weaknesses, and a considerable number of measures (notably direct support measures) have been established to facilitate and promote collaboration and networking, notably between industry and academia. Prominent among these is the Co-operative Research Centres scheme, which was recently favourably evaluated and is set to continue. A further recently launched major initiative, the Regional Knowledge Centres programme, has similar objectives, highlighting the need for some streamlining between initiatives. The number of centres to be supported under this scheme also appears quite large for such a small research system. By contrast, the new funding strategy of NKTH envisages a much more focused approach to funding the centres, and will provide larger amounts of support to a much-reduced number of National Research Centres.

At the same time, cluster-based policies have been adopted. While these have the potential to better embed MNEs into the various regional innovation systems, the integration of indigenous SMEs into these clusters is generally rather weak. Here, the volume and intensity of co-operation and the efficiency of cluster management need to be improved. While the establishment of the National Technology Platforms is not a cluster-based programme in a strict sense, it could provide a basis for articulation of Hungarian innovation policy with European policy.

STI policy makers need to be aware of the risk that the various schemes promoting clusters, networks and collaboration may send confusing, even conflicting signals to actors. The establishment of well-functioning governance and communication structures between the various initiatives seems a daunting, yet important, task for the governance of innovation policy.

Overall, and apart from the difficulties highlighted above, Hungarian innovation policy has rightly embarked upon approaches for strengthening linkages at the national and the regional levels, which are broader in scope than a mere focus on industry-science R&D collaboration. The question, as in other areas of innovation policy, is again one of implementation and the establishment of sound, transparent and stable institutional frameworks for cluster development and industry-science relations.

3.4.4. Fostering critical mass, excellence and relevance in public research

The public research system, notably the universities and the HAS, should play an important role in the Hungarian innovation system, as a strong science base is necessary for a high-performing innovation system. The share of research activities carried out in these institutions is high by international standards, and they perform quite well in terms of scientific output. However, significant weaknesses need to be addressed through further (accelerated) reforms.

A major challenge is to establish better links and networks involving enterprises and regional clusters using current policy initiatives (*e.g.* competence centres, regional knowledge centres, etc.) while at the same time ensuring the quality of basic research. To achieve this goal, the reform of public research institutions should be accelerated, and they should be offered more performance-based incentives. At present, such incentives are weak.

Public research institutions receive large amounts of block grant funding or have been granted ownership of important assets (including real estate). This institutional funding is generally insufficiently tied to strict criteria regarding research quality. Furthermore, universities and the Hungarian Academy of Sciences have been very active in acquiring projects from NKTH, apparently in reaction to the much greater availability of funds for applied and collaborative research. Much more competitive funding is officially earmarked for applied research than for basic research. This imbalance is likely to become more pronounced with the EU funds in the period to 2013. In order to increase transparency (and to align incentives with stated objectives), competitive funding for basic research ought to be stepped up considerably. This would also avoid an artificial "crowding-in" of academic research institutions into applied research.

In general, Hungary has been slow to reform its public research system. The HAS in particular has been slow to undertake institutional changes to adapt to emerging scientific fields and to correct some weaknesses such as: high overheads and operating expenditures, conservative membership policy, and lack of rigorous performance evaluation. The reforms and new targets stipulated by the Mid-term STI Policy Strategy have been implemented and met only partially. To contribute more to the national innovation system as well as to maintain its international standing as a research institution, the HAS should adopt a more strategic approach to managing its portfolio of institutes and increase its responsiveness to new research opportunities as well as its attractiveness to excellent young researchers. Furthermore, the multiple functions of the HAS should be more clearly separated to minimise the risk of conflicts of interest and to improve the management of individual functions. Indeed, the question of whether all functions should remain under the HAS or whether some should be spun out, *e.g.* its research funding function, should be considered. Finally, there is a need to further improve the selection process for funding research projects. In particular, greater involvement of international peer reviewers should be encouraged, as is best practice in many other OECD countries.

