GROWTH REPORT

2023

'The true power of a nation is the number of scientifically educated citizens.'

Hitel (Credit) 178.
Count István Széchenyi

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Pursuant to Act CXXXIX of 2013 on the Magyar Nemzeti Bank, the primary objective of Hungary's central bank is to achieve and maintain price stability. Low inflation ensures higher long-term economic growth and a more predictable economic environment, and moderates the cyclical fluctuations that impact both households and companies. Without prejudice to its primary objective, the MNB supports the maintenance of the stability of the financial intermediary system, the enhancement of its resilience and its sustainable contribution to economic growth, as well as the Government's policies on economic and environmental sustainability using the instruments at its disposal.

The growth trends of the economy may influence, both directly and indirectly, the ability of monetary policy to achieve the objectives set out in the MNB Act and consequently the conduct of monetary policy. Changes in the dynamics and structure of economic growth may determine the evolution of short-run inflation trends, while the longer-term growth potential and its factors can have a fundamental impact on the assessment of the financial stability of the economy. With that in mind, in the future the Magyar Nemzeti Bank will provide a biannual overview of the most important trends shaping economic growth over the short, medium and longer term, presenting its assessments to members of the profession at home and abroad in its Growth Report.

The analysis was prepared by the Directorate Economic Forecast and Analysis, under the general guidance of Gergely Baksay, Executive Director for Economic Analysis and Competitiveness. The Report was prepared by staff at the MNB's Directorate Economic Forecast and Analysis and the members of the Scale-up Hungary team. The Scale-up Hungary team consists of Barnabás Virág (deputy governor of the MNB responsible for monetary policy and financial stability), István Szabó PhD (director, ELTE Research and Industrial Relations Center), András Balatoni (director of the Directorate Economic Forecast and Analysis, MNB), Mihály Szoboszlai (senior expert at the MNB, data rockstar of the Scale-up Hungary team), Péter Fáykiss (director of the Digitalization Directorate, MNB), Gábor Bayer (director, 77 Elektronika Ltd.), dr. István Sárhegyi (advisor to the chairman at the 4iG Plc.), László Jónás (head of strategy at the Design Terminal Nonprofit Ltd.), prof. István Peták (founder and CEO of the Oncompass Medicine Hungary Ltd.), dr. Zsolt Szalay (head of department of the BME) és dr. András Nemeslaki (head of department of the BME). The team was supported by BME staff, including Dorottya Szemere and Tamás Iványi. The Report also incorporates valuable input from other areas of the MNB. We thank Réka Egervári and Orsolya Micsinai for their spectacular design work as publication editors. In addition, special thanks go to Tímea Várnai (senior expert at the MNB) for her cohesive work in managing the team of writers and editors as well as organising, compiling and coordinating their texts and figures throughout the entire report. The Report was approved for publication by Dr. György Matolcsy, Governor of the Magyar Nemzeti Bank.

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Foreword

Hungary is at a turning point. The key factors that have allowed Hungary to achieve its current level of economic prosperity – cost and location – face exhaustion as a source of economic dynamism into the future. To sustain and accelerate economic growth, Hungary will need to pivot and focus on a new competitiveness agenda: innovation-driven enterprise. Today 1100 innovation-driven enterprises within Hungary – less than 0.3 per cent of all companies – account for 13 percent of exports and more than 22 percent of growth. The next growth challenge for Hungary is therefore to "set the table" so that these companies not only continue to expand but are joined by a wider cohort of innovation-driven enterprises. Realizing this promise depends on sustained engagement among critical stakeholders and proactive strategic initiatives to enable acceleration through "smart money," growth-oriented financial instruments, and encouraging a culture of innovation and entrepreneurship in the rising generation.

This insightful analysis and timely call to action are at the heart of this rigorous and stimulating MNB Growth Report 2023. Building on work conducted by the Hungary stakeholder team participating in the MIT Regional Entrepreneurship Acceleration Program (MIT REAP), this Report offers an overview of the Hungarian innovation ecosystem (including its key institutions and players), an in-depth analysis of the prevalence and outsized macroeconomic impact of Hungarian innovation-driven enterprises (HIDEs), and a set of proposed strategic initiatives includes both short-term priorities and an integrated strategic plan.

As one of the faculty founders of MIT REAP, it is a pleasure to see how the Report builds on the tools we have developed to examine and enable innovation-driven entrepreneurship in ecosystems around the world. The Report adapts and rigorously applies those frameworks to understand the current bottlenecks and provide critical guidance for Hungary going forward. Two key elements of the Report stand out. First, the Report smartly redirects attention from the factors that have led Hungarian growth over the past decade and examines the conditions that will need to be present for growth going forward. Importantly, the Report highlights the relatively low level of realized innovation and growth-oriented entrepreneurship in Hungary, compared to European peers. Second, given the important of enhancing the potential for innovation impact in Hungary, the Report undertakes a novel and provocative analysis of the HIDEs – firms that have some kind of innovative activity meanwhile they are at the "gazelle" phase or have achieved past growth and are now exporting. The Report documents the outsized impact this relatively small number of enterprises have on Hungarian macroeconomic performance. The Report finds that the HIDEs are also distinctive, not only in the industries they serve but in their appetite for risk and experimentation. And, the Report finds that lack of finance – and effective risk capital institutions – may be holding those firms back from growth and other firms from joining their ranks.

This analysis motivates both short-term priorities and an overall strategic orientation for the Hungarian economic agenda going forward. Importantly, the Report highlights the critical importance of establishing a policy framework for more effective instruments for risk capital including convertible and SAFE notes. Establishing a modern set of risk capital institutions will allow potential HIDEs to attract and secure capital that has the potential to expand their numbers. It is encouraging to see that these key strategic initiatives are already shaping public debate and potential legislative action.

The next generation of Hungarian business leaders need to be able to undertake the experimentation and learning (i.e., risks). That will allow them to bring their ideas to impact and drive broader Hungarian economic dynamism. Doing so is not the work of a single actor or program. Instead, it will be through sustained engagement by all of the key stakeholders within the ecosystem – innovators and entrepreneurs, risk capitalists, corporates, universities, and government – that Hungary will be able to fully realize its potential and so avoid a "middle-income" growth trap.

This work will not be easy – it requires sustained trust and engagement across institutions and nurturing a toleration for "failure" that are inherent to the process of innovation. However, this Report demonstrates the importance of achieving this transition. The future prosperity of Hungary depends not on extending its current economic model into the future, but on accelerating unique Hungarian innovation-driven enterprises.

I look forward to seeing this transformation be realized going forward!

PROFESSOR SCOTT STERN

David Sarnoff Professor of Management, MIT Sloan School
Co-Founder and Co-Faculty Director,
MIT Regional Entrepreneurship Acceleration Program

1 Executive summary

The Growth Report offers a comprehensive overview of the trajectory of the Hungarian economy in a longue durée perspective, including its expected directions and the most important factors determining this trajectory. The Magyar Nemzeti Bank analyses economic growth trends in several regular publications, such as the Inflation Report, the Report on the Balance of Payments, and the Financial Stability Report. These publications typically focus on short and medium-term developments in the economy, specifically analysing changes in variables which determine the directions taken in monetary policy. The aim of the Growth Report is to present Hungary's longer-term growth trajectory directly, in some cases spanning an entire business cycle, as well as its determining factors, using both standard and alternative indicators.

For Hungary to continue its economic catch-up in the 2020s and to break out of the middle-income trap, Hungary needs to shift to an intensive, quality-based growth model. By catching up in the 2010s, the Hungarian economy made economic history based on growth that was mainly founded on extensive (quantitative) factors. Demographic trends, conditions of economic structure and developments in world commodity markets point to a possible slowing or even stalling of the catch-up process in the medium term within the former structures. Emerging victorious in the 2020s will therefore require a shift to a new growth model, one that is defined more by intensive and qualitative traits and is based on increasing productivity and competitivenessas as well as improving energy efficiency.

One key element of the intensive growth turnaround is a corporate sector based on innovation and continuous renewal, which enhances the domestic capacity to add value by creating marketable knowledge and skills. Innovation activity in Hungary lags significantly behind the EU average, both in terms of spending and results. The ratio of public and private investments to GDP has increased, but it is also important that they are properly structured to increase productivity. Particularly among small businesses, the accumulation of intellectual assets (so-called smart investment) is low, which is also shown by the low number of patents, trademarks and designs. Hungary's innovation efficiency shows a considerable growth potential by international standards, currently being at 57 percent compared to the EU average, and 37 percent relative to the TOP 5 EU countries.

Using a framework developed by MIT, one of the world's leading universities in innovation, this year's Growth Report analyses the current state of the domestic innovation ecosystem and identifies the key opportunities to progress. To develop the Hungarian innovation ecosystem, the Magyar Nemzeti Bank, in partnership with several other organisations, – together with the Budapest University of Technology and Economics, the National Research, Development and Innovation Office and leading market innovators such as 4iG Plc., 77 Elektronika Ltd., Design Terminal Nonprofit Ltd. and Oncompass Medicine Hungary Ltd. –, joined the Regional Entrepreneurship Acceleration Program (REAP) launched by the Massachusetts Institute of Technology (MIT) business school. The ultimate goal of the MIT Regional Entrepreneurship Acceleration Program is to support a regional entrepreneurship acceleration strategy based on innovation support. At the centre of this system are 'Innovation-Driven Enterprises' (IDEs), which differ from traditional SMEs in that they base their competitiveness on innovation, and their innovation performance enables them to achieve superior business results. Besides being a market driver of innovation, IDEs also make a significant contribution to employment growth through the spill-over effects of their activities.

Institutions – rules, practices and norms – provide the basis for an innovation ecosystem to function properly. The institutional foundations set the framework within which companies operate, protect investors, private property in the broad sense, and innovation, ensure a free flow of resources, fair competition and promote opportunities for cooperation. As a Member State of the European Union, Hungary has an appropriate legal and economic framework, we have access to the EU's common market, patent rights are guaranteed, and the security of a broad legal environment supports innovation and entrepreneurship. The Hungarian economy is integrated into international production chains and has a high share of FDI, which is also a positive sign of institutional development. Hungary also performs well in infrastructure, with a mid-table ranking within the EU in terms of critical infrastructure for the 21st century, but among the leaders in some segments of digital infrastructure.

All elements of MIT's five-stakeholder model (university, government, risk capital, corporate and the entrepreneur himself) can be found in Hungary, but the cooperation between the stakeholders and the exploitation of network effects currently lags behind best practices, so there is significant growth potential. The cooperation between researchers and entrepreneurs in Hungary is below the EU average. A change of mindset is needed for cooperation to work well. Cooperation between universities, research institutions, risk capital and industry can be strengthened by targeted instruments. It is equally important that the impact of joint research partnerships between large companies and universities reaches the SME sector.

Launching Innovation-Driven Enterprises requires significant capital investment in the early stage and only a small proportion of ideas will succeed, so risk-taking and sharing is key to bringing cutting-edge innovations to fruition. Enterprises interested in innovation can grow faster than they could on their own if they attract external partners and risk (or venture) capital, such as smart money or angel investors. For this, it is important to know properly the financing and investment options. In terms of investors, the Central and Eastern European region, including Hungary, is dominated by government sources, which is a significant difference compared to regions with more developed venture capital markets. The range of venture capital investors in Hungary is quite heterogeneous: small funds tend to manage the finances of wealthy individuals, while at the other end of the scale there are large state and EU-backed funds. In the case of Hungarian start-ups receiving investment, the sectors most targeted by investors are consumer goods, services and ICT. One major challenge in the domestic venture capital market is that the investment policy of venture capital funds is rather risk-averse, entrepreneurship is generally lower, and it is hard to find professionals with the right experience.

The most important element of the innovation ecosystem is constituted by Hungarian Innovation-Driven Enterprises (HIDE). Innovation = invention × commercialisation. The specific Hungarian IDE (HIDE) definition is also built around this. HIDE companies can be characterised by some kind of innovation effort (R&D-related tax credit or grants) or result (patent, trademark), and either have fast-growing (so-called gazelle) status or, although no longer in gazelle status, are showing strong export performance.

Several data collection methodologies were used to investigate the operation of innovation-driven enterprises and the Hungarian ecosystem. By merging innovation and other data, we have created a structured database of millions of data points, which has allowed us to identify Hungarian innovation-driven enterprises and to understand their real economic and financial characteristics in depth. We also carried out a questionnaire survey among Hungarian innovative firms, in which we addressed qualitative questions to identify firm-specific factors, motivation and risk-taking attitudes that could not be detected from analytical databases. The questionnaire was completed by nearly 200 enterprises. Finally, interviews with managers of growth-oriented innovative enterprises and venture capitalists provided additional valuable insights, which were also captured in the analyses and assessments.

Our research has identified around 1,100 innovation-driven enterprises, which, despite accounting for only 0.3 percent of all active Hungarian companies, they made up 13 percent of total gross exports and 22.8 percent of annual GDP growth in Hungary between 2009 and 2019. These companies are mature (9–12 years old) and predominantly Hungarian-owned. In terms of their activities, 43 percent of them operate in narrow industries requiring specific expertise. HIDE firms are more often found in knowledge-intensive sectors such as natural science and technical research and development, computer programming, engineering, technical/business management and information technology advisory services, manufacturing and (wholesale) trade of special products, as well as creative subsectors. International experience shows that innovation-driven operations are highly concentrated geographically. This phenomenon also occurs in the domestic context. Almost half of the HIDE companies are located in the capital, but a large number of innovation-driven enterprises are also present in county capitals with multi-disciplinary universities (Debrecen, Győr and Pécs).

We conducted a questionnaire survey targeting domestic HIDEs, which confirmed that funding was a critical issue for innovative and innovation-driven enterprises. For most enterprises, currently the most available fundraising options are self-financing (88 percent), various subsidies (71 percent) and tax allowances (61 percent). Less than 40 percent of enterprises have access to alternative sources of funding, and awareness of these tools is not widespread among enterprises either. Just over a third of the enterprises surveyed identified venture capital investment, which is central to the MIT concept, as an available option.

The primary research also revealed that innovative companies are much more likely to be risk-takers than the average Hungarian company: they accept the risk of making mistakes in business, chalking it up to experience. However, this perception is not common among those who want to start a business. Only 16.8 percent of Hungarian adults who see a good opportunity in starting a business are not afraid of the potential failures of becoming an entrepreneur. Making progress here is crucially important for the domestic development in the medium and long term.

The main strategic objectives are to ensure the conditions for the use of "smart money" and to make greater use of it. Fast and flexible investment structures are particularly important for pre-seed stage innovators. In addition to friends and family as well as crowdfunding, business angels and venture capital firms investing in early stage startups can also be a way for innovators to invest, but "traditional" capital raising is frequently trust-based, time-consuming and involves significant additional costs (e.g. legal, advisory) that early-stage innovators can not take on. In addition, agreeing on an appropriate business valuation can be tricky for a start-up. In line with international best practices, specialised alternative financing instruments such as convertible notes and SAFE (Simple Agreement for Future Equity) notes have been created to provide simple and flexible financing without the burdens that come with more traditional capital raising. In Hungary, the most important alternative investment instruments (convertible notes and SAFE notes) were not established in the past. Improving the regulatory framework for convertible and SAFE notes can strengthen the funding base for domestic innovation potential.

Rethinking the role of public venture capital investments should be considered. International experience shows that public approaches to venture capital investment should be changed, and a co-investment approach would be more appropriate. The Lithuanian public financing practice could be a good example, where the public venture capital investor does not invest independently, based on its own processes, but typically as a co-investor, jointly with a market player and on the same terms. This could reduce the bureaucratic burden for both start-ups and public venture capital investors, and even speed up decision-making processes.

A state veto on foreign acquisitions is necessary in many areas, but rationalising it could increase investor valuations of domestic companies: a state veto on foreign acquisitions may be justified in a number of areas (e.g.: defence industry, cybersecurity), but the current regulation provides an overly broad framework for this, which may reduce the investor valuation of domestic innovation-driven enterprises and the ability to raise further capital. Rationalising the state veto, either on a sectoral or size basis, would mitigate this risk, which could also prevent Hungarian innovators from launching start-ups based abroad because of this risk.

A significant proportion of Hungarian companies cited weak demand as the reason for the lack of innovation. This is where innovative public procurement procedures can help based on international examples. There are two options here: first, instead of a specific product, the contracting authority *buys R&D services* for a product, service or process that does not yet exist, as a solution to a given problem. In the second case, instead of purchasing widely available products, the contracting authority, as an early adopter, *buys a product, service or process* that is new to the market and has essentially novel characteristics. In addition, this instrument also fits in with the EU's innovation strategy, where demand-side elements play an increasingly important role.

At the heart of the innovation-driven ecosystem we find the cooperation of five stakeholders (government, corporates, universities, risk capital and entrepreneurs). The number and quality of stakeholder interactions in Hungary can be increased. Increasing synergy between stakeholders is of key importance in the medium term. It is important to create platforms where the key players of the Hungarian innovation ecosystem can establish an active and continuously expanding network of contacts.

We need to shape the mindset of young talents to increase risk-taking and entrepreneurship. Our results show that Hungary lags significantly behind its regional peers and developed countries in terms of risk appetite. Meanwhile, our survey results show that the leaders of successful, innovation-driven and fast-growing enterprises are more tolerant of risk, and the fear of failure is much less pronounced. It is a long process to change the mindset of society, and schools and education, like other significant changes, have a major role to play.

2 The state of the Hungarian innovation ecosystem

By catching up in the 2010s, the Hungarian economy made economic history, based on growth that was mainly founded on extensive (quantitative) factors. Demographic trends, the conditions of economic structure and commodity market developments point to the fact that growth may slow down or stall within the previous structures. Emerging victorious in the 2020s will therefore require a shift to a new growth model, one that is defined more by intensive and qualitative traits and is based on increasing productivity and competitiveness as well as improving energy efficiency.

One key element of the intensive growth-led turnaround is a corporate sector based on innovation and continuous renewal, where the capacity of the Hungarian corporate sector to add value is enhanced through the creation of marketable knowledge and skills. Innovation activity in Hungary lags significantly behind the EU average, both in terms of spending and results. The ratio of public and private investments to GDP is high, but it is also important that they are properly structured to increase productivity.

The total Hungarian R&D expenditure was 1.65 percent of GDP in 2021, which is still below the 1.8 percent target originally set for 2020. Particularly among small businesses, the accumulation of intellectual assets (so-called smart investment) is low, which is also shown by the low number of patents, trademarks and designs.

The efficiency of the innovation system is particularly important, as innovation is one of the most important drivers of labour productivity. Hungary's innovation efficiency shows a considerable growth potential by international standards, currently being at 57 percent compared to the EU average and 37 percent to the top 5 EU countries. Opportunities for significant progress can be identified particularly in increasing the number of patents as well as trademark and design patents. In these indicators, the Hungarian figure is only about 30 percent compared to the EU average. What is encouraging looking ahead is that knowledge-intensive employment has increased in recent years, so the registration and utilisation of innovation results may increase more quickly in the future.

2.1 Innovation is a prerequisite for intensive growth

By catching up in the 2010s, the Hungarian economy made economic history, the basis of which was growth founded on extensive (quantitative) factors. From an economy in crisis, Hungary successfully returned to a path of playing economic catch-up by growing employment and ensuring a high investment rate expanding capacities (Matolcsy, 2020). The formula for success was the simultaneous creation of equilibrium and growth, to which we owe the most economically successful decade of the last 100 years.

Two factors make it difficult to pursue an extensive growth model: quantitative constraints and the external environment. On the one hand, the economy faces quantitative constraints on the labour market. The working-age population will decrease over the next decade due to demographic processes. On the other hand, the quantitative

increase in investment is limited by capacity. These are the conditions under which adapting to a changing external environment has to take place: cheap energy is no longer a given, cheap finance is no longer available, and geopolitical conflicts are at multi-decade highs.

To continue catching up, Hungary needs to shift to a quality-based intensive growth model. To ensure long-term growth, priority must be given to a sustainable, quality-based catch-up while maintaining balanced growth (Matolcsy, 2022). The intensive growth must focus on increasing efficiency and productivity, which will contribute to the necessary sustainability turnaround through a more efficient use of resources.

The economy catching up sustainably would ensure that Hungary breaks out of the middle-income trap, but this requires a turnaround in competitiveness and sustainability. The Competitiveness Programme of the MNB (2019) sets out its recommendations in 330 points in 12 areas, stating that, in addition to a macro-financial balance and real economic stability, a competitive economy requires *an entrepreneurial ecosystem based on innovation and renewal*, good institutions and effective regulation, quality education and health care, modern infrastructure and financial resources available in a sound structure. The reforms have a multiplier effect that goes beyond themselves, triggering diversified and positive processes throughout the national economy that channel back in multiple ways. Namely, this allows for the release of previously inactive resources with greater efficiency (MNB, 2019).