The picture is perhaps a little brighter in the HEIs, as adjustment and modernisation have been high on the policy agenda since the early phases of transition. Over time, there have been considerable changes within HEIs and in their relations to other actors. Recently, government policy has moved towards modern management practices in HEIs, although results have been mixed. Perceptions, notably among HEI staff, that balancing educational and research autonomy against sound management of public resources is a zero-sum game need to be challenged, as they are slowing the reform process. Thus, there remains plenty of room for further improvement in the governance of HEIs and a continuing role for government policy to drive the necessary reforms.

3.4.5. Maximising benefits from the internationalisation of R&D

International links are of outstanding importance for the Hungarian innovation system, as reflected, for example, in the prominent role of MNEs in the country's economy, the significant share of funding of R&D from abroad, and the high degree of international research co-operation (for example, through the EC's Framework Programme).

Several policy measures have been in place for a number of years to facilitate international co-operation and participation in international networks, Framework Programme projects, conferences, etc. Similar measures were launched in 2007 to support Hungarian participation in 7th Framework Programme projects. These measures have clearly had positive effects, with Hungarian researchers among the top three new EU member states participating in the EU Framework Programmes (in terms of the number of project participations and flow of funds). However, participation rates still compare unfavourably to those of EU15 advanced economies of similar size, suggesting that there is plenty of room for improvement. Hungary also participates actively in other European programmes, such as EUREKA, COST and various bilateral intergovernmental initiatives. Hungarian researchers also benefit from access to large-scale pan-European research infrastructures, such as CERN. These and other bilateral and multilateral R&D programmes are important vehicles for the Hungarian R&D community to benefit from and contribute to knowledge circulation.

Given the level of Hungary's participation in European programmes, the European level already has substantial influence on the direction of its science, technology and innovation policy. This influence is likely to increase with the spread of policy practices through channels such as the ERAnets, in which Hungarian participation has so far been low, or the positioning of the recently established Hungarian national technology platforms *vis-à-vis* the European Technology Platforms and Joint Technology Initiatives. Moreover, the unprecedented levels of funds to be made available for innovation-related measures through the Structural and Cohesion Funds (to 2013) imply an even more prominent role for the EU in Hungarian innovation policy.

Evidence suggests that for countries with relatively low R&D intensity and weak innovation performance, EU policies can have a very strong impact on shaping the national system. National policy making and implementation capacities need to be stepped up in parallel if resources are to be sufficiently directed and appropriately utilised. The challenge for Hungarian innovation policy in its articulation with the EU's STI policy is thus twofold: on the one hand, to make the best use possible of the tools provided by European policy, on the other to maintain sufficient local steering capacity.

In addition to research and innovation collaboration within the EU, Hungary should seek to maintain and further develop bilateral relationships with – both historical and newly emerging – knowledge centres outside the European Union and even the OECD area. There are likely to be collaboration opportunities with partners in emerging economies, particularly in Asia, as well as by re-establishing former links with collaborators in Russia. The recent launch of a new government programme to foster such linkages is therefore to be welcomed.

With respect to MNEs, the major task for Hungarian innovation policy seems to be to better embed these enterprises into the national innovation fabric, particularly given prospects of greater international competition for hosting R&D and high-technology production facilities. There are signs that this is happening, but more could be done. While cluster initiatives at the regional level might provide a promising avenue, a shortage of HRST could prove an important bottleneck for attracting and retaining high-skill jobs in the future in light of the comparatively low numbers of S&E graduates. Furthermore, the global competition for talent could exacerbate HRST shortages as Hungarian skilled labour is attracted to better opportunities abroad. To counter the risk of HRST shortages, the government has recently launched a scheme to attract researchers working abroad (including, but not exclusively, Hungarian scientists), to fund research activities of young scientists with a PhD either at prominent Hungarian or foreign laboratories, and to support the access of PhD students and young scientists to large research facilities abroad. Such schemes are very appropriate given the challenge of fostering mobility of human resources and provide research opportunities for young Hungarian researchers.

Hungary has done well in attracting high-quality FDI. However, the record of Hungarian firms investing abroad has been much less impressive, as reflected in a relatively low stock of outward FDI. While Hungarian firms have started to invest abroad, particularly in the region and encouraged by EU enlargement, the benefits of outward investment need to be better recognised, as it can help to link Hungary to international sources of knowledge and technology.

In general, an opening towards international benchmarking of research and research institutes as well as greater use of international peer review should help to ensuring high-quality research and teaching. For HEIs, participation in the Bologna process and greater international comparability of programmes of study should help to ensure quality standards in teaching and the obligation to assess and evaluate research performance should contribute to excellence in research.

3.4.6. Strengthening the human resource base for STI and innovation

Owing in large part to the influx of FDI, Hungary is catching up in terms of the proportion of workers employed in professional and technical occupations, with the country becoming a platform for increasingly skill-intensive, technology-driven manufacturing. Nevertheless, vocational education remains underdeveloped compared to the OECD average, as does continuing education. This should be a cause for policy concern.

At the same time, if Hungary is to move up the value chain and become a more innovation-driven economy, it needs to produce more graduates, particularly in science and engineering (S&E). The level of tertiary education attainment remains well below the OECD average, although recent increases in enrolment rates indicate that Hungary is making some headway. Furthermore, despite a marked increase in the proportion of S&E graduates produced by the tertiary education system, Hungary still produces the lowest proportion of such graduates among OECD countries.

This comparatively small supply of (S&E) graduates reflects, at least in part, low levels of demand for such skills. During the transition period, the number of researchers employed in Hungary fell drastically and the working conditions of many of those who remained in employment deteriorated. A low level of interest in S&E degrees has therefore been understandable. However, the number of researchers employed in Hungary has since increased markedly, although the levels are still low compared to the OECD average. Much of the increase has been in the private sector, and firms have recently become the largest employers of researchers, a welcome development that moves Hungary closer to the OECD norm. However, the uncertainty of the transition period has left an ageing researcher workforce, particularly in the public sector. If these institutions are to renew themselves and further develop their capabilities, they will need to attract a younger cohort of researchers, including new graduates.

If increased future demand for highly skilled workers, particularly from the private sector, is to be met, Hungary needs to do more to address issues of supply. Recently, a number of initiatives for raising the level of S&E graduates have been introduced: *e.g.* a change in the quotas for publicly financed enrolments, provision of tax incentives for employing MSc and PhD students. Various scholarship schemes facilitate PhD studies as well as the pursuit of research careers for post-docs. On the issue of brain drain, however, there seems to be no specific measures, for example, directed towards Hungarians working abroad or offering favourable conditions to excellent scientists from abroad.

The government has also played a part in increasing the supply of graduates by raising its expenditure on education, particularly for tertiary education, although it has failed to keep pace with the explosion in student numbers over the past decade. This is likely to have a detrimental effect on educational quality, unless it is offset by increased public and/or private funding and/or more efficient HEIs. There is, at least in theory, considerable scope for private households to cover some of the costs of tertiary education. If the introduction of tuition fees is not possible, the government should consider alternative means of obtaining more private contributions.

In terms of the efficiency of the tertiary education sector, recent legislation has only partially succeeded in introducing new modes of governance in HEIs in order to increase efficiency (to supplement traditional modes of academic governance). On the positive side, the introduction of new, vocationally oriented degrees is to be welcomed. However, there is still considerable scope for greater consultation between HEIs and the business sector on the content and mix of course offerings. Representatives of industry claim that more creative and practical skills, the ability to communicate for co-operation and teamwork, and entrepreneurial/innovation skills are lacking in current curricula. The lack of such soft skills may be detrimental to innovation activities of enterprises. The government should therefore redouble its efforts in this area so that HEIs become better placed to respond to demand signals, particularly from the business sector. At the same time, core grant allocations to HEIs should be made responsive to appropriate evaluative criteria, and the planned development of a new evaluation and benchmarking system is to be welcomed.