The key terms in the sustainability turnaround are knowledge capital, digitalisation and green energy. The theses of the turnaround in sustainability are summarised in the study entitled New Sustainable Economics (MNB, 2022b). The role of "smart" capital, i.e. information and communication technology and intangible assets, has become even more important with the new technological revolution and the development of digitalisation, since "smart" investments significantly improve efficiency and productivity (Várnai, 2022). Knowledge is essential for innovation, and its role will become increasingly valued in the 21st century, with intellectual capital, talent and creativity becoming sources of wealth (Asztalos, 2022).

Fostering innovation is a prerequisite for the turnaround in sustainability. The 21st century presents economies with complex challenges. This calls for a transformation of government innovation policies. Beyond funding innovation, governments will play a greater role in setting innovation targets and coordinating innovation projects (Gábriel, 2022).

The turnaround in competitiveness and sustainability will help our country move up and to more productive roles in global value chains, but this will require more innovation and better functioning markets. The current state of the Hungarian innovation ecosystem is presented in the following sections, the characteristics of domestic innovative gazelles in Section 5, and the main implications in Section 6.

2.2 Bottlenecks in innovation

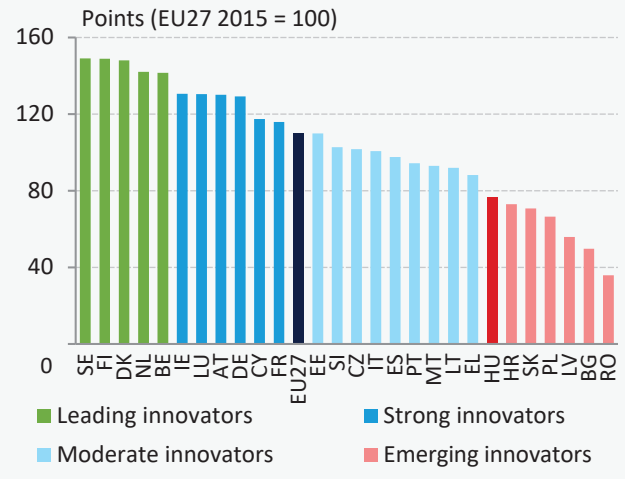
2.2.1 INNOVATION PERFORMANCE

Hungary has been an emerging innovator for years. The European Commission classifies EU countries into 4 groups based on their innovation performance.[1] Hungary is among the countries with the lowest innovation performance, ahead of six others, including Slovakia and Poland in the region. The leading innovators include Sweden, Finland, Denmark, the Netherlands and Belgium, all of which have outstanding innovation performances.

Despite our improving performance, Hungary's gap to the EU increased in 2022 (European Commission, 2022a). In 2022, Hungary moved up one place in the European Innovation Scoreboard (EIS) to the top of the emerging innovator group (Chart 2-1), but its performance relative to the EU still declined. Hungary's innovation performance improved by 7.1 percentage points between 2015 and 2022, but this is below the growth rate of the EU as a whole (9.9 percentage points).

1 The European Commission measures the innovation performance of countries with the European Innovation Scoreboard (EIS).

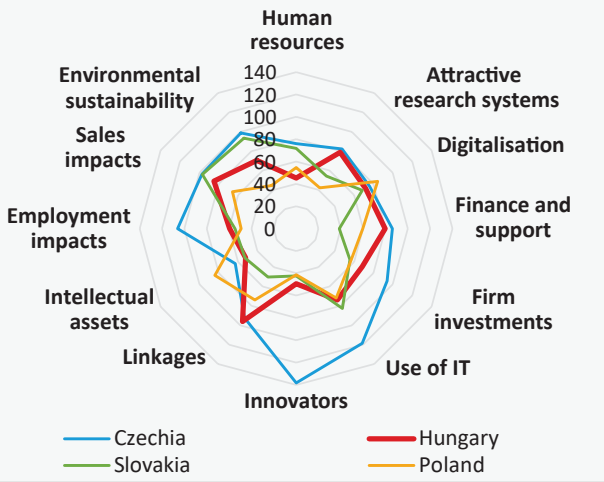
Chart 2-1: European innovation performance (2022)



Note: Consolidated Innovation Index.
Source: European Innovation Scoreboard (EIS), 2022.

The indicators describing Hungarian research systems, the presence of innovators, and collaboration have experienced an evolving trend in recent years. Between 2015 and 2019, the innovation index essentially remained unchanged, but since 2019 it has been rising steadily, albeit slightly. The complex index used in the EIS comprises several groups of indicators, and the set of data describing the research system as a whole has produced one of the best improvements. This sub-index has been rising steadily since 2017. The indicator groups of innovators and linkages have also been trending upwards. **According to the latest data, it is only in the area of cooperation that Hungary's performance reaches the EU average** (Chart 2-2).

Chart 2-2: Innovation performance of the V4 countries (EU27=100)



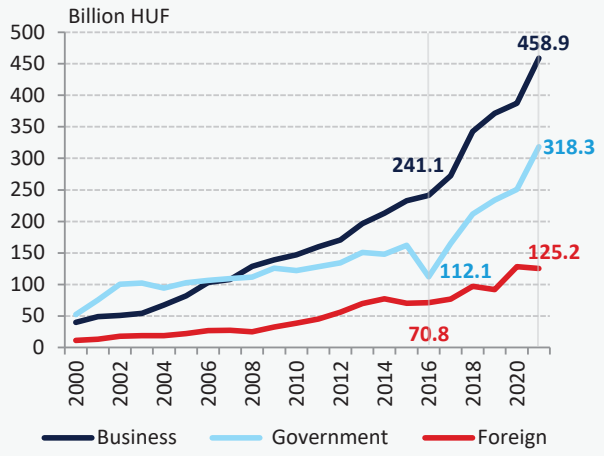
Source: European Innovation Scoreboard (EIS), 2022.

2.2.2 R&D EXPENDITURE

Total Hungarian R&D expenditure was 1.65 percent of GDP in 2021, but it is still below the 1.8 percent target originally set for 2020. Despite the trend of growth since 2016, the main recurring finding of the European Commission's country reports is that Hungary's Gross Expenditure on Research and Development (GERD) to GDP ratio is low compared to the EU average, and therefore an increase in support is still needed. Although Hungary's performance is outstanding among the countries in the region, it still remains below the EU average of 2.26 percent. Increasing resources is therefore a priority objective in the Hungarian Research, Development and Innovation (RDI) Strategy 2021–2030[2]. In line with this, Hungary has taken significant steps in recent years towards a predictable RDI financing system that is sustainable in the long term. However, the results are not yet visible in the output of the innovation system – e.g. in patents (see Section 2.3).

R&D spending in the Hungarian business sector nearly doubled between 2016 and 2021, and reached 1.24 percent of GDP (Chart 2-3). Business Expenditure on R&D (BERD) compares favourably with the V4 countries: we are ahead of Slovakia (0.52 percent) and Poland (0.91 percent) and are essentially on a par with the Czech Republic (1.25 percent).

Chart 2-3: R&D expenditures by source



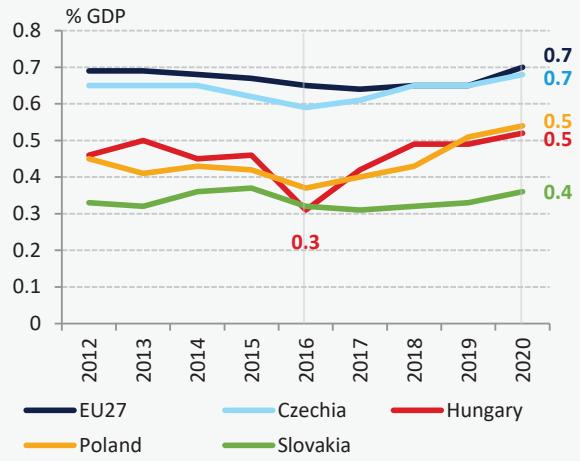
Source: HCSO.

The ratio of budget-financed R&D expenditures to GDP is below the EU average, despite a steady increase since 2016 (Chart 2-4). The country reports of recent years (European Commission 2019, 2020, 2022a) also emphasise that while overall R&D expenditure in Hungary has increased in recent years, this is typically due to an increase in

2 https://nkfih.gov.hu/hivatalrol/hivatal-kiadvanyai/magyarorszag-kutatasi-fejlesztesi-innovacios-strategiaja-2021-2030

corporate R&D expenditures. Corporate resources accounted for more than half of the expenditures in 2020. However, public budget resources have also been trending upwards since 2016. Budget-financed R&D expenditures account for 0.52 percent of GDP, below the EU average (0.7 percent).

Chart 2-4: Budget R&D expenditures

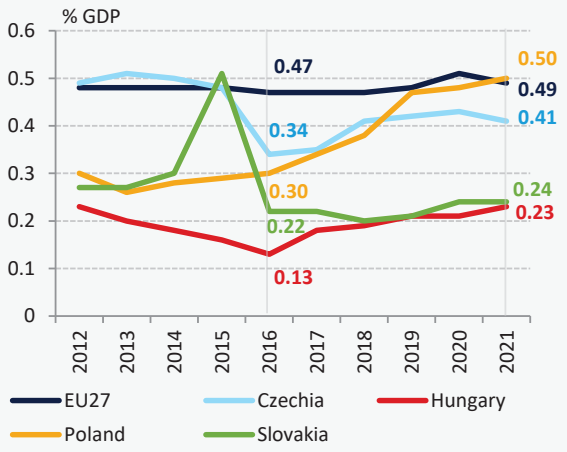


Source: Eurostat.

2.2.3 PUBLICLY FINANCED R&D SYSTEM

In the Commission's view, the quality of publicly financed science is weakening as a consequence of under-financing, and therefore a higher level of support than at present is justified. The European Commission's Country Report 2019 underlines that the level of R&D expenditure in the publicly financed RDI system is lagging behind the EU average, which has a negative impact on research and innovation. The R&D expenditures used by the higher education sector are not only below the EU average (approximately half of that figure), but also the lowest among the Visegrad Four countries (Chart 2-5).

Chart 2-5: R&D expenditures used by the higher education sector



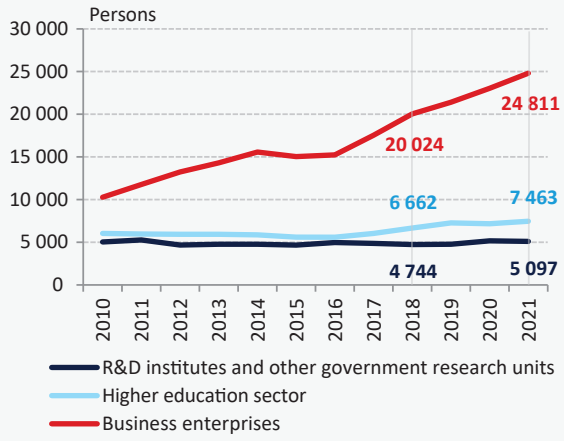
Source: Eurostat.

The lack of financial resources has a negative impact on the career prospects of public sector researchers (European Commission, 2019), and their number decreased between 2010 and 2018. Furthermore, according to the Commission's 2022 Country Report, the quality of the Hungarian public science system has not improved and the workforce and human resources with an understanding of science remain low (European Commission, 2022).

As a result, Hungarian scientific excellence is stagnating. Within scientific publications, the share of publications in the top 10 per cent of scientific publications cited worldwide has increased slightly.

At times of labour shortages, the academic sector was also under considerable pressure from the draining power of market companies. Government policy has recognised that the decline in the number of researchers may be due not only to the relative stagnation of public spending as a share of GDP. During the economic downturn and labour shortages of recent years, the academic sector has been under considerable pressure from the industry's draining power (see Section 2.2.5). Accordingly, in the last few years, in addition to increasing public expenditure, the strategic objectives of Hungarian RDI have also focused on an attractive career model for researchers and more flexible mobility of researchers between sectors. Although the number of researchers continues to rise mainly in the business sector, in 2021 there were 25 percent more researchers in state research sites than five years earlier (Chart 2-6).

Chart 2-6: Calculated number of researchers



Source: HCSO.

2.2.4 CHARACTERISTICS OF SKILLED LABOUR IN TERMS OF QUANTITY AND QUALITY

Skilled labour has been identified as one of the main bottlenecks in the development of the Hungarian research and innovation system in recent country reports (European Commission, 2019). Science, Technology, Engineering and Mathematics (STEM, Hungarian acronym: MTMI) are recognised as relevant workforce areas from the perspective of developing innovation.

Country Report 2022 underlines that more than a third of students participating in university education do not graduate, with high drop-out rates particularly in information technology, engineering and natural science. Within the population aged 25–34, the share of those with natural science and technology qualifications remains below the EU average, and has even decreased since 2015, limiting Hungary's capacity to innovate. This is where the Hungarian diploma-rescue programme helped in 2020, which relaxed the requirements on language exams. Until 2019, the number of graduates in STEM fields in higher education stagnated at an average of 12 persons per 1,000 inhabitants in the younger age group of 20–29 years. In 2020, however, as a result of the diploma-rescue programme, this figure temporarily jumped to 23.5 persons, according to Eurostat data.

It is also an indicator of the quality of education in Hungary that the education system in the country is widely perceived by enterprises to be a barrier to innovation in questionnaire surveys. In Hungary, as part of the National Smart Specialisation Strategy (S3) (presented in more detail in Section 4.2), the situation of education was examined in the Entrepreneurial Discovery Process (EDP), too. Respondents to the questionnaire also overwhelmingly identified the education system as a barrier to innovation in basic, secondary and higher education as well as vocational training.

The new initiatives launched by the national RDI policy will further help to stimulate this process (see Section 4.2). These include the National Research, Development and Innovation Office's (NRDI) calls for proposals for *"Infrastructure and skills development for practice-oriented higher education"* and *"Institutional innovation in higher education courses and services aligned with the core activities of adult education institutions and strengthening adult education activities in higher education",* which foster Hungarian research, development and innovation.[3]

2.2.5 RESEARCH CAREER MODEL

The appeal of the research career model is low, although the downwards trend in the number of researchers working in publicly funded research posts since 2010 was reversed in 2019. In addition to systemic inadequacies in the level of R&D expenditure at national level, there may be several reasons for these negative trends, such as the draining power of industry, the unpredictability and relative unpopularity of academic research careers among younger generations, and more competitive incomes in other sectors.

The share of women among researchers in R&D jobs between 2010 and 2020 ranged between 29 and 32 percent – in terms of total R&D employment across all sectors. The share of women researchers in R&D institutes and other government research units was 39 percent, in the higher education sector 38 percent, and at business enterprises only 17 percent in 2020, i.e. the share of women researchers in the business R&D sector is very under-represented.

It is important for Hungary to increase the attractiveness of scientific and innovation careers by introducing incentives that promote the mobility of researchers between the business and public sectors. One way of achieving this was the development of cooperative doctoral programmes. In addition, the system of support for all stages of a researcher's career has been strengthened further (e.g. the New National Excellence Programme has been extended to include Bolyai+ fellows and, from 2020, young researchers).

3 https://nkfih.gov.hu/english-2017/calls-to-foster-rdi/system-of-domestic-rdi

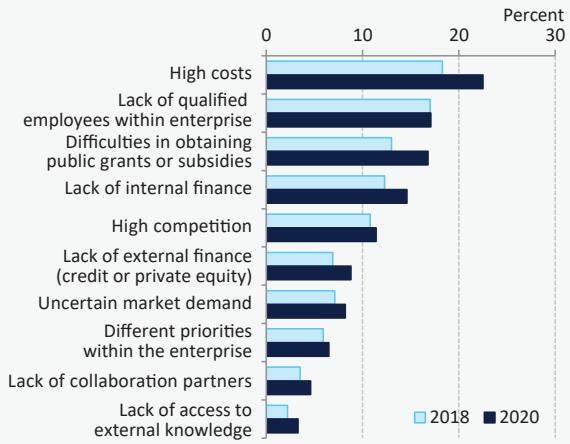
2.2.6 INNOVATION CAPACITY AT SMES

The innovation capacity of enterprises must be increased to bring more innovative domestic products and services representing higher added value to the market. Regular feedback from the Commission's country reports (SBA, 2019 and 2022) is that despite various types of support, the innovation capacity of SMEs has not improved significantly in recent years, and the innovation propensity and activity level of enterprises is typically low.

The barriers to starting or carrying out innovation activities are the high cost of innovation, the lack of skilled labour and the difficulties in obtaining public funding. Hungarian enterprises reported on the barriers to starting or implementing innovation activities in the latest Eurostat questionnaire survey for the period 2018–2020. It is worth pointing out that there is no change compared to 2018 in terms of which factors are the most important barriers and in what order. However, almost all of these factors were seen as strong barriers by more enterprises in 2020 than in 2018. For example, in 2018, 18.3 percent of enterprises considered the high cost of innovation to be a strong barrier, while in 2020, this was 22.5 percent (Chart 2-7).

Another problem is that businesses are not open-minded enough even for open innovation. In open innovation, the innovation process crosses the organisational boundaries of the company. When developing a complex technology, it is more efficient for a large company to involve another specialised – usually smaller – company as well. This type of cooperation is most common in the high-tech sectors (e.g. software, electronics and biotechnology), but is also increasingly used in less technology-intensive sectors (machinery, consumer goods and logistics). The spread of open innovation means new opportunities for innovators in small open economies (Béza–Kállay, 2013).

Chart 2-7: Factors hampering innovation activities among enterprises in Hungary



Source: Eurostat, CIS 2018-2020.

The particularly low level of innovation among small businesses contributes to the low level of accumulation of intellectual assets in Hungary, as shown by the number of patents, trademarks and designs (European Commission, 2019). Focusing on trademarks, it is clear that the willingness and ability of enterprises to file trademarks increases in parallel with their size (Table 2-1). Furthermore, among innovative businesses, there are on average twice as many that have trademark applications.

Table 2-1: Enterprises with own trademark applications

Enterprises with own trademark			
All	With 10-49 employees	With 50-249 employees	Above 250 employees
Enterprises			
3.9%	3.2%	5.5%	12.3%
Innovative enterprises			
8.1%	6.9%	8.7%	18.5%

Source: Eurostat, CIS 2018–2020.

2.3 Innovation efficiency

Innovation is one of the most important drivers of labour productivity (MNB, 2022a). Most business R&D expenditure is financed with the aim of gaining a market advantage for the company by increasing its productivity or consolidating its position. Countries that spend more on innovation are able to maintain or improve their level of development thanks to their significant expenditures. The positive impact of innovation expenditures on economic performance is also confirmed by studies on micro-data from enterprises. The efficiency of research and development, i.e. the ability

to turn research expenditures into economically exploitable results (patents, trademarks, know-how or intellectual capital), is a key determinant of the economy's long-term growth prospects (Szalai, 2022).

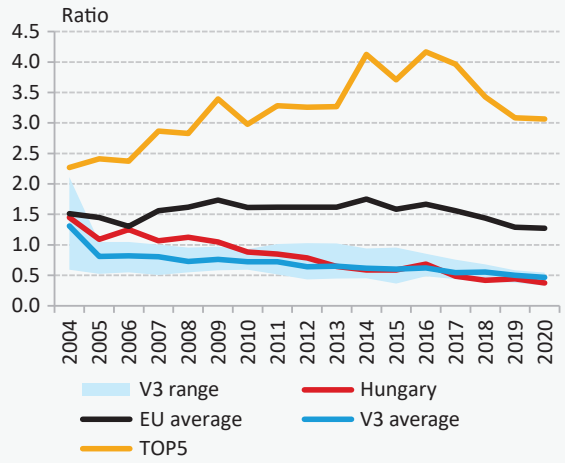
The efficiency of innovation measures how the human and material resources (expenditures) required for innovation are translated into the results (output indicators) of the research process. Bottlenecks in the expenditures were presented in Section 2.2 (for more details see also Productivity Report of the MNB, 2022).

In the data series of statistical offices, only part of innovation expenditures is reported – namely the R&D expenditures. In response to this deficiency, the 2018 Community Innovation Survey (CIS) also measures the costs associated with market innovation. The indicator shows that the innovation expenditures of Hungarian companies amount to 2 percent of GDP, slightly below the EU average. A backlog can be identified particularly in the capital goods linked to innovation. This latter factor chiefly means intangible assets, but also includes all expenditure that has a direct impact on innovation results.

The positive trend in innovation expenditures in recent years has so far had a positive impact on only a few output indicators. Hungary's innovation efficiency remains low by international standards, at 57 percent compared to the EU average and 37 percent to the top 5 EU countries. The Productivity Report of the MNB (2022) shows that, in terms of R&D numbers, only the number of top publications has seen a significant increase, but it is worth noting that despite the increase, Hungary still lags significantly behind the EU average. Among the innovation output metrics, we saw a further increase in the number of trademark applications, with both Hungarian and foreign applications contributing to this increase, based on nationally filed applications. Among nationally filed patents in 2020, most new trademark applications were filed by pharmaceutical companies (Richter and EGIS). We find both domestic and foreign designs associated with the decline in design patents over several years.

The decreasing efficiency of R&D expenditures is mainly linked to the decline in the number of patents (Chart 2-8). The declining patent activity observed globally also exists in our region, and thus the phenomenon is present in Hungary as well. Although more international patents were registered in 2019 as a percentage of the population than a year earlier, R&D expenditures also showed a modest increase, so the ratio of the two figures improved only slightly.

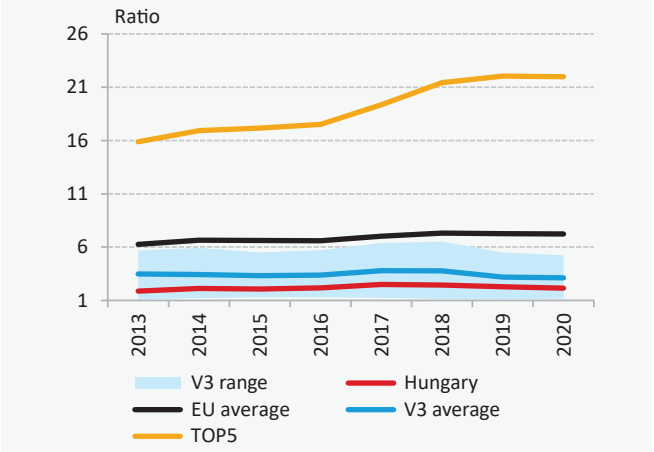
Chart 2-8: Number of patents relative to R&D spending



Note: The TOP5 countries were defined based on the data available for the last year and were plotted as a simple arithmetic average of the values for the same countries retrospectively. The TOP5 countries in order: Luxembourg, Malta, Finland, Netherlands, Sweden.
Source: MNB calculations based on Eurostat and WIPO.

When looking at the number of trademarks and design patents per knowledge-intensive employee, Hungary lags behind both the EU and regional averages (Chart 2-9). This indicator is able to capture innovation performance in a broader sense, and within the family of patent rights (patent, trademark and design patent) it is worth looking at these two types because they typically affect more enterprises than patent law. In 2020, the number of people employed in knowledge-intensive jobs in Hungary increased by 80,000 compared to 2019, which is more favourable than in Poland with a population four times higher. All sectors contributed to the growth, with the largest increases registered in the areas of professional services and manufacturing. The effect of this on innovation outputs may appear later (MNB, 2022a).

Chart 2-9: Trademark and design patents relative to knowledge-intensive employees



Note: Patents were compiled based on the EIS scale, while knowledge-intensive employees are expressed as a percentage of all employees. The TOP5 countries were defined based on the data available for the last year and were plotted as a simple arithmetic average of the values for the same countries retrospectively. The TOP5 countries in order: Estonia, Slovenia, Latvia, Lithuania, Denmark.
Source: MNB based on Eurostat and European Commission (EIS).

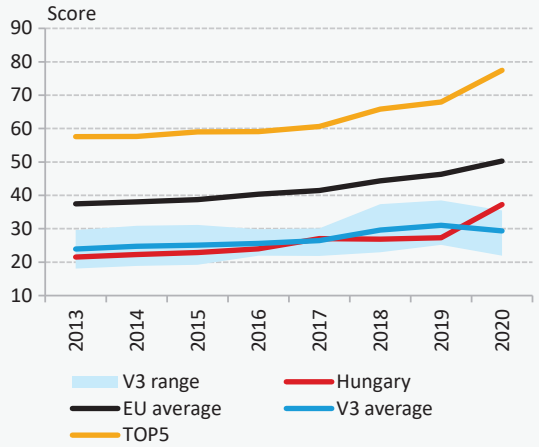
In international comparison, Hungary's innovation efficiency could not improve significantly in recent years. Despite expenditures trending upwards, there is no clear improvement in output indicators. Internationally, the figures for citations remain favourable, but further improvements should be achieved with registering intellectual property rights. The factors behind this are discussed below.

The Hungarian innovation system is both supported and hindered by the high level of state involvement. On the one hand, higher public involvement than the EU average helps to finance innovation, as there is considerable uncertainty about the return on investment for corporate R&D projects. A strong public commitment can encourage companies to take more risk. On the other hand, however, it is questionable whether sustained state involvement can stimulate the creation and use of innovation activities in the longer term or, on the contrary, create a dependency relationship.

The Hungarian R&D strategy adopted in 2021 foresees an even greater role for the state on the one hand, and has set the goal to create self-sustaining, market-based operating models with greater state support on the other. It also sees a possible way to increase patent registrations by further stimulating the patent activity of universities and public research institutes (MNB, 2022a).

Knowledge flows have improved significantly in Hungary, but Hungary still ranks 19th in the EU. On the one hand, the sharp improvement in the composite indicator in 2020 was attributable to increased innovation collaboration of SMEs (Chart 2-10). The indicator measures the cooperation between SMEs and with public research institutions in the 3 years preceding the survey (2018). On the other hand, the flow between knowledge-intensive jobs has improved too, which has also been observed to improve innovation.

Chart 2-10: Composite indicator measuring innovation cooperation



Note: The indicator includes the number of innovative SMEs cooperating with each other, the number of public and private joint publications and the mobility of R&D personnel between jobs. The EU average is a weighted average of the results from Member States, which may therefore differ from the figures in EIS. The TOP5 countries were defined based on the data available for the last year and were plotted as a simple arithmetic average of the values for the same countries retrospectively. The TOP5 countries in order: Cyprus, Estonia, Finland, Denmark, Belgium.
Source: MNB calculations based on Eurostat and European Commission (EIS).

The Commission's country reports stress that the domestic RDI system is generally poorly embedded in the international RDI ecosystem. Encouraging RDI actors to enter the international arena and increasing their capacity for transnational cooperation remains necessary.

The internationalisation of the domestic RDI and SME system needs further development to enable Hungarian actors to act as equal partners with researchers from core countries. However, in a regional comparison, domestic RDI is performing well, and the structure of the resources allocated under the framework programme of RDI grants shows that there is a pool of researchers able to meet the requirements of the European RDI system to a large extent. Despite the fact that the vast majority of H2020 funds were awarded to the EU-15, the EU's framework programme to support RDI has 2048 projects involving Hungarian partners, which won EUR 441 million, according to E-Corda data from February 2023.

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3

3 MIT REAP Entrepreneurship Acceleration Program

To develop the Hungarian innovation ecosystem, we joined the Regional Entrepreneurship Acceleration Program (REAP) launched by the Massachusetts Institute of Technology (MIT) business school – together with the Budapest University of Technology and Economics, the National Research, Development and Innovation Office and leading market innovators such as 4iG Plc., 77 Elektronika Ltd., Design Terminal Nonprofit Ltd. and Oncompass Medicine Hungary Ltd. The MIT programme focuses on the innovation and economic readiness of regions with a population of 1 to 10 million people that have at least one innovation hub. Our aim is to develop Hungary's innovation ecosystem through the MIT REAP programme, applying the MIT framework for enterprise development in practice.

The ultimate goal of the MIT Regional Entrepreneurship Acceleration Program is to develop a regional entrepreneurship acceleration strategy based on innovation support. At the centre of this process are the 'Innovation-Driven Enterprises' (IDEs), which differ from traditional SMEs in that they base their competitiveness on innovation and their innovation performance enables them to achieve superior business results. The capital investment required to start up an IDE is high, which is why they are rarely created through self-financing or solely from entrepreneurial savings. Besides being a market driver of innovation, IDEs also make a significant contribution to employment growth through the spill-over effects of their activities.

To develop and increase the number of innovation-driven enterprises, MIT sees the application of the 3S innovation model (System–Stakeholder–Strategy) as a feasible way forward. Firstly, a Systems approach is needed to understand the drivers of the innovation ecosystem. The innovation ecosystem consists of four elements. Foundational institutions create the stability and proper functioning of the ecosystem as a system. The innovation (I-CAP) and entrepreneurship (E-CAP) capabilities are the two pillars of the region's innovation-driven development. The fourth element is the economic and social impact of IDEs, which is determined by their closely linked capabilities through the competitiveness of the region.

Secondly, the role of Stakeholders must be defined. MIT's five-stakeholder model includes: the government, universities, corporates, the entrepreneur and risk capital. The model emphasises the role of entrepreneurs, as they play the key role in the creation of IDEs. The representation of risk capital is critical in shaping the ecosystem, especially in the domestic context. A successful innovation ecosystem is built through close cooperation between the actors: collectively getting organisational support, and jointly developing and adopting the strategy.

Finally, the Strategy, which is based on the so-called "collective impact" theory. According to the theory of collective impact, objectives and action plans for social and economic problems of such a magnitude like accelerating innovation capacity, for example, can only be set and implemented collectively, i.e. in agreement with each other, by the stakeholders representing different sectors. When designing a strategy to improve competitiveness, in addition to identifying IDEs and analysing the situation of the business ecosystem, network effects should also be taken into account, as well as the fact that competitiveness is expressed in clusters.

3.1 MIT Regional Entrepreneurship Acceleration Program (REAP)

The 2023 Growth Report was prepared as part of the MIT REAP (Regional Entrepreneurship Acceleration Program), a program run by the Massachusetts Institute of Technology (MIT) Business School. The name Massachusetts Institute of Technology (MIT) is almost synonymous with innovation, being at the forefront of technical development and creating technology-driven businesses. MIT has been leading the QS ranking of universities since 2012, and alongside 100 Nobel Prize-winning researchers, it collaborates with more than 800 companies in 65 research laboratories on theoretical and applied research. The university's motto – "Mens et manus" (meaning: mind and hand) – also reflects the educational ideals of MIT's founders, education for practical application. MIT's innovative results are proven by the fact that the university's patent fees on 700 inventions alone generate 85 million dollars in revenue. In 2022, industrial research topped 166 million dollars, accounting for 22 percent of the university's total revenue.

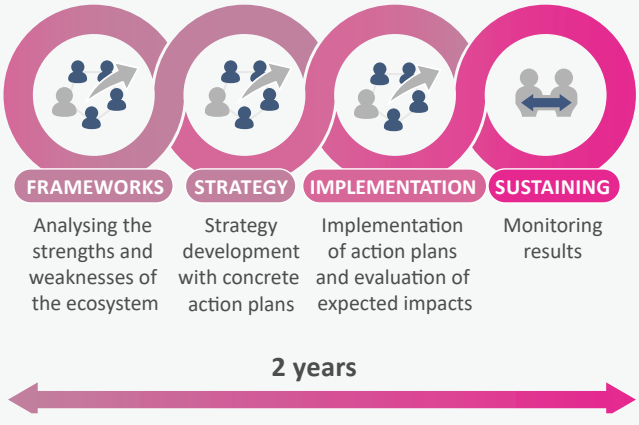
In 2012, the MIT's business school (Sloan School of Management) launched the MIT REAP (Regional Entrepreneurship Acceleration Program) to support the development of the innovation ecosystem in regions with 1–10 million people. Hungary joined in the 9th round – in 2022-2023 – as a pioneer from the Central and Eastern European region. In the same round, in 2022/23, four American regions (Des Moines, Kansas City, Omaha and St. Louis), Western Australia, the Dominican Republic and the city of Piauí in Brazil started work in addition to Hungary. The regions are represented by regional leaders and experts involved in developing the innovation ecosystem.

The MIT Entrepreneurship Programme focuses on the innovation and economic readiness of regions. A region can be a country, a region or even a city. MIT recommends that their programme is best suited to regions with a population of between 1 and 10 million people. A region can apply for the programme regardless of the development level of its innovation-driven entrepreneurial ecosystem, but it must have (at least) one innovation hub. Boston's leading university argues it is in these regions that a critical mass of entrepreneurs can be achieved, whose results can be well measured and effectively coordinated at the institutional level.

Through the MIT REAP program, leaders from the participating regions put the MIT framework for enterprise development into practice to develop the innovation ecosystem in their respective region: they contribute to the region's competitiveness and economic growth through strategic action plans. The essence of the REAP concept and process (Chart 3-1) is that as a first step the participants assess and understand the strengths and weaknesses of the region's innovation ecosystem, then a systematic analysis and planning process follows to jointly develop a strategy with action plans to initiate concrete changes or interventions with a view to improving innovation capabilities. In a third step, the expected impacts of the interventions are assessed and, in particular, a concrete, so-called "must-win battle" is fought, i.e. an action plan is implemented and the results monitored. The four action phases of the process last two years, taking the participants from analysis to implementation, in continuous consultation with senior MIT experts, the other regions participating in the program and previous successful REAP participants.

This year's Growth Report highlights the strengths and weaknesses of the region's innovation ecosystem and lays the groundwork for the strategy to be developed in the third phase of the program.

Chart 3-1: Roadmap of the MIT REAP program



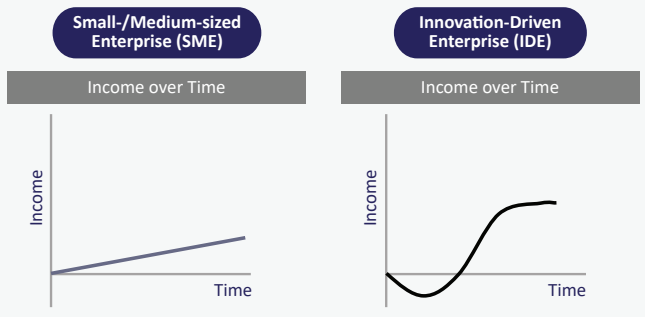
Source: MNB based on MIT.

3.2 Foundations for regional economic growth: Innovation-Driven Enterprises (IDE)

The REAP entrepreneurship acceleration methodology aims to identify and support the emergence of Innovation-Driven Enterprises (IDE). IDE companies are different from traditional SMEs in that they base their competitiveness on innovation, and their innovation performance enables them to achieve superior business results – exponential growth and superior export performance. This latter feature is particularly important in Hungary because unfortunately we have very few companies – especially in the SME sector – that are able to generate the majority of their income in foreign markets.

IDE enterprises are rarely created from self-financing or from entrepreneurial savings alone. A key difference between the life cycle of an IDE and that of a traditional SME is the substantial capital investment required in the start-up phase of an IDE (Chart 3-2), especially in cases where the innovation relates to a deep technology or the commercialisation of an idea that requires technical development or capacity building. Therefore, an integral part of the MIT's IDE model is the provision of appropriate early-stage financing (risk capital) for enterprises, and "smart money" to provide skills and capabilities alongside the financing.

Chart 3-2: Life cycle of traditional SMEs and innovation-driven enterprises



Source: MNB base on Aulet and Murray (2013).

In addition to their direct income-generating and employment-generating capacity, IDEs also contribute to the competitiveness of regional business clusters through their network of business contacts. Experience has shown that IDEs also stimulate the growth of traditional businesses, as one employee in a fast-growing IDE company creates 5 more jobs at suppliers.

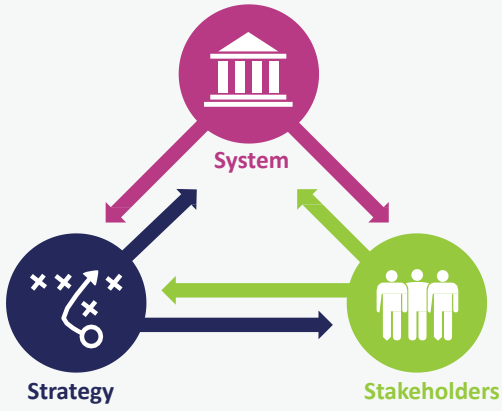
3.3 MIT's 3S innovation model – Stakeholders, System, Strategy

To develop a regional entrepreneurship acceleration strategy based on innovation support, an (innovation) framework is needed.

Innovation is nothing but the invention and its commercialisation (Bill Aulet). MIT's approach to innovation, the essence of the REAP program's conceptual model, is best illustrated by a succinct statement by Bill Aulet, Director of the Martin Trust Center for MIT Entrepreneurship. The English word invention not only means a technological invention, but can also be interpreted as an idea, a new approach to a problem, and of course, in the case of innovations "with a capital i", as the exploitation of scientific results. Without delving too much into an analysis of the problems of domestic innovation performance, it is relatively safe to say that in the case of Hungary, the second element of the relationship – i.e. the economic exploitation of domestic patents, of inventions "with a small and capital i" – faces decade-long challenges (see Section 2.3).

The three pillars for improving innovation performance are System, Stakeholders and Strategy. The starting point for the REAP program, based on the research of Bill Aulet and others, is the recognition that innovation performance, and hence regional competitiveness and economic growth, can be stimulated by building and strengthening three fundamental pillars – the system, the stakeholders and the strategy (Chart 3-3).

Chart 3-3: MIT REAP Innovation Framework



Source: MIT.

Firstly, a Systems approach is needed to understand the factors that influence the innovation ecosystem. The so-called ***innovation ecosystem*** consists of the actors, institutions and related foundations of each region, which is crucial for competitiveness and economic growth. The world's innovation capabilities, the attitudes and relationships of the actors that determine innovation performance (e.g. government involvement, regulatory framework or the state of democratic institutions) and the comparative advantages associated with economic clusters vary widely, and therefore the innovation ecosystem needs to be examined as a system.

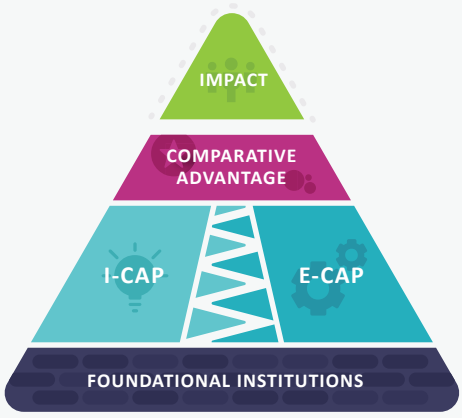
The second S in the MIT innovation model is the role of Stakeholders. A key thesis of the REAP program is that innovation performance does not depend on the efforts of a single key player, but on joint work, networking and cooperation between stakeholders.

The third S is Strategy, which is based on the so-called "collective impact" theory. According to the theory, objectives and action plans related to social and economic problems of such a magnitude as increasing innovation capabilities can only be set and implemented collectively, i.e. in agreement with each other, by stakeholders representing different sectors. Therefore, stakeholders must not only gain organisational support individually, but also collectively, and jointly develop and agree on the indicators of the strategy and the timetable for their evaluation and monitoring.

3.3.1 THE INNOVATION ECOSYSTEM

The innovation ecosystem consists of four elements (Chart 3-4): foundational institutions, innovation (I-CAP) and entrepreneurship (E-CAP) capabilities, comparative advantages, and economic and social impact of IDEs.

Chart 3-4: System elements in MIT REAP framework



Source: MIT.

It is the foundational institutions – rules, practices and norms – that ensure the stability and proper functioning of the ecosystem as a system. They set the framework, ensure the protection of investors, broadly defined private property and innovation, low investment costs, the free flow of resources, and fair competition.

The innovation (I-CAP) and entrepreneurship (E-CAP) capabilities are the "twin engines" of the region's innovation-driven development – at the second level of the system. This area requires the most quantitative analyses regarding the development of ecosystems. *Innovation Capacity* (I-CAP) determines the success of innovative solutions in a region. By this we mean the whole chain "from idea to exploitation", in other words, innovation capacity covers not only R&D, but also the translation of scientific results into economic benefits. *Entrepreneurship Capacity* (E-CAP) covers the conditions for starting a business, the entrepreneurial spirit.

These two capabilities define the region's strengths and weaknesses, that is, the comparative advantages and disadvantages. For example, a region's I-CAP strength may be the presence of good universities with a strong research network and medical research capacity; while another region may have a comparative advantage due to a vibrant investor culture, easy business administration, or possibly tax incentives.

I-CAP and E-CAP skills can be explored through quantitative analysis (questionnaires, secondary data collection, interviews or analysis of professional materials). The region's capabilities are measured by a combination of five assessment factors:

- funding – available resources and how they can be used;
- infrastructure – the infrastructure situation in the region;
- human capital – the readiness, skills and education of human capital;
- demand and markets – demand and the absorption capacity of the market;
- culture and motivation – cultural and motivational factors.

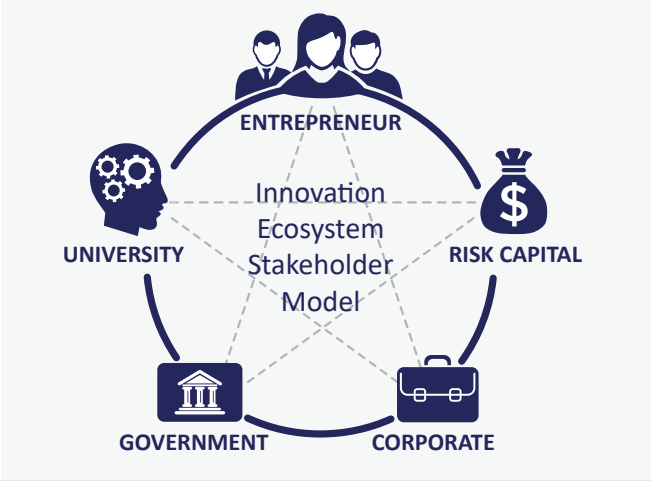
The closely linked capabilities also determine the economic and social impacts of IDE companies through the competitiveness of the region.