Abbreviations and Acronyms

APEH	Hungarian Tax and Financial Control Administration (in Hungarian: *Adó- és Penzügyi Ellenörzési Hivatal*)
ÁSZ	State Audit Office (in Hungarian: *Állami Számvevőszék*)
BERD	Business enterprise expenditure on research and development
CEECs	Central and Eastern European countries
CERN	European Organisation for Nuclear Research
CIS	Community Innovation Survey
COST	European Co-operation in the field of Science and Technical Research
CRC	Co-operative Research Centre
EC	European Commission
EDOP	Economic Development Operational Programme (of the New Hungarian Development Plan of 2007-2013) (in Hungarian: *Gazdaságfejlesztési Operatív Program* - GOP)
EECA	Eastern Europe and central Asia
EPO	European Patent Office
ERDF	European Regional Development Fund
EU	European Union
EUR	Euro
FDI	Foreign direct investment
FTE	Full-time equivalent
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
HAS	Hungarian Academy of Sciences (in Hungarian: *Magyar Tudományos Akadémia* - MTA)

HEI	Higher education institution
HRST	Human resources for science and technology
HUF	Hungarian Forint
ICT	Information and communications technology
IKTA	Information and Communications Technologies and Applications programme
IPR	Intellectual property rights
ISIC	International Standard Industrial Classification (United Nations)
ITU	International Telecommunication Union
JPO	Japan Patent Office
KEKKH	Central Office for Administrative and Public Services
KKK	Competence centres programme
KMÜFA	Central Basic Programme for Research and Technological Development
KSH	Central Statistical Office of Hungary (in Hungarian: *Központi Statisztikai Hivatal*)
KuTIT	Research and Technological Innovation Council (in Hungarian: *Kutatási és Technológiai Innovációs Tanács*)
MAG Zrt	Hungarian Economy Development Centre (in Hungarian: *Magyar Gazdaságfejlesztési Központ Zrt*)
MEKIK	Hungarian Public Administration Interoperability Programme
MIK	Mobile Innovation Centre
MNB	National Bank of Hungary (in Hungarian: *Magyar Nemzeti Bank*)
MNE	Multinational enterprise
MSTI	Main Science and Technology Indicators (OECD)
MSZH	Hungarian Patent Office (in Hungarian: *Magyar Szabadalmi Hivatal*)
MTESZ	Hungarian Federation of Technical and Scientific Societies (in Hungarian: *Műszaki és Természettudományos Egyesületek Szövetsége*)
MVA	Hungarian Foundation for Enterprise Promotion (in Hungarian: *Magyar Vállalkozásfejlesztési Alapítvány*)
NDP	National Development Plan

NFÜ	National Development Agency (in Hungarian: *Nemzeti Fejlesztési Ügynökség*)
NHDP	New Hungary Development Plan
NIS	National innovation system
NKTH	National Office for Research & Technology (in Hungarian: *Nemzeti Kutatási és Technológiai Hivatal*)
NUTS	The Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard for referencing the administrative divisions of countries for statistical purposes, developed and used by the European Union
OTKA	Hungarian Scientific Research Fund (in Hungarian: *Országos Tudományos Kutatási Alapprogramok*)
PCT	Patent Cooperation Treaty
PPP	Purchasing power parity
PRO	Public research organisation
R&D	Research and development
RDTI	Research, technology development and innovation
RFT	Regional Development Council (in Hungarian: *Regionális Fejlesztési Tanács*)
RFÜ	Regional Development Agencies (in Hungarian: *Regionális Fejlesztési Ügynökségek*)
RIÜ	Regional innovation agencies
RKC	Regional knowledge centres
RSE	Researchers, scientists and engineers
RTD	Research and technology development
S&E	Science & engineering
S&T	Science and technology
SME	Small, medium and micro enterprise
STI	Science, technology and innovation
TBP	Technology balance of payments
TEP	Hungarian Technology Foresight Programme (in Hungarian: *Technológiai Előretekintési Program*)

TFP	Total factor productivity
TTPK	Science and Technology Policy Council (in Hungarian: *Tudomány- és Technológia-Politikai Kollégium*)
TTTT	Science, Technology Policy and Competitiveness Advisory Board (in Hungarian: *Tudomány- és technológiapoliti ka és Versenyképességi Tanácsadó Testület*)
UNCTAD	United Nations Conference on Trade and Development
USD	US dollars
USPTO	US Patent and Trademark Office
VAT	Value-added tax
VISZ	Association of Business Incubators (in Hungarian: *Vállalkozói Inkubátorok Szövetsége*)

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