3.3.2 ELEMENTS AND PRACTICAL RELEVANCE OF THE FIVE-STAKEHOLDER MODEL

There are several stakeholder models in innovation literature. In the European context, the triple helix model associated with Etzkowitz (Etzkowitz, 2004) or the quadruple helix concept (Etzkowitz–Zhou, 2006), which has recently been used frequently in EU tenders, are the most common. The first emphasises the role of the government, universities and corporates as stakeholders, and argues that a successful innovation ecosystem is created through the close cooperation of these three actors. The quadruple helix complements this triple helix with civil society actors, which is particularly important for social, environmental and other sustainability innovations.

The regions participating in the REAP programme delegate at least one actor from each of the five areas (Chart 3-5), that is, (1) government or public service leaders, (2) senior corporate executives, (3) academic decision-makers from academic or administrative areas, and, unlike other models, (4) entrepreneurs and (5) investors also take part in the program.

Chart 3-5: The five stakeholders building the Innovation Ecosystem Model in MIT REAP framework



Source: MIT.

The entrepreneur is at the top of the pentagon in Chart 3-5, as they play the most important role in the creation of IDEs. Without entrepreneurial ideas, commitment, ambition or risk-taking, there can be no above-average, or even exponential, business growth.

The key to success is the equality and cooperation between stakeholders. In the IDE ecosystem-driven growth concept, the key to achieving economic impact is the collaboration between stakeholders, in a manner that none of the stakeholders has a "privileged" role in business development. The five stakeholders ensure success together, in which each one has a key role to play. Therefore, the action learning methodology of the REAP program returns in a circular manner to how participants can strengthen cooperation and deepen and broaden the range of stakeholders.

3.3.3 STRATEGY – DIRECTIONS AND CONCRETE PLANS FOR THE DEVELOPMENT OF THE INNOVATION ECOSYSTEM

The first element of the strategy is to take stock of the resources, institutions and capacities of our region and identify bottlenecks. What are the strengths of the region and what skills can it build on? Where to invest and where to improve to increase the impact of IDEs?

When designing a strategy to improve competitiveness, in addition to analysing the situation of the business ecosystem, it should also be taken into account that competitiveness manifests in *clusters.* The clusters are the fulcrums where these two capacity types (entrepreneurship and innovation) can work effectively, and their potential can be exploited. Clusters concentrate the potential to commercialise new technology, scale up the business model and increase its global impact.

According to the theory of collective impact, objectives and action plans for social and economic problems of such a magnitude like increasing innovation capacity can only be set and implemented collectively, i.e. in agreement with each other, by the stakeholders representing different sectors. Therefore, the steps of strategy-making based on the theory of collective impact are:

- obtain organisational support from participants;
- stakeholder engagement – deepening and broadening in the ecosystem – and close, ongoing communication;
- adopt jointly agreed targets and indicators to measure them;
- evaluation of indicators and development of a common agenda.

As part of the MIT REAP strategy, Policy Program Interventions (PPI) should be developed first. PPIs are specific objectives which one or more stakeholders can work on together to achieve and by which the elements of the ecosystem can be improved to support the development of IDEs. Such interventions include competitions, accelerators, programs to promote business presence, or even legislative changes to support entrepreneurship and innovation.

Secondly, a high priority intervention linked to the PPIs should be identified and must be implemented during the program without fail. This implementation is started by the stakeholder team representing the region during the second year of the REAP program. The REAP methodology refers to this tellingly as a "must-win battle (MWB)" i.e. a project that ends successfully by all means.

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4 Institutions and key players

The stability and proper functioning of the innovation ecosystem is created by foundational institutions – rules, practices and standards. The institutional foundations set the framework of rules, protect investors, private property in a broad sense and innovation, ensure a free flow of resources, fair competition and promote opportunities for cooperation. Collaboration between the corporate sector as well as public and educational institutions boosts the region's innovation capacity by creating a strong research network. The role of risk capital (or venture capital) is also critical in the development of a well-developed innovation ecosystem, due to the high risk of return on innovation investments.

Hungary, as a member of the European Union, has an internationally sound legal and economic system: it has access to the EU's common market, patent rights are guaranteed, and innovation is supported by the security of the legal environment in a broad sense. Hungarian companies are integrated into international production chains and the share of FDI is high. As for infrastructure, Hungary performs well: it is in a mid-table position within the EU regarding modern infrastructure, and is among the leaders in some segments of digital infrastructure. Increasing low productivity would support the development of the Hungarian innovation ecosystem, where risk-taking and financing are the bottlenecks.

The National Smart Specialisation Strategy (2021–2027), the most important document of public innovation policy, covers three main areas: the Research, Development and Innovation (RDI) Strategy, the National Digitalisation Strategy and the strategy for Strengthening Hungarian SMEs. The vision of the RDI strategy is a knowledge-based, balanced, sustainable economy and society capable of creating high added value. To achieve this, the Government has pledged to increase R&D spending as a share of GDP to 3 percent by 2030 and to launch strong and targeted support programmes.

There are three main groups of research organisations that promote innovation: public and non-profit research organisations, higher education institutions and research sites in the corporate sector. Due to the traditional separation of research, education and innovation organisations, cooperation between researchers and entrepreneurs in Hungary remains below the EU average. For cooperation to work well, a change of mindset is needed. This has started with the optimisation of knowledge transfer processes, but the technology transfer process needs improving. Cooperation between universities, research institutions, industry and venture capital can be strengthened by targeted instruments. It is equally important that the impacts of joint research partnerships between large companies and universities reach the SME sector.

Launching Innovation Driven Enterprises requires significant capital investment in the early stage and only a small proportion of ideas will succeed, so risk-taking and risk-sharing are key to bringing cutting-edge innovations to fruition. With the support of external partners and venture capital, such as smart money or angel investors, companies interested in innovation can grow faster than they could on their own. For this, it is important to know properly the financing and investment options. In terms of investors, the Central and Eastern European region, including Hungary, is dominated by government sources, which is a significant difference compared to regions with more developed venture capital markets. The range of venture capital investors in Hungary is quite heterogeneous: small funds tend to manage the finances of wealthy individuals, while at the other end of the scale there are large state and EU-backed funds.

A well-functioning venture capital market is essential first of all for start-up financing, especially for high value-added, high growth, innovation-driven businesses. The investment opportunities available in Hungary now cover virtually the entire life

cycle of a company. In the case of Hungarian start-ups receiving investment, the sectors most targeted by investors are consumer goods, services and ICT. A major challenge in the domestic venture capital market is that the investment policy of venture capital funds is rather risk-averse, entrepreneurship is generally lower, and it is hard to find professionals with the right experience.

4.1 Foundational institutions in Hungary

It is the foundational institutions – institutions, rules, practices and standards – that ensure the stability and proper functioning of the ecosystem as a system. They ensure the framework, protect investors, private property in a broad sense, innovation, ensure low investment costs, free flow of resources and fair competition.

In Hungary, as a member of the European Union, patent rights are guaranteed and the legal environment is secure, supporting innovation and entrepreneurship. Legal certainty and the predictability of the regulatory environment play an important role in the proper functioning and development of innovation ecosystems. This is highlighted in the MIT's framework because the MIT's entrepreneurship acceleration programme is also used by emerging regions, and the lack of legal certainty is a specific feature of these regions. Hungary, as a member of the European Union, protects private property in a broad sense and patent rights, so this is not a bottleneck in the development of the innovation ecosystem (for more details on sectoral innovation policies, see Section 4.2). The reason why the number of new patents registered annually is below the EU and Visegrad averages must be sought elsewhere (MNB, 2022).

As a member of the European Union, Hungary not only shares a common legal framework, but also has access to the EU's common market. The common market ensures the free movement of resources – goods, labour and capital – between the Member States. The common *goods market* provides a larger market for domestic innovative enterprises and greater growth opportunities. Although the Hungarian population's foreign language skills are weaker than the EU and regional averages, which reduces access to knowledge sharing channels for some *employees* (MNB, 2022), there is still access for domestic actors. The common *capital market* ensures a low level of investment costs. In the common markets, regulators ensure fair competition.

Domestic companies are integrated into international production chains and the share of FDI is high. Foreign direct investments bring modern factories and state-of-the-art innovative production technology to Hungary, providing opportunities for foreign sales. Foreign trade and integration into global value chains are essential for small open economies to catch up sustainably. Thanks to the latter and an active foreign trade policy, Hungarian enterprises benefit from one of the most favourable sets of customs conditions in the EU (MNB, 2022).

Hungary performs well as regards infrastructure: it is in a mid-table position within the EU regarding modern infrastructure, while in some segments of digital infrastructure it is among the leaders. The MNB's Competitiveness Report (2022) underlines that Hungary ranks 15th among the EU27 countries in modern infrastructure (51.5 points). This is higher than the V3 average (50.7 points), but lower than the EU average (54.0 points) and the Nordic TOP5 average (60.0 points). Hungary numbers among the EU leaders in terms of internet infrastructure speed and wired internet penetration. The former is thirty-five and seventeen megabits per second higher than the Visegrad and EU averages respectively, while the latter is almost twice the Visegrad average and around one and a half times the EU average. The development of internet infrastructure in Hungary is competitive by international standards, but this technological advantage is not sufficiently exploited in everyday life by businesses, households and public administration. However, considerable progress has been made in recent years in the digitalisation of public administration and the development of traditional and modern infrastructure.

In recent years, the stability of the domestic financial system has been strengthening, and digitalisation has begun. The financial system has increasingly focused recently on innovative technological solutions and the use of digital space and channels to meet consumer needs.

There is room for progress in the development of the Hungarian innovation ecosystem by increasing low productivity – the bottlenecks are risk-taking and financing. As stated in the MNB's Competitiveness Report (2022), there is room for improvement, especially in the area of productivity growth, which can be supported by, among other things, a sufficient, healthy and skilled workforce; strengthening companies' capacity for innovation, digitalisation and exports; and easy and quick

access to finance. Improving the capabilities (see Section 5.5) and financing (see Sections 4.5 and 5.5) of enterprises helps innovation, which is one of the main drivers of productivity. As Matolcsy (2023) writes in his Reader's Diary, in America in 1973 the driving force of productivity faded, one reason being that no new breakthroughs were made.

4.2 Public innovation policies in Hungary

4.2.1 STRATEGY HISTORY AND OPERATIONAL PROGRAMMES

4.2.1.1 Precedents and early programmes

In the years following the change of regime, there was no independent and comprehensive R&D or RDI public policy or strategy. Research issues were partly reflected in sectoral strategies and partly in higher education strategies (e.g. the restructuring related to obtaining doctoral degrees and their affiliation to universities).

After a series of recommendation documents from the second half of the 1990s, the first report was prepared that could be construed as laying the foundations for a government strategy. In 2004, the report entitled *Science and Technology Policy in Hungary*[5] formulated concrete government proposals for implementation, and in parallel, *Act CXXXIV of 2004 on Research, Development and Technological Innovation* was adopted, partly based on the report, which provided a uniform legal background for the field (Birkner et al., 2023).

Hungary's accession to the European Union in 2004 was a major factor in the development of the strategies. Namely, use of the EU's Structural Funds requires the preparation of strategy papers setting out the framework for use of the funds. Since EU accession, strategy-making has essentially been aligned with the development cycles.

The first National Development Plan (2004–2006) already included RDI objectives, while the third priority of the Economic Competitiveness Operational Programme (ECOP) was R&D and innovation. The objectives of the first National Development Plan included supporting application-oriented R&D; improving the conditions for research and technology transfer in the public/university and non-profit sectors; and strengthening the innovation capabilities of enterprises.

The New Hungary Development Plan (2007–2013) placed the development of the RDI system at the heart of economic development, and the first comprehensive and independent RDI strategy since the change of regime was born. The strategy[6] adopted in 2007 focused on knowledge- and technology-intensive skills and capacities. The Economic Development Operational Programme (EDOP) (2007–2013) also allocated resources on this basis: the *R&D and Innovation for Competitiveness* priority accounted for around 30 percent of the programme's resources.

The applied research and technology transfer activities of higher education institutions were supported by Measure 4.2 of the Social Renewal Operational Programme (SROP) funded by the European Social Fund (ESF). This helped establish the university Technology and Knowledge Transfer Service Offices.

In addition to the above, the regional operational programmes of the 2007–2013 period also included support for innovation, including the development of incubators.

4.2.1.2 2014–2020 programming period

The Széchenyi 2020 programme included the development elements of the 2014–2020 planning cycle.

The National Research, Development and Innovation Strategy for 2013–2020 has already identified the most important policy directions, including the pillars of knowledge production, knowledge flow and knowledge exploitation. Worthy of note in the strategy is the recognition that, in addition to the domestic funding leg, it has made preparing for the central EU funding programme, Horizon2020, one of the focuses of development (Ministry of National Economy, 2013).

A unified legal and institutional framework for implementing the strategic objectives was created by the new RDI Act, Act LXXVI of 2014 on Scientific Research, Development and Innovation.

A new feature of the cycle is that Member States could only receive funding from the Structural Funds to strengthen research, development and innovation (RDI)

5 Science and Technology Policy in Hungary: Present Status and Breakthrough Possibilities, Report of the Science and Technology Policy Advisory Board 2004 (http://nih.gov.hu/download.php?docID=19391)

6 The Government's mid-term (2007–2013) science, technology and innovation policy (STI) strategy. (http://nih.gov.hu/download.php?docID=17503)

and to develop information and communication technologies if they had prepared a National Smart Specialisation Strategy. The strategy included sectoral development priorities and action plans, identifying regional strengths. The six sectoral priorities included advanced vehicle and other engineering technologies and the development of clean and renewable energies. The strategy formulated two horizontal development priorities: information and communication technologies (ICT) and services as well as an inclusive and sustainable society and a liveable environment. The latter included education and training as well as promoting entrepreneurial skills and developing partnerships (NRDIO, 2014).

The Economic Development and Innovation Operational Programme (EDIOP), the operational programme for the period 2014–2020, even emphasised the importance of innovation in its name. The research, technological development and innovation priority included three specific objectives:

1. enhancing R&I activity among knowledge- and technology-intensive enterprises;
2. increasing the number of strategic R&I networks among companies performing R&D activities as well as public and non-profit research organisations (research and educational organisations);
3. increasing participation in Horizon 2020 by strengthening the R&I capacities of public and non-profit research organisations (research and educational organisations) and enterprises.

As the EDIOP funds could be used in the convergence regions, the Competitive Central Hungary Operational Programme (CCHOP) set similar objectives for the rest of the country, as regards the Central Hungary region (at that time Budapest and Pest county combined). In addition to these, the Human Resources Development Operational Programme (HRDOP) supported university innovation tenders in connection with the economic development and innovation OP.

4.2.2 STRATEGIES AND PROGRAMMES IN PLACE

The current strategic framework is aligned with the Council's country-specific recommendations linked to the National Reform Programmes (NRPs) to be prepared annually for EU Member States. The problems identified in Section 2 are reflected in the country-specific recommendations.

4.2.2.1 Recommendations and analyses of the situation

The 2019 recommendation's assessment of the situation suggests that increasing research and innovation capacities can improve Hungary's low innovation performance and raise productivity. The low level of intellectual capital accumulation is also reflected in the low number of applications for patents, trademarks and designs, the low number of innovative enterprises and the low level of internationalisation among small and medium-sized enterprises. Innovation is particularly low among small businesses, which hinders their participation in the global value chain. Private sector R&D is concentrated in a few large, mainly foreign-owned companies, with generous government support. Supporting cooperation between science and businesses would help improve innovation performance and technology transfer. The quality of publicly financed research is low due to inefficient R&D policies and underfunding, with public sector R&D spending well below the EU average. The 2019 country-specific recommendation therefore encourages Hungary to put research and innovation at the heart of investment-oriented economic policy.

The 2020 recommendation points out that Hungary is an emerging innovator and one of the main barriers to innovation is the lack of highly skilled employees. Research and development (R&D) expenditure has been growing slowly, fuelled mainly by the business sector which benefits from the highest level of public support across the EU. However, public sector R&D spending has fallen over the past decade. Recovery from the COVID-19 pandemic requires investment in public research and innovation and a supportive research environment.

The 2022 recommendation reiterates the 2020 recommendation that Hungary should put the green and digital transition at the heart of its investments, in particular clean and efficient energy production and use, sustainable transport, waste and water management, research and innovation, and digital infrastructure for schools.

The 2022 analysis of the situation highlights that research and innovation are indispensable drivers of long-term growth and competitiveness, but Hungary is still deemed an emerging innovator. The country-specific recommendation calls on Hungary to promote reforms and investments in sustainable water and waste management, circular economy, digitalisation of enterprises, green and digital skills, research and innovation.

4.2.2.2 The current RDI strategy

The vision of the "Research, Development and Innovation Strategy of Hungary (2021–2030)" (RDI Strategy) is a knowledge-based, balanced, sustainable economy and society capable of creating high added value in all areas of the country. The RDI policy has set the goal for Hungary to catch up from being one of the EU's emerging innovators to become one of Europe's strong innovators by the end of the decade. In line with the relevant country-specific recommendations, the RDI Strategy aims to put research and innovation at the heart of investment-oriented economic policy and to strengthen investment in research and innovation (ITM – NRDIO, 2021).

In the RDI Strategy the Government committed to increasing R&D spending as a share of GDP to 3 percent by 2030. To achieve the government's objectives, competitiveness needs to be enhanced with an economy creating high added value that is open to innovation, and a business sector that uses and develops modern technology and is able to respond flexibly to the processes taking place in the world.

To meet these objectives, Hungary has launched and intends to launch strong and targeted support programmes to enhance the innovation performance of Hungarian enterprises, to promote the networking of organisations engaged in RDI activities, to support cooperation between universities, research institutions and industry (see Section 4.4), to increase the number of innovative enterprises, to enhance knowledge flows, to improve research infrastructure as well as to create a critical research base and increase the supply of researchers.

The horizontal objectives of the RDI strategy include: encouragement of openness to innovation; creating a regulatory framework and business environment supportive of RDI; creating a funding system that promotes both stability and incentivisation; and stimulation of challenge- and demand-driven RDI.

4.2.2.3 National Smart Specialisation Strategy

Parallel to the development of the RDI strategy, the National Smart Specialisation Strategy 2021–2027 was also formulated (NRDIO, 2021).

In the 2021–2027 development cycle, the territorial approach to the policy instrument will cover a much broader scope than in the previous cycle, including digitalisation and enterprise development, in addition to RDI policy. In terms of both design and implementation, the current Strategy covers a total of four specific European development objectives: strengthening research and innovation capacities, digitalisation, SME growth and developing the skills needed for the Strategy.

The new Strategy can now be seen as an umbrella strategy covering three sectoral strategies[7]:

1. Research and Development and Innovation Strategy of Hungary (2021–2030);
2. Strategy for strengthening Hungarian micro, small and medium-sized enterprises (2019–2030);
3. National Digitalisation Strategy (2022–2030)

The Strategy's priorities were carried out using the so-called "entrepreneurial discovery process" (EDP) in line with EU methodological recommendations, and with the involvement of a wide range of stakeholders.

In the Strategy, eight national economic priorities identify smart specialisation directions where the concentration of resources and the promotion of RDI development can provide a significant competitive advantage for Hungary. These are as follows:

1. Cutting-edge technologies;
2. Health care;
3. Digitalisation of the economy;
4. Energy, climate;
5. Services;
6. Resource-efficient economy;
7. Agriculture, food industry;
8. Creative industries.

In the Strategy two horizontal priorities formulate the goals related to skills development and the modernisation of the business environment to support the effective delivery of the national economic priorities, namely:

1. Training and education;
2. Innovation in the public sector and universities.

7 The documents listed can be found in the list of references.

4.2.2.4 Related Operational Programmes

On 22 December 2022, the European Commission adopted the EDIOP Plus and DROP Plus programmes in an implementing decision. In terms of the RDI projects of economic actors, the distinction between EDIOP Plus and DROP Plus will be determined based on the activity to be developed in the submitted project.

Priority 2 of EDIOP Plus provides development funds for research and innovation capacity building, dissemination of advanced technologies and skills development. The development of research and innovation capacities is divided into three actions. Firstly, *supporting knowledge* production strengthens research infrastructures. Secondly, it encourages *knowledge flow* by supporting RDI cooperation through the expansion of R&D and technology transfer activities of knowledge intermediary organisations within which support is provided for infrastructure investments (e.g. National Laboratories, Competence Centres). Thirdly, it supports R&D and innovation in the market sector by *strengthening knowledge exploitation* via increasing corporate RDI activity.

Programmes funded in the context of the Recovery and Resilience Facility (RRF) support skills development for higher education students, academics, researchers and employees related to the Smart Specialisation Strategy, and the National Laboratory Programme related to knowledge flows.

4.3 Key players in the RDI sector

4.3.1 RESEARCH ORGANISATIONS

There are three main groups of organisations that carry out research and thus promote innovation in certain areas: public or non-profit research organisations, higher education institutions, and research organisations in the corporate sector.

The public research organisations are part of the MTA's basic research network. The research network was transferred from the Hungarian Academy of Sciences to the independent Eötvös Loránd Research Network (ELKH) from 1 September 2019. The scientific research network consists of 11 research centres and 7 independent research institutes. Established in 1993 to carry out applied research and experimental development and to provide R&D services, the Bay Zoltán Research Centre is part of the Hungarian innovation ecosystem, first as a foundation and then as a non-profit private limited company. It operates 4 divisions and 11 laboratories / research platforms. Public non-profit research institutions, which cover a wider range than the ELKH network, e.g. including some public collections, account for about 14 percent of the research capacity (R&D personnel).

In the higher education sector, there are 5 public universities, 21 public foundation universities or universities of applied sciences as well as 10 private universities and 27 religious universities.

4.3.2 SUPPORTING INSTITUTIONS

The key organisation of the Hungarian RDI support system is the National Research, Development and Innovation Office (NRDI Office). The predecessor organisation called the National Committee for Technical Development (OMFB), which had operated in various forms since 1961, became an independent government body again on 1 January 2004 under the name of the National Research and Technology Office (NKTH), the legal successor of which was the National Innovation Office (NIH), from which the National Research, Development and Innovation Office (NRDI Office) was formed on 1 January 2015 by merging with the Hungarian Scientific Research Fund (OTKA).

The NRDI Office manages the National Research, Development and Innovation Fund, a separate fund financed by innovation contributions, and makes recommendations to the Government on RDI policy. The primary proposer, among its policy tasks, prepares the scientific research, development and innovation strategy, represents the Government of Hungary and the Hungarian RDI community in international and European RDI organisations.

The flow of basic research and scientific information is ensured by the Library and Information Centre of the Hungarian Academy of Sciences (MTA KIK) by maintaining two central services. The Hungarian Science Bibliography (MTMT) registers the Hungarian publication output, while the Electronic Information Service National Programme (EISZ) provides access to scientific databases funded by the NRDI Office.

The Hungarian Intellectual Property Office (HIPO, until 2010 the Hungarian Patent Office) is the government office responsible for protecting intellectual property, including industrial property and certain types of copyright. In addition to these activities, it provides R&D classifications for the purpose of tax credits.

4.3.3 FUNDING INSTITUTIONS

The central body for public funding of RDI is the National Research Development and Innovation Office, as described above, which manages the public National RDI Fund and its three sub-funds. In addition to the Fund itself, some international funds are also managed by the National RDI Fund.

In the field of private investment and support in Hungary, there are a significant number of venture fund managers, i.e. a broad network of private investors, with strong professional cooperation (Hungarian Venture Capital and Private Equity Association, HVCA). In the case of the venture capital network, Hiventures Venture Capital Fund Management Ltd., operating since 2017, should be highlighted as an intermediary for public funds. As a public equity investor, Hiventures' start-up business line aims to provide equity funding for Hungarian start-ups with innovative solutions and high growth potential. The MIT REAP program emphasises that the representation of risk capital is critical in shaping an advanced ecosystem, which is why we focus on the role of the venture capital market in Section 4.5.

As an additional financing option for businesses, the Hungarian Development Bank (MFB) established the MFB Points network to provide EU-sourced repayable financial instruments, i.e. repayable grants in the form of loans, available in the 2014–2020 funding cycle.

4.4 Business-university partnerships in Hungary

In the 1970s, financial support for R&D was mainly provided by the government, chiefly for the defence and aerospace industries, while industry or civil organisations played a much smaller role in innovation. The state was at the forefront of developments in the defence and space industries, and the results slowly trickled down to everyday civilian life.

In recent decades, however, this trend has slowly but surely reversed, and nowadays the bulk of financial resources devoted to innovation is increasingly directed to the private sector and its companies. Given the practical benefits of these developments and the promise of the resulting profits, the corporate sector is at the forefront of developing communication technologies (such as 5G), artificial intelligence research (such as Chat-GPT), autonomous and quantum-based technologies, biotechnology and space research.

For a large company, the ideas of university students can be an important source of product and process innovation, and it is also very important for students to gain practical experience of real company problems.

In the MIT's five-stakeholder model, large mature companies are also key. In Hungary, corporate research centres account for about 66 percent of the R&D workforce. However, domestic corporate research is highly concentrated, with much of it taking place in the domestic phase of global production chains in large companies. The organic integration of these large companies into the domestic ecosystem is moderate, and connections are typically limited to a single university or educational institution. Thus a self-reinforcing process cannot emerge that would endogenously expand marketable knowledge and improve the quantitative and qualitative output of the innovation process.

Building and maintaining links between innovative organisations (universities, companies, bridging institutions) is just as important for market actors involved in innovation-oriented activities as it is for government actors coordinating economic development activities. The development of university-industry cooperations plays a prominent role in the innovation policy of the European Union, in the New Hungary Development Plan and in the institutional development strategies of some Hungarian higher education institutions (Vilmányi, 2011).

The potential of cooperation between universities, large companies and government is exemplified by NATO's DIANA[8] initiative which was supported by 22 NATO member states, including Hungary. Among other things, DIANA focuses on artificial intelligence, quantum technologies, biotechnologies, hypersonic technologies, space research, and innovations in the development of new materials. The core objective of the DIANA project is to provide a common platform for industry, start-ups and academia to research and adapt emerging technologies for dual use. In the context of DIANA, an innovation network of 9 accelerator centres and 63 test centres will be set up in the countries of the alliance.

Universities in Hungary have increasingly extensive links with large companies. According to Vilmányi (2011), these relationships can be grouped into three categories: collabo-

8 https://www.diana.nato.int/about-diana.html

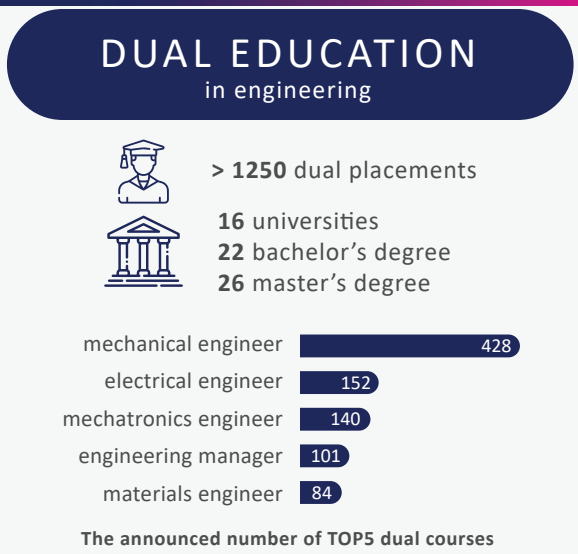
rations formed in the course of *operation* (procurements, labour market presence), collaboration opportunities in the *investment activities of universities* (real estate development and business development collaborations), and *education* collaborations (e.g. workforce development, consultancy, development). However, the third form of cooperation is the most relevant for R&D and innovation. Interactions between actors can range from ad-hoc meetings to formalised joint R&D projects. They can also be implemented at individual and institutional level. The latter, of course, offers a higher level of formalisation and intensity.

One type of education collaboration between universities and industry is internships, often based on personal contacts, or student work. Trainees and student workers are typically referred directly to companies by the university under a formal or informal partnership. The companies also offer the students a job after graduation if they are mutually satisfied. The longer-term sustainability of this type of cooperation is helped by the fact that it is not centrally organised but works through personal contacts, so the demand for skills can find the supply. Firms and universities regularly and consciously invite and send students on internships that require specific knowledge and are linked to their interests.

Another type of university-industry education cooperation is dual training, in which students take part in vocational training where education is provided in parallel and complementary ways at both the educational institution and at companies. In Hungary, the widest range of dual training is found in engineering, but there are also courses in economics, agriculture and IT. There is also an example of a master's degree in biotechnology among agricultural courses.

More than 1250 traineeships are currently available in engineering in 22 bachelor's and 26 master's courses at 16 universities (Chart 4-1). The former dual courses, which were mainly BA courses, have been extended to master's courses as well. One problem with the training is that the proportion of trainers with active industry/sectoral experience remains low.

Chart 4-1: Dual education in engineering



Note: Information released in February 2022.
Source: ITM, Felvi.hu

Automotive companies have entered education through a number of dual training schemes in response to the tight labour market (Table 4-1). Such dual training courses in cooperation with the automotive industry are also taking place at universities in Budapest and county seats, joined not only by car manufacturers but also by automotive suppliers.

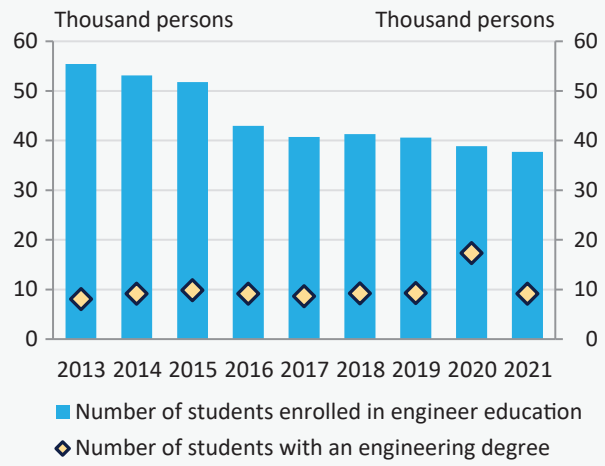
Table 4-1: Main automotive partners working with universities in Hungary

Training institution	Main partners
BME	Aeroplex, Knorr-Bremse, Robert Bosch, Siemens
University of Debrecen	Aventics, ContiTech, Diehl Aviation, FAG, Flexi Force, Inter Traction Electrics, Jabil Circuit, Joyson Safety, Linamar, Michelin, Robert Bosch Automotive, TYCO Electronics
University of Miskolc	Aluinvent, Apollo Tyres, Aventics, BorsodChem, CERTA, DYNEA Hungary, FAG, Fobutech, GE, Guardian Orosháza, Hajdu Autotechnika, Johnson Electric, Joyson Safety Systems, Linamar, Robert Bosch, Schinwa, Turbo Tech
John von Neumann University	Eckerle Industrie, Ferzol, Flextronics International, Hechinger, Hilti, Linamar, Mercedes-Benz, Phoenix Mecano, SMR Automotive, Videoton, Xomox, Zollner
University of Nyíregyháza	AJG Agrogép, Agrotec Magyarország, ContiTech, Diehl Aviation, Debreceni Közlekedési Zrt., Eissmann Automotive, Hübner-HGumi és Műanyag, Jász-Plasztik, Michelin, Tungsram Operations, Unilever
Szent István University	Audi Hungária, AUTOLIV, BKV Zrt., BOSCH Automotive, BPW-Hungária, EDAG Hungary, ZalaZONE Ipari Park, Otto Fuchs Hungary, Rail Cargo Hungaria

Source: felvi.hu

Despite the fact that the automotive industry is also a partner in higher education, the number of students enrolled in technical courses has decreased in recent years (Chart 4-2). The universities in the capital and county seats offer courses in vehicle engineering, while the capital also offers courses in vehicle operations engineering and autonomous vehicle management. In 2020, the number of graduates temporarily jumped as a result of the diploma-rescue programme.

Chart 4-2: Engineering education in Hungarian higher education



Note: Student statistics include the number of students in vocational training. Courses offered by institutions in September 2023.
Source: HCSO, Eurostat, Felvi.hu.

4.4.1 RELATIONSHIPS TO BE STRENGTHENED

As a barrier to knowledge flow and innovation, the situation and problems of higher education in Hungary must be addressed, which have a significant impact on the support and servicing the needs of enterprises belonging to the ecosystem.

According to the Commission's 2019 Country Report, research–entrepreneur cooperation in Hungary remains below the EU average due to the traditional separation of research, education and innovation organisations (European Commission, 2019). There has been very significant progress in private R&D investment, but the links between academia and business remain weak, as shown by the low share of public research funded by the private sector (20 percent of the EU average) (European Commission, 2022a).

A change in mindset is needed for cooperation to work well, which has started with the optimisation of knowledge transfer processes. The survey carried out under the EDP during the design of the National Smart Specialisation Strategy in Hungary confirmed not only that the actors of the RDI system largely perceive the domestic education system as a barrier to knowledge flow and innovation (see Section 2.2.4), but also that the low level of cooperation between academia and the business sector is a major problem. In Hungary, the willingness to cooperate should be reconsidered, mainly in terms of willingness to cooperate and the sense of responsibility. The aim of knowledge transfer collaborations, on the one hand, is to transfer the complex knowledge accumulated by the universities' departments or stakeholders to the industrial side. On the other hand, it is not only the attitude of university actors that can cause difficulties in the cooperation process.

In addition to knowledge transfer processes, technology transfer processes also need improved. In recent years, the industry's involvement in research projects has become increasingly specialised in narrow projects where the return on investment is measurable and understood. One such user-driven construct is *cooperative research,* which is a developmental activity between two or more parties, embodied in an institutionalised contract involving a research mandate, a consortium agreement or informal interactions (Inzelt, 2004). Of these, the most commonly used form in Hungary today is the research contract. In terms of content, it involves a member or a unit of the university carrying out tasks for a company, on a contract basis, to develop a solution to a problem defined in a specific project. A research contract can often be the first step towards a longer-term commitment to an institution. However, based on market experience in Hungary, closer technical cooperation beyond the concrete project is rare or non-existent. *Technology transfer* is a different solution in terms of its operational objective, as it is a form of cooperation focusing on the transfer of results in the form of technologies, technical and methodological solutions (Bartha, 2014).

The success of consortia partnerships between universities and companies needs to be rethought so that the primary goal of the stakeholders should be the development of the final marketable product or technology. At present, the parties involved in a proposal often look for an idea for the proposal and find each other through the call for proposals. This is because the call for proposals includes the need for collaboration. However, collaborations would work effectively if research centres and companies found each other with an innovative idea and healthy market motivation. Then the joint motivation of the collaborating stakeholders would significantly increase the success of the

project. This, however, requires public support through the right channels and the promotion of domestic entrepreneurship. A well-functioning innovation ecosystem supports not only the production of exportable products and services, but also the creation of new jobs.

According to expert reports prepared by the Commission, targeted public funding should support cooperation between universities, research institutes and industry. For example, the ZalaZONE project was launched in May 2016 to facilitate both the aforementioned knowledge and technology transfer processes among governmental, industrial and academic actors. By establishing the Zalaegerszeg automotive test track, the government of Hungary aimed to help strengthen automotive R&D capacities in Hungary and support the European automotive industry with a unique research and testing infrastructure. In line with this, the company responsible for managing and implementing the test track will also be responsible for developing the related automotive and engineering knowledge, supporting the related R&D, education and knowledge transfer – while managing the test track concept, delivering the investment and creating a competitive operation.

In response to national and international feedback, the RDI policy has launched a number of initiatives to encourage cooperation in recent years. Examples include Centres for Higher Education and Industrial Cooperation; Competence Centres; University Innovation Ecosystem; participation in the Applied National Research Institutes Network and the creation and complex development of 8 National Laboratories. In the case of the latter, to promote knowledge transfer and usability, additional filters were added to the indicators to compel participants to consider how the research will be implemented, what societal purpose it will serve and which industrial actors it will benefit.

Another problem mentioned by experts is that the impacts of joint research partnerships between large corporates and universities do not reach the SME sector. Knowledge generated through joint research should be demonstrated and made available to SMEs to strengthen knowledge building and technology transfer (NRDIO, 2019).

The government is increasingly focusing on university centres to strengthen university networks and local innovation ecosystems, which has resulted in an improved rate of cooperation between innovative enterprises and universities in Hungary. According to the 2018 innovation survey, between 2016 and 2018, 10.6 percent of innovative enterprises collaborated with a higher education institution in Hungary, lagging behind the EU average of 12 percent. However, in contrast to the decline in the countries of the region, the next 2020 innovation survey shows that in Hungary the figure rose to 11.1 percent, above the EU average (10.5 percent) (Table 4-2).

Table 4-2: Proportion of innovative enterprises collaborating with higher education institutions (%)

	2018	2020
EU27	12.0	10.5
Czechia	11.0	9.8
Poland	9.9	7.4
Hungary	10.6	11.1
Slovakia	10.3	7.1

Source: Eurostat, CIS 2018–2020.

4.5 Role of the venture capital market

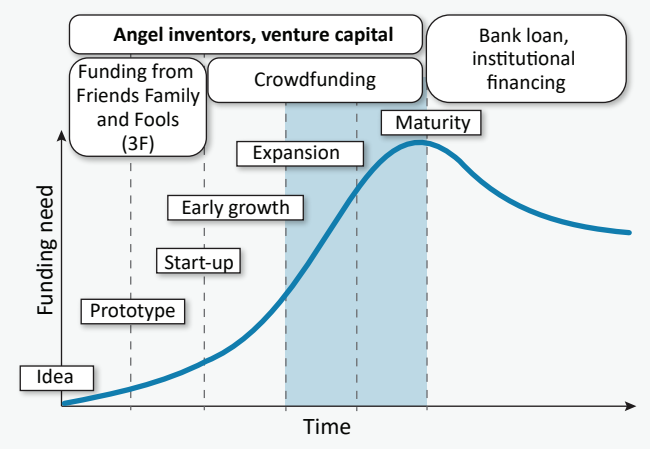
4.5.1 ROLE OF AN EFFICIENT VENTURE CAPITAL MARKET IN DEVELOPING WELL-FUNCTIONING INNOVATION ECOSYSTEMS

The cooperation of public and educational institutions and the corporate sector is not enough to achieve rapid growth. Namely, because of the high risk of return on investment in innovation, enterprises interested in innovation can grow faster with the support of external partners than they could on their own. This is why the MIT REAP program emphasises that the involvement of venture capital is critical to shaping an advanced ecosystem.

Innovation-driven businesses require significant investment to develop and scale their new business solutions, the main source of which typically comes from venture capital investment. Innovation-driven businesses in their early growth and expansion phase require a level of capital investment that is not possible with bank or other more "traditional" financing due to their lower turnover and low number of completed financial years (Chart 4 3). Risk capital market players can provide innovation-driven businesses with flexible and fast financing, which they can use to hire skilled labour, purchase assets or services and expand dynamically in the market. In many cases, venture capital investors also provide strategic business support through their extensive experience and network of contacts. Many players in well-functioning venture capital markets are former start-up founders who have a deep under-

standing of the challenges associated with building successful innovation-driven businesses. A well-developed venture capital market can therefore help start-ups in many areas, which is why it is important that regulators prioritise the development of the venture capital market, which is key to sustaining a dynamic ecosystem and high value-added economic growth.

Chart 4-3: Venture capital investments in the corporate life cycle



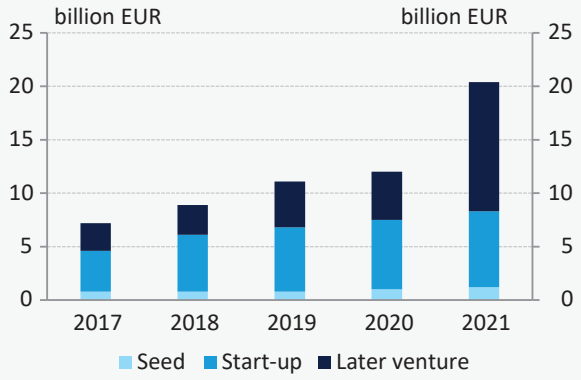
Source: MNB.

A well-functioning venture capital market is essential for the initial financing of especially high value-added, high growth, innovation-driven businesses. Companies that have received venture capital investment are a narrow and specialised group, with only 0.05 percent of start-ups in Europe receiving such funding. Although their number is small, they are already dominant among companies that have reached a valuation of more than a billion dollars (so-called "unicorns") or have gone public, with 15 percent of companies with a value of more than a billion dollars in 2010 and 55 percent in 2020 being financed with venture capital (see, for example, Karsai, 2021).

4.5.2 VENTURE CAPITAL MARKET IN THE EUROPEAN UNION AND THE CEE REGION

Venture capital investment in Europe has seen a significant increase in both the number of companies and the amount of capital invested, reaching over EUR 20 billion by 2021. Venture capital market investments have been on a rising trend in recent years and increased significantly in 2021, mainly due to so-called "later venture" deals (investments in more mature companies) (Chart 4-4).

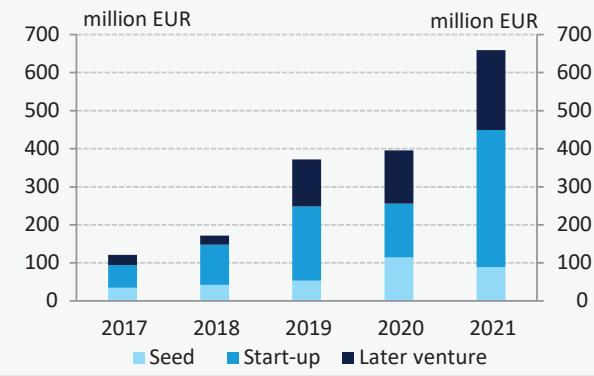
Chart 4-4: Total value of venture capital investment in Europe



Source: Invest Europe (2022).

The Central and Eastern European region is characterised by a significantly lower level of investment, with EUR 659 million of venture capital invested in 2021. More than half of this (EUR 360 million) is made up of start-up stage investments, which more than doubled compared to 2020, but later-round investments also showed a significant increase in 2021 (Chart 4-5).

Chart 4-5: Total value of venture capital investment in Central an Eastern Europe

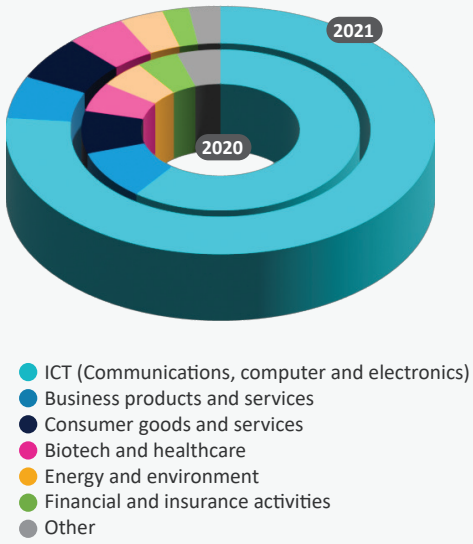


Source: Invest Europe (2022).

The Central and Eastern European region is dominated by government sources of funds, which is a significant difference compared to regions with more developed venture capital markets. In addition to government funds, business angels and corporate investors also play an important role, with these actors having roughly similar shares in private equity investments.

The most popular industry among venture capital investors is information and communication technology (ICT). In 2021, this sector accounted for more than half of total investment at EU level and around 76 percent at CEE regional level, up from 60 percent in the previous year. The markets for consumer goods and business goods and services are still dominant, with a share of around 5–6 percent, both down a few percentage points compared to 2020 (Chart 4-6).

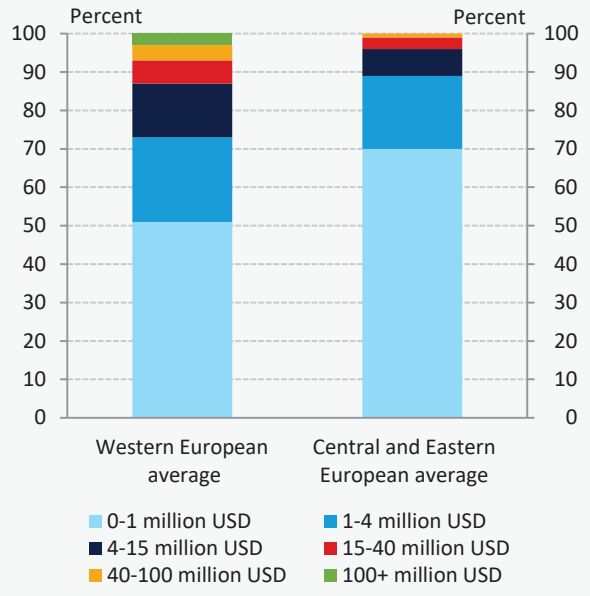
Chart 4-6: Distribution of venture capital investment value in Central and Eastern Europe by sector



Source: Invest Europe (2022).

Although the Central and Eastern European region has seen significant venture capital market activity in recent years, there is still a major gap in the size of early-round investments compared to Western Europe. Early "seed" investments in the CEE region represent 70 percent compared to 51 percent in Western Europe (Chart 4-7), and there is also a significant difference in the number of unicorns: while the UK alone had 110 unicorns by 2021, only 10–20 start-ups worth at least USD 1 billion are visible in CEE.

Chart 4-7: Evolution of different investor bases by region

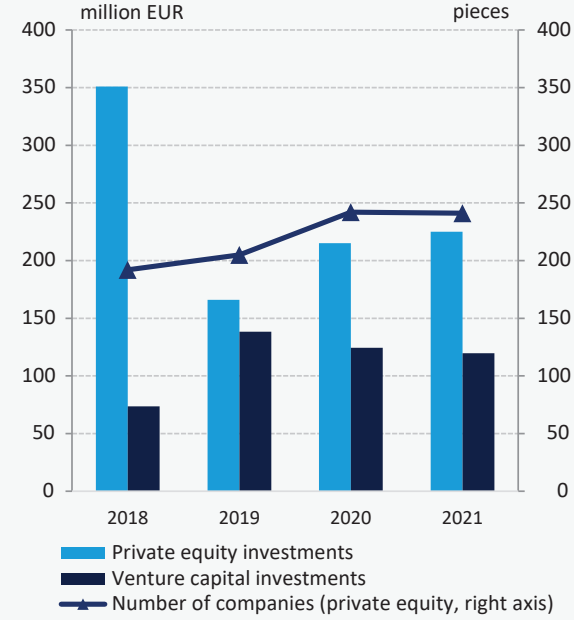


Source: Bain (2022).

4.5.3 VENTURE CAPITAL MARKET IN HUNGARY

The number of Hungarian venture capital investments[9] has been growing steadily in recent years, but the market is still significantly smaller than in the region's leading countries (Poland, Estonia, Lithuania). Looking at the domestic market from both an entrepreneurial and an investor perspective, Hungarian companies tend to receive a higher value of venture capital investment than domestic venture capitalists invest, either domestically or abroad. In terms of the overall market, some EUR 225 million was invested by private equity investors in Hungarian companies through 241 transactions in 2021, of which around half can be considered venture capital investments (Chart 4-8).

Chart 4-8: Total value of private equity and venture capital investments and the number of transactions in Hungary



Source: HVCA(2022).

The circle of domestic venture capital investors is quite heterogeneous. In addition to the major public players, private venture capital investors and institutions with a banking background are also active. Although not dominant in the past, the role of business angels, a key priority for early-stage innovation-driven businesses, is gradually growing. Compared to international experience, the presence of family offices is the only less common feature, mainly for historical reasons.

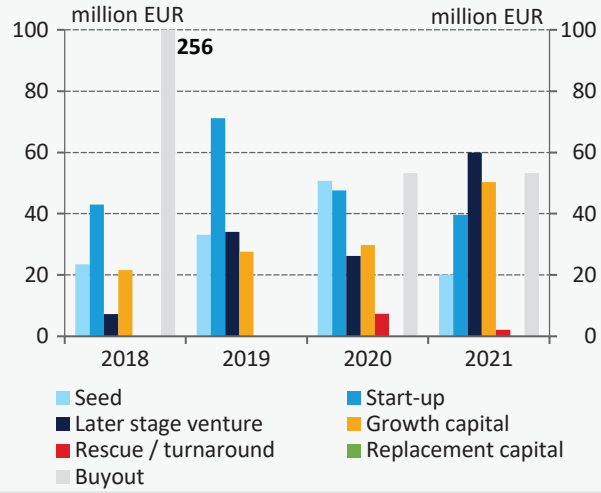
A major challenge in the domestic venture capital market is that there have essentially been few highly successful exits. Hungary is practically the only country in the region

9 For the domestic investor market, data on venture capital market are often not available, so where they are lacking, private equity data covering a wider range of investment types are presented.

that has not yet seen a unicorn business (a start-up with a valuation of at least USD 1 billion). The experience of accelerators, incubators and venture capital firms shows that it is relatively difficult to find suitable start-ups, and entrepreneurship in Hungary is generally lower than in most of the surrounding countries.

The investment opportunities available in Hungary now cover virtually the entire life cycle of a company. As several investment programmes and investors are open to support projects that are still in the idea phase, pre-seed and incubation investments are also relevant on the Hungarian market. Seed and start-up capital investments are available for innovation-driven businesses in a more mature stage, and there are also a number of investment opportunities for later-stage firms, which could include various new rounds of investment, buyouts or even M&As (Chart 4 9). Although financing opportunities are widely available for innovation-driven businesses, investment amounts and company valuations are typically much lower in the Hungarian market than in more developed markets in the region or in Western European countries.

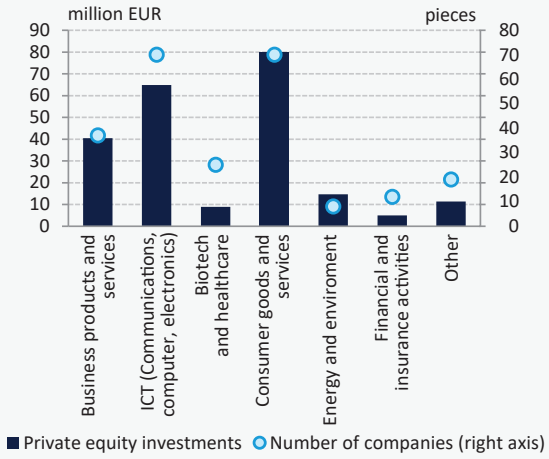
Chart 4-9: Private equity investment types in Hungary



Source: Invest Europe (2022).

In the case of Hungarian start-ups receiving investment, there is a broad spectrum of industries covered. Market data for 2021 show that consumer goods and services as well as the ICT sectors are the most targeted by investors, with energy and environmental, biotech and healthcare companies less so (Chart 4 10). For the energy sector, the lag in transaction activity compared to other industries can partly be explained by the generally higher financing requirements for various investments: in 2021, the largest transactions (in terms of average deal size) were made in the energy and environment sector, with an average deal size of EUR 1.8 million, about twice as much as in the ICT sector.

Chart 4-10: Private equity investment types in Hungary by sector



Source: HVCA (2022).

4.5.4 STATE OF HUNGARIAN VENTURE CAPITAL ECOSYSTEM BASED ON SURVEY BY SCALE-UP HUNGARY

As part of the international MIT REAP initiative, the MIT REAP Hungary team conducted extensive interviews with key players in the Hungarian venture capital market. The interviews, typically qualitative in nature, provided useful information and experiences on the potential development of the Hungarian innovation-driven business ecosystem, and our analysis is based mainly on these interviews.

Hungarian venture capital funds typically range from EUR 5 million to EUR 400 million in size, while typical investment tickets are generally between EUR 50,000 and EUR 1 million. Small funds usually manage the finances of wealthy individuals, while at the other end of the scale there are large sovereign wealth funds. Stakeholders are active at several levels in the Hungarian ecosystem:

- Generally speaking, *global and international funds* rarely have a local presence and are only present in Hungary for specific transactions. The average transaction size is between EUR 50 and EUR 100 million.

- In most cases, *regional funds* already have an active local presence, but the transaction process is typically managed from other venture capital centres (London, Amsterdam, Berlin, etc.) and they are often sector-focused funds. The average investment amount is at least EUR 1 million, but mostly in the EUR 10+ million category. At the entry level of this category we do find Hungarian-related funds.

- In Hungary, *public and EU-supported funds* have multiplied over the past decade. In most cases, capital is invested within the country's borders, but regional investments are increasingly common too.

Many domestic venture capital investors consider it a challenge to find professionals with the right experience in the field. In the 2010s, a milestone in the development of the Hungarian venture capital ecosystem was the emergence of the Jeremie funds (Joint European Resources for Micro to Medium Enterprises), which set the sector on a more dynamic path and significantly transformed the Hungarian start-up financing landscape. As it is mainly from this period onwards that there has been more activity in the venture capital market, Hungarian investment professionals typically have 5 to 15 years of experience, while investment experts with up to 20 to 30 years of experience, often present in more developed markets, are quite rare.

An important characteristic of the domestic market, according to the survey, is that the investment policy of venture capital funds is in most cases considered to be rather risk-averse. Part of the reason for this risk-averse attitude may also be that many professionals in the field have experience from the traditional financial sector and often apply the same approaches to this market, where they might not be suitable due to the different business model. It is often this attitude that means domestic risk venture capital investors expect too high a share for a given investment in the different financing rounds, which can reduce not only the valuation of the company at the time of investment, but also the interest of potential future investors. Another important shortcoming of the Hungarian ecosystem is that there is less mentoring and advisory activity from investors based on deeper practical experience, mainly due to the relatively short history of Hungarian venture capital. It would also help the ecosystem if more and more successful ex-start-up founders with significant "exits" were to invest and mentor, although some encouraging initiatives in this context have been launched in recent times.

The most important investment criteria for Hungarian investors are the size of the potential market, the technology used, the right business plan, the existence of a prototype and the composition of the entrepreneurial team. More recently, the role of co-investors in individual investments has become increasingly important. Compared to international experience, intensive R&D activity and the existence of patents related to the activity are less important criteria for domestic investors.

Venture capital investors consider that one of the key deficiencies of Hungarian innovation-driven businesses is their lack of ability to sell and build markets. The right business plan and product–market fit are also important factors where Hungarian venture capital firms generally see Hungarian start-ups come up short. A general lack of trust in venture capital in the ecosystem also hinders development, as innovative actors for whom the involvement of venture capital could be justified tend to look for other solutions first. In many cases, this is also because start-ups do not really understand the operational logic of venture capital investments.

Among domestic venture capital investors, the legal framework in Hungary is generally well known, which helps operations and creates a clear framework for cooperation for both investors and start-ups. An important risk-mitigating factor for venture capital investors is the availability and relative ease of access to public databases, and the relatively good overall transparency of the companies' operations and ownership structure by international standards.

According to the survey, a significant proportion of Hungarian venture capital market participants believe that the presence of the state in the market does not always deliver the expected results. The strength of the domestic market is that, partly due to the strong state involvement, there is still a substantial amount of venture capital funding available, even in the current yield environment. However, state-owned venture capital investors may have a distorting effect on the Hungarian venture capital ecosystem, as on the one hand they may crowd funding out due to different incentives (in many cases they focus on the amount of capital placed rather than on the return), while on the other hand, state-owned investors may be relatively slow to make investment decisions on new rounds of fundraising, partly because of significant internal regulation and bureaucracy. This could even pose a serious risk for newer investment rounds, as the slow decision-making process could deprive start-ups of potential investments.

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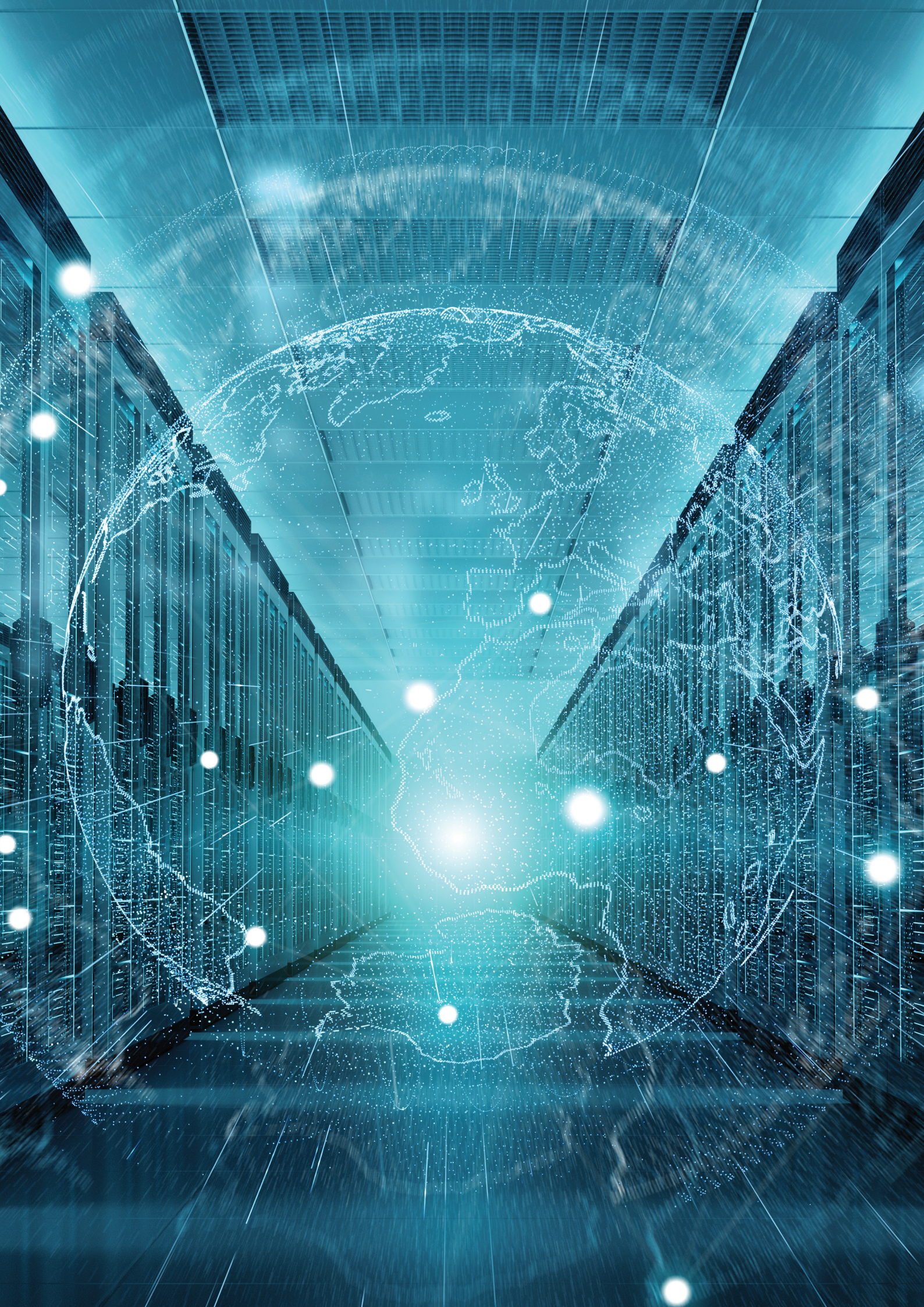


5 Hungarian Innovation-driven Enterprises (HIDEs)

The last stakeholders we mention in the methodology of the MIT REAP programme are the entrepreneurs who play a prominent role in creating IDEs. Without entrepreneurial ideas, commitment, ambition or risk-taking, there can be no above-average, or even exponential, business growth. We identified the Hungarian innovation-driven enterprises (HIDEs) by complementing the basic MIT definition and taking domestic characteristics into account. We consider companies HIDEs that are characterised by some innovation effort or achievement (patent, protected trademark, tax credit because of R&D expenses or government subsidy related to R&D) and, in addition, they are fast-growing (so-called gazelle) or are not in gazelle status any longer, but they show strong export performance.

Our research has identified around 1,100 innovation-driven enterprises in total. Although they accounted for a mere 0.3 percent of active Hungarian companies, they made up 13 percent of total gross exports and 22.8 percent of annual Hungarian GDP growth. These companies are mature (9–12 years old), and mostly Hungarian-owned. As for their activities, 43 percent of them operate in narrow industries requiring specific knowledge. HIDEs are more often found in knowledge-intensive sectors, such as natural science and technical research and development, computer programming, engineering, technical, business management and IT advisory services, manufacturing and (wholesale) trade of special products, as well as creative subsectors. International experience shows that innovation-driven operation is strongly concentrated geographically. This phenomenon is observed in Hungary as well. Nearly half of the HIDEs operate in the capital, and many innovation-driven firms are present in county seats as well where there are multi-disciplinary universities.

Neither rapid growth nor isolated innovative production systems are sufficient for steady and dynamic economic convergence. In most cases, (non-innovative) gazelle companies grow as one-hit wonders, and they are usually unable to repeat their outstanding expansion. At the same time, high and persistent growth is not a given among innovative companies. According to our numerical findings, the growing share of intangible assets and an export focus increase the probability of an innovative company developing into a HIDE. Nevertheless, financing the operation from equity reduces this likelihood.

During the mapping of Hungarian innovation (I-CAP) and entrepreneurship (E-CAP) capabilities we found that funding proved to be a crucial point among innovative and innovation-driven companies. Currently, self-financing (88 percent), various subsidies (71 percent) and tax allowances (61 percent) are the fundraising options available for the majority of innovative companies. Less than 40 percent of enterprises have access to alternative sources of funding, and these are not very well-known either. Barely more than a third of the responding companies indicated risk capital investment as an option, which plays a central role in the MIT concept.

Primary research also revealed that innovative companies and entrepreneurs, much more likely to be risk-takers than the national average, accept the risk of making mistakes in business, chalking it up to experience. However, this approach is not common among those who intend to set up an undertaking in Hungary. A mere 16.8 percent of the adult Hungarian population that consider launching an enterprise as a good opportunity are not afraid of the potential failures of becoming an entrepreneur. Overcoming this fear is crucially important for the growth of Hungary, both in the medium and long term.

5.1 Concept of Hungarian innovation-driven enterprises (HIDE)

To find Hungarian innovation-driven companies, we revert to Bill Aulet's concept of innovation = invention × commercialisation. On this basis, we consider innovation-driven companies in Hungary to be those that

1. make some innovation effort or have an innovation output that can be identified and linked to the firm;

2. have seen their sales increase exponentially, at least during one growth phase.

5.2 Data used

5.2.1. MULTI-LINKED, NEW RESEARCH DATABASE AND ACCOMPANYING QUESTIONNAIRE

MIT's entrepreneurship programme focuses on the innovation and economic readiness of regions, but a more comprehensive and deeper understanding requires micro data. The results of the programme can be measured well for entrepreneurs in regions with a population of between 1–10 million people. The number of innovation-driven enterprises becomes a key statistical indicator for the assessment, and business-level information is needed to register these data.

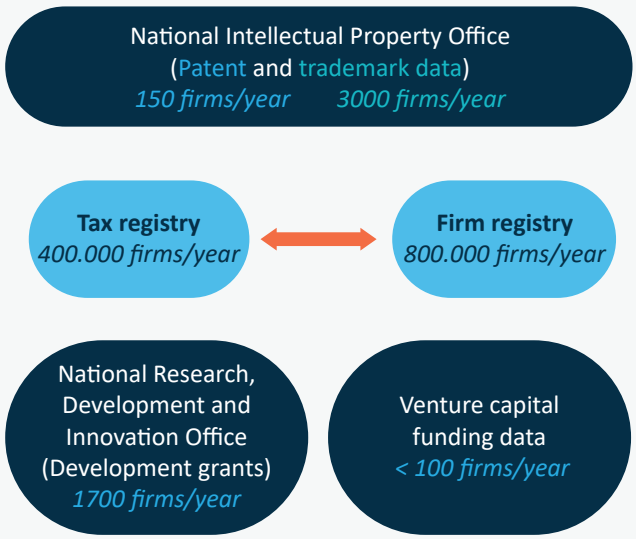
Micro data analysis techniques provide knowledge that allow well-founded systemic decision-making, parallel to business-level monitoring of Hungarian innovation and entrepreneurship capabilities. To identify innovation-driven enterprises, we created a database integrated from various, individual data.

The phenomenon of innovation-driven growth is strongly concentrated geographically, and the increase in the concentration of IDEs stimulates growth through the network effect (Audretsch and Feldman, 2004). The logic of 'common location', with the growing exchange networks and the ensuing network effects, means that successful regions (and nations) continuously perform better, while the less successful ones tend to lag behind. The system-like behaviour of these locations has an impact on the whole region where this process takes place, even on the nearby municipalities that did not exceed the threshold of accelerating growth (or at least not at the same pace). Ultimately, as the impact mechanism prevails, concentrated innovation-driven development may become prevalent in the national economy of small countries.

Innovation-driven enterprises induce a multiplier effect in the labour market as well. According to Moretti's (2012) research findings, each new high-tech job in a given town ultimately results in the creation of 5 additional jobs. Innovative activities brought technology-intensive jobs and high salaries to communities where places of business were established, and their impact on the local economy was much deeper than that of previous interrelations. The spill-over effect of these activities proved to be significant in the local labour markets. The quality of the jobs created varied depending on qualifications; the number of new jobs filled increased in services in particular (teachers, nurses, lawyers, employees in restaurants, hotels and trade).

Bearing these effects in mind, for the sake of completeness we created a unique research database with multiple data links to learn about Hungarian innovation-driven enterprises (Chart 5-1). One can learn about the performance of Hungarian enterprises from their submitted accounts. So as a central database we used a corporate database comprising the balance sheets and accounting profitability information of Hungarian corporate taxpayers. With the help of company identification numbers we merged the individual innovation-related characteristics to the economic data to be able to carry out a comprehensive research analysis. We matched various data that describe some kind of explicit innovation activity in addition to R&D tax allowances. Accordingly, besides information from the National Research, Development and Innovation Office (NRDI Office), we used patent and trademark office data as well in order to assess innovation capacities. Companies' statistical data, such as sectoral classification, size or age, came from the company registry. Finally, we collected the enterprises financed with risk capital from the US Crunchbase market database. Crunchbase is one of the best-known databases of start-up firms. This platform systematically gathers together innovative companies awaiting financing and that are in different phases of raising private capital to establish relations with the people behind them and to pursue new opportunities.

Chart 5-1: Sources of the multi-linked analytical database with annually observable firm numbers



Note: risk capital financing data are from the US Crunchbase database (crunchbase.com).
Source: MNB.

We merged the available corporate micro databases extensively to take the region-specific characteristics into account (Chart 5-1). In view of the historical and geographical situation, each region provides different conditions for reaching the same targets. Budden et al. (2019) emphasise that although 'innovation-driven enterprises' are the indicators of success, measuring them requires a complex approach, especially because time is needed for them to evolve, even after systemic changes and efforts. They also urge a comprehensive understanding of the innovation and economic capacities of regions through intensive use of data.

The unique multi-linked corporate database results in hundreds of millions of data points. The balance sheet and income statement data of nearly 400,000 companies a year, with at least 50 characteristics in the 10-year observation period (2009–2019, see Section 5.1.2) produces 200 million data points, which may multiply with the expansion of the set of variables.

Only the observable innovation inputs and outputs can be incorporated into the data-based analytical framework. In many cases the elements of the innovation process remain unseen (in a statistical approach). Since innovations may take on a form that cannot be tracked in economic statements, measuring them is subject to limitations. Examples include investments into intangible assets or imports of licences and know-how, assets that have already been accepted as verified innovations and can be implemented from fewer resources than own developments. Moreover, innovations, proposals and rationalisations may trigger a wave of ideas for a company, representing greater value than many of its own patents, although – from a legal protection and scientific point of view – they do not qualify as inventions.

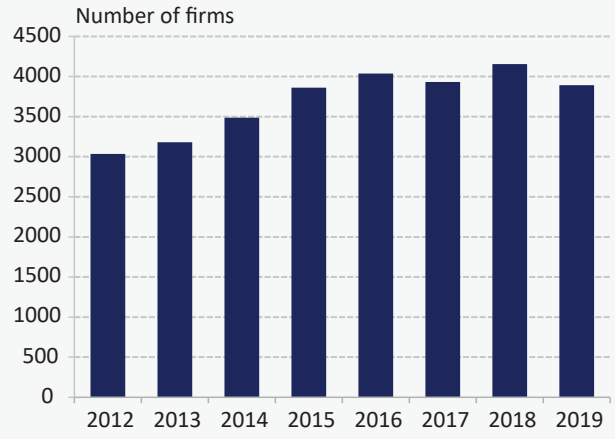
To explore companies' characteristics that are difficult to perceive, we conducted a questionnaire survey among the Hungarian innovative companies identified from the database. To assess the Hungarian innovation and entrepreneurship ecosystem, as well as to identify possibilities of further development, the data-based exploratory analysis was accompanied by primary research as well. The research was carried out as part of the NRDI Office's own data collection procedure. Those completing the questionnaire were selected from the new and unique database mentioned above. Firstly, the questions explored qualitative company-specific facts, needs and levels of satisfaction that cannot be gleaned from databases. Secondly, the advantages of the responses are their timeliness as well as their reliability, which stem from the data collection method. The questionnaire consisted of 27 questions to be answered by indicating a value on a scale of 1-6. Grade 1 on the scale meant complete disagreement, while grade 6 meant complete agreement with the given statement. The questions covered 5 topics, such as innovation-economic environment (1), the role of human capital (2) and financing (3), market competition (4), as well as cultural motivation factors. In addition, 13 questions focused on the availability of special forms of funding. Beside yes or no answers, 'don't know' was also an option. The conclusions drawn from the responses of 182 respondents are presented in Section 6.5.

5.2.2 TIME HORIZON OF THE ANALYSIS (2009–2019)

Research and development activities and rapid corporate growth are connected with the fluctuations in economic cycles. Technical-scientific development exerts its impact on productivity through market demand. The upswing in demand for a given innovation takes place with a delay. The appearance of products manufactured using new technologies and then seeing them gain ground vis-à-vis old products takes time. However, if there is an upturn in the relevant demand, the business cycle rises, and the productivity indicator for the whole economy rises sharply. Nevertheless, the rapid rise in productivity is attributable not only to technical development, the increase in capacity utilisation, the effect of the growing yield and the upswing in economic activity also play a role here. Many start-up firms are established in the wake of this latter factor, several

of which achieved rapid growth as a result of the strengthening demand. The number of high-growth enterprises topped out in 2018 (Charts 5-2 and 5-3). Overall, the objective manifestation of technical and scientific progress is reflected in the productivity indicators indirectly with a lag. At the same time, and from the other side, methodologically it is more difficult to detect what proportion of the expansion in productivity originates purely from the result of technological changes (Szalavetz, 2011).

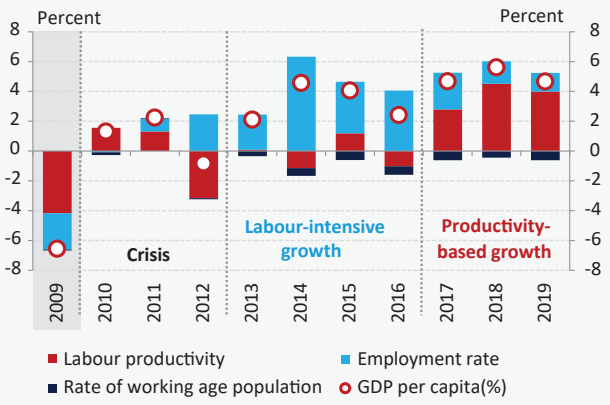
Chart 5-2: Number of companies with high (headcount) growth (2012–2019)



Note: Private sector excluding agriculture and financial intermediation. Enterprises with a headcount of at least 10 people. In the definition of the DIW Econ Institute, fast-growing companies are firms whose headcount increased by at least 10 percent on average in 3 consecutive years. This definition is different from the one we use.
Source: MNB based on DIW-ECON.

As we wanted to investigate the relations between innovation and growth over an entire growth cycle, in the subsequent calculations we examined the period between 2009 and 2019 (Chart 5-3). Amidst the disruptions caused by the Great Recession in 2008–2009 and the COVID-19 pandemic (2020), Hungarian economic growth can be broken down into three distinct partial periods. The post-crisis recovery period lasted until 2012, followed by a subperiod of extensive growth based on a wider labour base, with a general increase in activity and employment rates until 2016 (a similar analysis of the period until 2016 was prepared in Hungary by Lengyel and Varga (2018)).

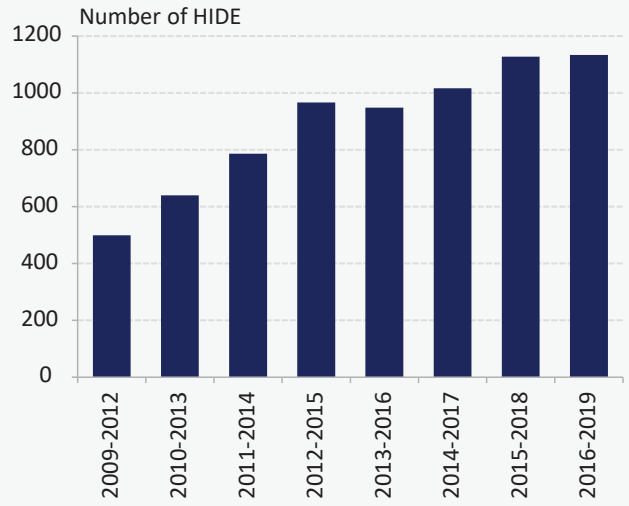
Chart 5-3: Breakdown of domestic growth factors (2009–2019)



Note: GDP at 2015 prices.
Source: MNB based on OECD.

In the period between 2017 and 2019, engaging more labour became more difficult, reaching a state of almost full employment in Hungary. This is when capital- and technology-intensive type growth came to the fore. The number of innovation-driven companies in Hungary also peaked in these years (Chart 5-4).

Chart 5-4: Number of Hungarian innovation-driven enterprises (HIDE) (2009-2019)



Note: in view of the gazelle growth, instead of the year, the relevant periods are indicated on the time axis.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

5.3 Hungarian innovation-driven enterprises

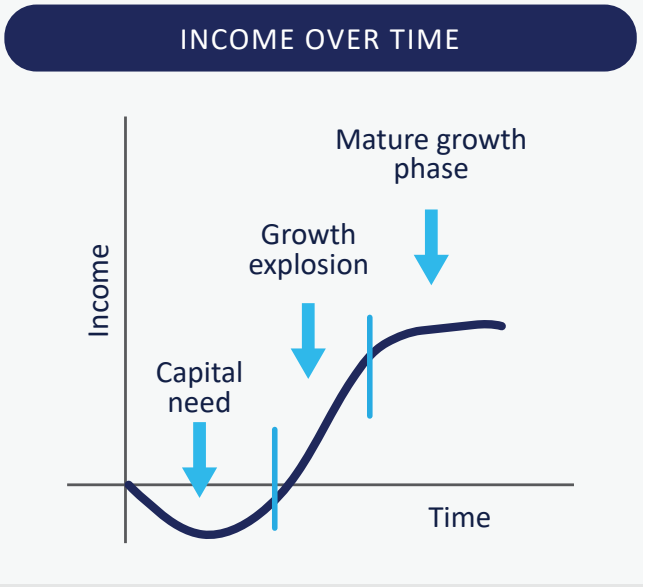
We considered two types of firms as Hungarian innovation-driven enterprises (i.e. HIDEs, inspired by the US acronym). Taking the Hungarian ecosystem into account, we reinterpreted the definition proposed by MIT (see Section 3.2) and expanded it with companies that reached beyond outstanding growth, but due to their foreign market participation are still forced to innovate continuously. These latter companies are called innovative exporters. Accordingly, a company operating in Hungary is a HIDE if it is

- an ***innovative gazelle,*** i.e. it demonstrated *observable innovation* performance in the period between 2009 and 2019, and it is in the *growth explosion phase,* i.e. it was able to increase its (real) sales revenue by at least an average 20 percent in three consecutive years, or
- an ***innovative exporter previously with gazelle status,*** and with an *observable innovation* performance it stepped into the *mature growth* phase – previously showed gazelle-type growth between 2009 and 2019, but in the given year its (real) sales growth is below 20 percent –and its *foreign market sales* account for at least 10 percent of its turnover.

The company's operational/growth strategy determines whether it is an 'innovation-driven' enterprise (Aulet and Murray, 2013). On the one hand, innovation-driven enterprises are firms that continuously introduce new ideas, processes or products to achieve growth and thus expand further and realise surplus market profits. On the other hand, the growth pattern of innovation-driven enterprises follows a specific S-shape (see Section 3.2). As these enterprises carry out research, development and innovation (RDI) activities in the introductory phase of the products/services offered, they invest more in the early stage of the corporate life cycle, then achieve explosive growth thanks to the competitive advantage from such investment.

Reinterpreting the life cycle of innovation-driven enterprises defined by MIT, in addition to the phases of early financing and explosive growth we also have the mature growth phase. To verify the stages of the theoretical growth curve with data, we modified the concept of the life cycle of innovation-driven enterprises for reasons of Hungarian characteristics and the recording of information. Before discussing the identification of HIDEs, below we also touch upon the three partial periods of the individual growth curve (Chart 5-5) and the importance of exporting.

Chart 5-5: Growth curve stages of innovation driven enterprises



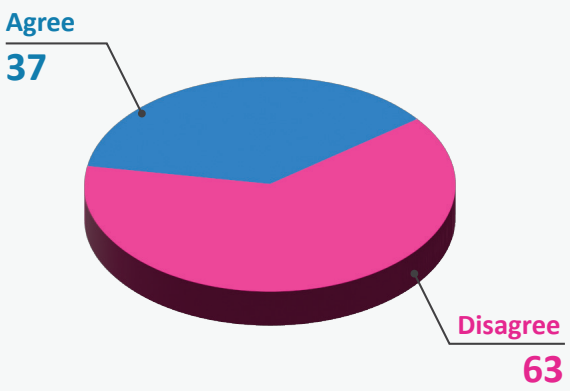
Source: MNB based on Aulet and Murray (2013).

5.3.1 EARLY GROWTH PHASE AND RISK CAPITAL FINANCING

Most IDE investments are in the early stage of development; the cash flow of these firms is initially negative. Research, development, production preparation, production and sales constitute the main functional units and phases of the innovation process. Due to the capital-intensive investment taking place prior to production and product rollout (the first three partial processes), innovation-driven enterprises face special challenges.

It follows from the necessity of these early expenditures that the driving force behind launching an innovation-oriented enterprise is mostly internal motivation. The findings of the qualitative questionnaire survey confirmed the assumption that the Hungarian enterprises that combine development creativity with entrepreneurship were not founded out of necessity. 63 percent of the respondents did not start their entrepreneurial activities because previous jobs were terminated, some other change in their life situation or a switch of careers (Chart 5-6). An internally motivated person starts the chosen activity because of some internal satisfaction, and is not compelled to act because of a particular consequence, pressure or reward (Deci and Ryan, 1985). MIT also finds that it is crucially important for the founders of these companies that their enterprise is socially, ecologically and/or economically useful and effective.

Chart 5-6: Share of innovation-driven enterprises launched under external pressure based on questionnaire



Note: Based on responses from 182 companies. Question: 'Was the launching of the entrepreneurial activity driven by the termination of previous job, other change in life situation or career changing reason?' The respondents chose on a scale of 1-6 whether they agree with the given assertion of the survey completely (6), mostly (5), rather agree (4), or the opposite (1, 2, 3). They could refuse to answer any question, or they could refer to a lack of information on a subject.
Source: MNB based on MIT – IDE project questionnaire survey.

Companies interested in innovation can grow faster with the support of external partners than they could on their own. Firstly, many and various resources (funds, time, expertise) are used before an idea brings economic benefits (including particularly high profits). Secondly, a very low share (approximately 5 percent) of the ideas are successful. Moreover, the distribution of economic benefits across the ideas realised is also very uneven. Accordingly, the taking and sharing of risks is crucial in bringing cutting-edge innovations to fruition.

In the MIT approach, risk capital plays a decisive role, but in Hungary this type of funding was not a widespread form of fundraising in the 2010s. Risk or venture capital evolved and became a viable risk-taking strategy in the United States. Its spread in Europe and Asia is still gradual, but not commonplace (for more details see Section 4.5). Enterprise funding is based on the principle of risk sharing in many developing countries. In lieu of private capital, the external party is the banking sector in a wider sense, which may be supplemented with the involvement of the state in the case of strategic planning. Likewise, venture capital has not become a widespread financing practice in financial intermediation in Hungary. In the 2010s, firms in the seed stage, full of ideas, faced financing difficulties, which meant the domestic growth patterns were different from the 'textbook' example. Hungarian innovative enterprises often had access to funds for development in the scale-up phase, and so accordingly we did not use the risk capital element in the Hungarian definition and when identifying companies. In spite of the frequency, we collected the companies financed with risk capital from the Crunchbase market data platform.

5.3.2 THE GROWTH EXPLOSION PHASE

From the existing definitions, we opted for the OECD's *gazelle* definition as the basis for exponential growth. Gazelle definitions may vary (see, inter alia, the studies by Ács–Mueller (2008), Henrekson and Johansson (2010), Schreyer (2000), OECD (2010), Eurostat – OECD (2007)), but because of the later comparisons outside Europe we used the definition of the Organisation for Economic Co-operation and Development (OECD) when creating the concept.

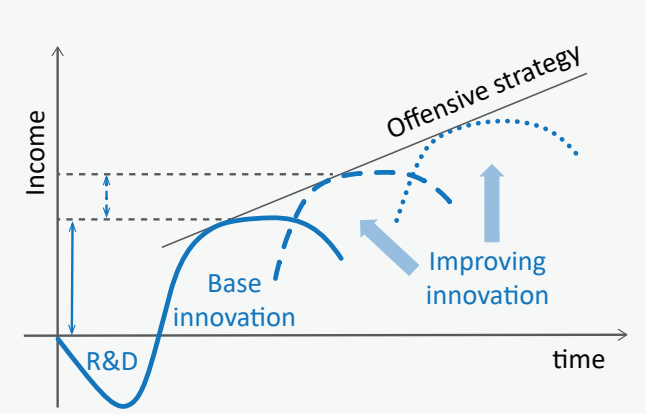
Fast-growing (otherwise known as *gazelle)* companies are the firms that increased their net sales revenue by at least 20 percent on average in three consecutive years. In practice, this means that the given group of companies nearly doubles its own sales revenue by the 4th year of this fast growth period. Although sales revenue figures are not negative income statement data, and their content differs from that of cash flow, which is closer to the theory, their widespread use and movement in tandem with corporate output make them accepted and suitable for business and real economic analyses alike.

5.3.3 MATURE GROWTH PHASE

Offensive innovation-driven strategy relies on continuous development, and results in long-term technological growth as opposed to short-term economic effectiveness. Changes in the initial product by profit rate are shown in the basic innovation curve of Chart 5-7. Stagnating technology becomes obsolete as time goes by, and if the features of the offered product do not adapt to the changing demand, the product enters the declining phase of its life cycle. From an engineering and technical perspective, a novelty that can be used economically is never a completed product; it alters and adapts itself upon interaction with society, in line with changing preferences. If – starting from the peak technological level reached with the basic innovation – the entrepreneur starts a new innovation that entails a major rise in the technological level (introducing a developing innovation), this change triggers an increase in productivity as well. Szántó (1985) calls this technology-renewal process offensive innovation strategy, and emphasises that this operating principle not only entails long-term economic results, but also contributes to raising a country's economic and scientific/technical potential. Therefore, taking the above into account, in addition to fast-growing, innovative

enterprises, we also considered innovation-driven the firms whose operations comprised the innovations listed above and which had left the growth explosion phase behind, but are still forced to innovate continuously due to their foreign market participation. For this reason, exporting firms are characterised not only by continuous innovation but also by higher innovation performance, as confirmed by the questionnaire survey.

Chart 5-7: Diagram of offensive development strategy based on Szántó (1985)



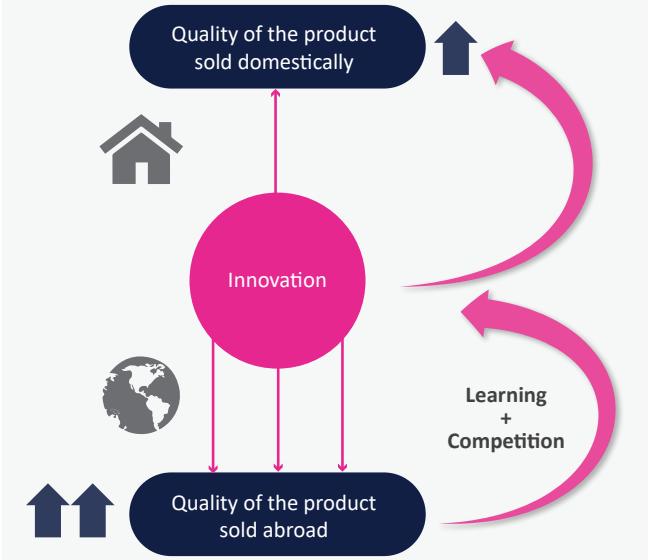
Source: MNB based on Szántó (1985).

5.3.4 IMPORTANCE OF EXPORTING

European exporting SMEs grow more than twice as fast as those that do not export. Moreover, SMEs active in international markets are three times more likely to introduce products or services that are new in their respective sectors than those that satisfy only domestic demand (European Commission, 2010). As regards small and medium-sized enterprises' innovation, exports and growth, the literature dealing with the internal and external drivers of innovation and exporting as well as with the dynamic relations between innovation and exporting was synthesised by Love and Roper (2015). In their comprehensive overview of the literature, they point out that the impact of various ecosystem components on the innovation and exports of SMEs requires further examination.

A company that wants to develop dynamically has to consider that the life cycle of a product is finite, and maintaining a competitive advantage requires unceasing innovation, especially in international markets. According to Lafontaine and Müller (1998), steadily raising innovation capability and continuous learning within the company (i.e. offensive innovation-driven strategy) is a requirement without which a company even 25 years ago would not have survived in global competition. Any innovation-related economic advantage is considered temporary. The cyclical nature of the innovation process is reflected in the fact that one generation of a product is replaced by another, and another life cycle takes the place of the diminishing life cycle. This process partly comprises the repeated assertion of Schumpeter's creative destruction. When there are strong competitors (increased competition), the life cycle of a product shortens, and companies need repeated developing innovations to gain new/further existing competitive advantages. Intensified global market competition is one of the triggers for shortening product life cycles. On the whole, presence on international markets, gaining markets or remaining in a market also require continuous innovation activity. In addition, establishing and maintaining expanding relations with customers, suppliers and other partners also warrant special flexibility – in many cases through process innovations.

Chart 5-8: Relationship between innovation exports and domestic market sales based on Golovko–Valentini (2011)



Note: Products with different characteristics.
Source: MNB visualisation based on the findings of Golovko–Valentini (2011).

Innovation and exporting are complementary strategies in terms of the growth of companies. Using Spanish corporate data, Golovko and Valentini (2011) confirmed that innovation and exports strengthen one another in a positive, dynamic cycle (Chart 5-8). Participation in export market competition helps companies learn (learning by exporting), and thus may increase innovation performance. At the same time, as a result of innovation, companies may enter geographical markets with new and better products, thus making exports more successful. Also, product developments resulting from adjustments to foreign markets may improve the quality of products sold in the domestic market as well, thus increasing domestic sales too. Consistent with the mutual effect, the authors also pointed out that the

positive impact of innovation activity on companies' growth rates is greater in the case of enterprises that were engaged in export sales as well, and vice versa.

There is a positive relationship between R&D growth and higher sales in the case of continuous product and process innovators. Deschryvere's (2014) study analyses the role of innovation persistence in corporate growth. His estimations on Finnish company-level data proved that the relations between higher sales and R&D growth were also stronger in the case of continuous innovators than in the case of occasional innovators. With the statistical method used, Deschryvere (2014) also highlighted that innovative efforts are only reflected in companies' performance indicators with a delay.

5.4 Identification and characteristics of HIDEs

5.4.1 IDENTIFICATION OF INNOVATION-DRIVEN ENTERPRISES

To identify HIDEs we took into account the industry, institutional and size classification of Hungarian companies. The main characteristics of innovation-driven enterprises include the following (Aulet and Murray, 2013):

1. exponential growth following initial loss-making period,
2. innovation activity,
3. focus on export markets,
4. tradable jobs and
5. varied ownership structures**.**

We identified the fast-growing businesses in our combined panel database, while we assigned the innovation elements from external data sources to the raw data (see Section 5.1 for details regarding company registration number and year). The observed innovation elements were used for identifying the companies through R&D tax allowances, development subsidies as well as registered trademarks and patents.

For administrative reasons, innovation activities prior to and following the growth period were also taken into consideration when identifying enterprises. Firstly, in many cases the innovation outputs (patent, trademark) were registered following the exponential growth period. Secondly, Hungarian enterprises – again, many of them – received innovation subsidies (inputs) as late as in the growth phase.

We considered enterprises whose export sales reached at least 10 percent of their turnover to be exporter. A foreign market focus was taken into account in line with the principles explained in Section 5.2.4, although this was not a criterion for fast-growing innovative enterprises. Halpern and Muraközy (2010) conducted an analysis on company-level data regarding innovation and growth. The findings of their research led to the conclusion that a foreign market focus does indeed prompt innovation, but domestic market supply is not necessarily an excluding factor in this respect.

We had no variables measuring convertible, highly trained jobs – transferable to other countries as well without further qualification or retraining – or ones measuring school qualification at firm level. Nevertheless, the evolution of sectoral clusters identified in the study indicated the existence of this characteristic as a consequence. Louis Pasteur (1822–1895), French microbiologist and chemist said: "in the fields of observation chance favours only the prepared mind." From another perspective Mansfield (1961) also pointed out that those with higher qualifications adapt new technological improvements more quickly.

Innovation-driven operation is more common in knowledge-intensive and high-tech industries. Accordingly, we narrowed the spheres of activities. Companies in construction, real estate, financial intermediation (not including financial enterprises providing fintech services), other services, as well as tourism and catering were excluded from the selection and subsequent analyses.

In the extended definition, varied ownership relates to acquisition of ownership via risk capital, which was excluded from the conditions of the exploratory analyses due to the infrequent occurrence of this form of funding. Finally, the groups presented in the next section do not contain the data of state-owned, community, non-profit companies and special purpose entities (SPEs). The threshold according to company size was tied to sales revenue, and thus we took into account the enterprises that generate annual net sales revenue of at least HUF 50 million.

We identified 1,100 Hungarian innovation-driven enterprises (HIDEs) based on our own, expanded concept. We focused on three characteristics of the enterprises: whether they are innovative, fast-growing gazelles or risk-capital

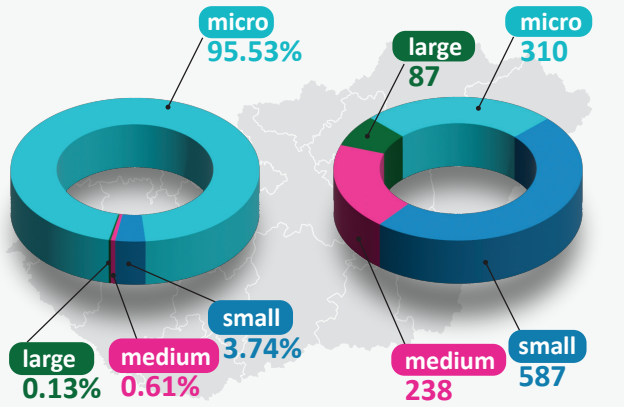
financed. 600 innovative gazelles met the simultaneous requirement of fast growth and innovation activity in the period between 2016 and 2019. In addition, the group of innovative exporters – no longer gazelles – widened the circle of Hungarian innovation-driven firms by an additional 500 enterprises. Risk capital financing is less frequent in Hungary: 150 Hungarian enterprises with risk capital financing were on the Crunchbase market platform in the period 2016-2019. Besides, previous analyses in Hungary also identified fewer than 800 enterprises supported by risk (venture) capital in the period between 2009 and 2018 (HVCA, 2021). So Hungarian innovative, fast-growing enterprises that receive such funds are called *super HIDEs.*

A further 3,500 innovative and 5,000 gazelle companies are potentially innovation-driven enterprises. Looking at the number of enterprises, roughly another 3,500 innovative companies operated in Hungary that did not exhibit fast growth or have any external market presence. 5,000 active corporate taxpayers (partnerships) with a significant increase in revenue were identified among the firms growing between 2016 and 2019. In the past decade, the characteristics of Hungarian gazelle companies were examined, inter alia, by: Békés and Muraközy (2012), Komlósi and Szerb (2016), Szerb, Komlósi and Varga (2017), Bodor et al. (2019) as well as Varga-Csajkás et al. (2019)). The innovative business elements of gazelle companies often remain concealed. Rapidly expanding IT services or professional, scientific and technical activities presumably contain innovative solutions and value-increasing processes. At the same time, if business statements do not reveal the elements of an enterprise's intellectual property, this is not only disadvantageous in terms of raising funds, but also makes it difficult to evaluate investment risks.

5.4.2 CHARACTERISTICS OF HUNGARIAN INNOVATION-DRIVEN ENTERPRISES

95.5 percent of partnerships are micro enterprises, whereas in the innovation-driven group this same ratio is 26.1 percent (Chart 5-9). This is partly because one precondition of being innovation-driven is at least one gazelle growth period (see Section 5.2), while the companies are evaluated after the growth. If the surge in sales revenues is accompanied – in statistical terms – by an adequate increase in headcount and total assets, micro enterprises change size category, reaching (at least) the category of small enterprise. Accordingly, nearly half of the HIDEs growing between 2016 and 2019 were small enterprises, one fifth were medium-sized, and 7.4 percent of them were large companies in 2019. By contrast, throughout the whole economy the total share of non-micro enterprises fell short of 5 percent.

Chart 5-9: Distribution of Hungarian partnerships and innovation-driven enterprises by size



DISTRIBUTION BY SIZE OF CORPORATE TAXPAYERS (2019)

NUMBER OF FIRMS BY SIZE OF INNOVATION-DRIVEN COMPANIES (2016–2019)

Note: Companies growing between 2016 and 2019. Eurostat definition was used for size classification.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

While the majority of micro-HIDEs (82 percent) were innovative gazelle-growth companies, the medium-sized and large HIDE groups mostly (67 percent and 76 percent respectively) comprised innovative exporters (Table 5-1). Small, large as well as start-up and mature companies also play an important role in innovation. One precondition for the birth of small companies is the existence of large companies, which provide infrastructure in a broad sense (physical networks, educational, social and economic conditions) for them. Although specialisation in the production of new products is advantageous for the establishment of small companies with narrow profiles, small-sized businesses can be founded by large entities as well to exploit potential opportunities that do not fit the profile of the entity but promise economic benefits. The ratio of exporting companies that 'outgrow' the domestic markets dominates among medium-sized and large companies. In the group of small companies, the shares of HIDE-type entities were close to one another (44–56 percent).

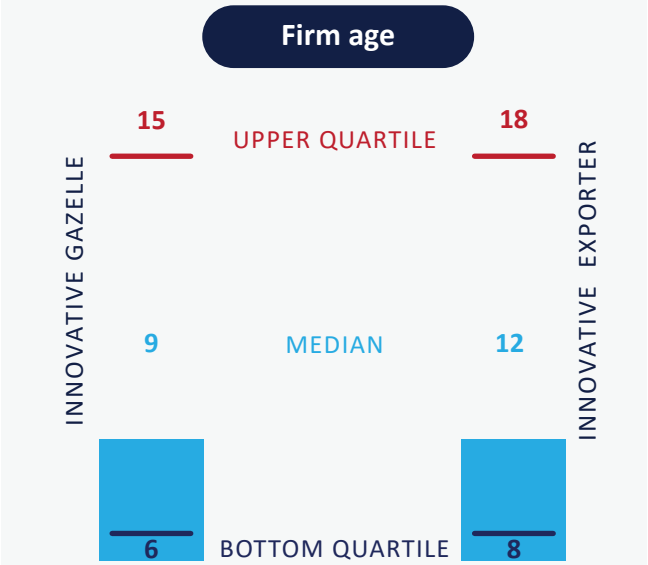
Table 5-1: Distribution of innovation-driven enterprises in Hungary by type and size

	Innovative gazelle	Innovative exporter
Micro	82%	18%
Small	56%	44%
Medium	33%	67%
Large	24%	76%

Note: Companies growing between 2016 and 2019. Eurostat definition was used for size classification. Distributions by line/size category.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

Hungarian innovation-driven enterprises are 'mature', typically 9–12-year-old companies (Chart 5-10). Introducing the basic innovation is a time-consuming and capital-intensive process, which precedes the fast-growth period. Accordingly, the median age of fast-growing innovative enterprises was 9 years, while the typical age of innovative exporter companies was 12 years. The impact of a company's age on innovation is not clear. On the one hand, older organisations are successful in innovation because they have sufficient resources and have tried-and-tested methods, which bring lasting results. On the other hand, organisations may become rigid and less open to changes with age. In addition, it can happen that a company only reports the innovation following the fast-growth period.

Chart 5-10: Distribution of Hungarian innovation-driven eneterprises by type and age



Note: Companies growing between 2016 and 2019.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

43 percent of innovation-driven enterprises operated in narrow industries (niche markets) that require special knowledge (Table 5-2). The concentration of innovation-driven enterprises according to activity can be detected at statistical class level as well (four-digit NACE breakdown). 43 percent of HIDEs operated in 23 (4 percent) of the 620 various statistical classes. HIDEs are more often found in knowledge-intensive activities, such as natural science and technical research and development, computer programming, engineering, technical, business management and IT advisory services, manufacturing and (wholesale) trade of special products as well as creative subsectors. Enterprises with special activity profiles working in niche markets belong to classes described as 'other' and 'n.c.e.'.

Table 5-2: Distribution of Hungarian innovation-driven enterprises by sector

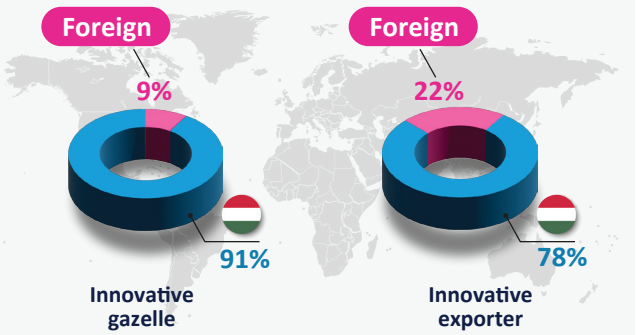
	Activity	Number of firms	Cumulative rate
1	Other scientific and technical research and development	64	5.6
2	Computer programming	63	11.2
3	Engineering activities; technical consultancy	38	14.6
4	Business and other management consultancy activities	37	17.8
5	Information technology consultancy	29	20.4
6	Wholesale trade services of chemical products	28	22.8
7	Manufacture of structural metal products	27	25.2
8	Road transport of goods	17	26.7
9	Metalworking	16	28.1
10	Other information technology services	16	29.5
11	Wholesale trade services of pharmaceutical goods and pharmaceutical preparations	15	30.9
12	Biotechnological research and development	15	32.2
13	Manufacture of other special-purpose machinery n.c.e.	14	33.4
14	Wholesale trade services of other food products	12	34.5
15	Wholesale trade services of other machinery and equipment n.e.c.	12	35.5
16	Manufacture of measuring instruments	11	36.5
17	Other software publishing	11	37.5
18	Manufacture of medical instruments	10	38.4
19	Installation of industrial machinery and equipment	10	39.2
20	Sale of motor vehicles, trailers and semi-trailers	10	40.1
21	Wholesale of computers, peripheral equipment and software	10	41.0
22	Technical investigation and analysis	10	41.9
23	Advertising agency activities	10	42.8

Note: Activity groups comprising at least 10 innovation-driven enterprises. Companies growing between 2016 and 2019. The acronym 'n.c.e.' means 'not classified elsewhere'.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

The majority of innovation-driven enterprises are Hungarian-owned (Chart 5-11). 91 percent of innovative gazelle companies and 78 percent of innovative exporter but not gazelle-growth firms in the given period were Hungarian-owned. As evident from the size breakdowns, small and

medium-sized enterprises together accounted for two-thirds of Hungarian innovation-driven companies. With their focused innovation strategies, SMEs can play leading roles in international niche markets, and may have close relationships with regional universities and educational institutions as well, which strengthens their local/regional embeddedness.

Chart 5-11: Distribution of Hungarian innovation-driven enterprises by type and ownership structure

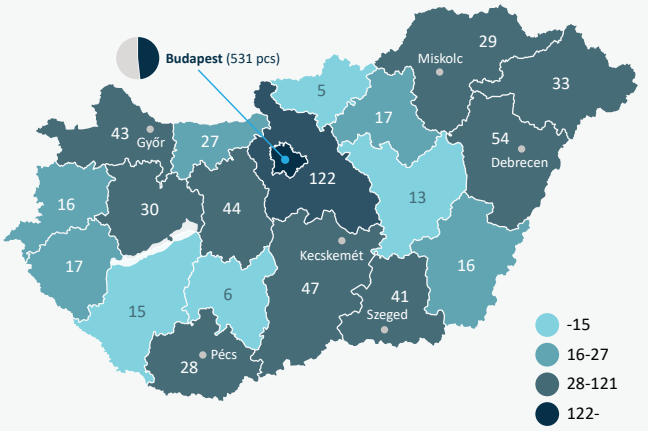


Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

Nearly half of the HIDEs operate in the capital, and many of them are present in county seats as well where there are multi-disciplinary universities (Chart 5-12). One precondition for applying to participate in MIT's regional enterprise development programme is that the given region should have an innovation hub. In most cases, this designated centre is a higher education institution. This requirement lies close to MIT in the sense that the most innovative places in the United States where the spirit of enterprise is the highest are found around research universities. Silicon Valley was built around Stanford University, while Boston's Route 128 Corridor was built around Harvard and MIT. The observed clusters can evolve for various reasons. The most important ones are the common inputs, local natural advantages, labour pooling and the feed-through of knowledge (Krugman, 1991). Geographical proximity facilitates increased interaction and stimulates local growth through the sharing of ideas (Lucas, 1988). By spreading knowledge, universities and research institutes help stimulate the economy. Accordingly, the realisation of innovations in the form of enterprises and their dissemination throughout society greatly depend on the quality of training and education. In general, the innovation performance of Hungarian enterprises is low (Ács et al., 2014, Komlósi et al., 2015), and they do not seek ways to cooperate and make progress together with universities (Inzelt, 2004). At the same time, the accompanying questionnaire reveals that a high ratio of domestic innovation-driven enterprises (74 percent) cooperate with tertiary education institutions.

Based on successful company/university cooperation frameworks it is worth investing resources and trust into promoting local network cooperation.

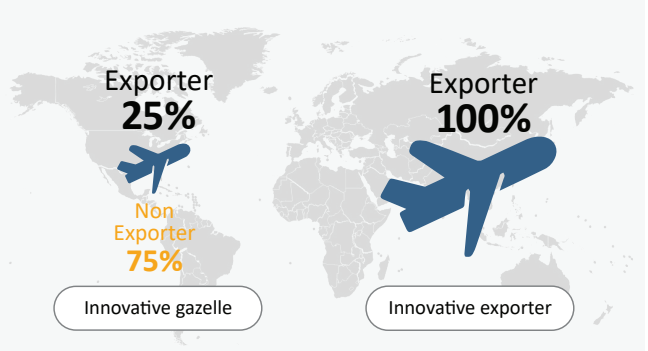
Chart 5-12: Spatial distribution of Hungarian innovation-driven enterprises



Note: Companies growing between 2016 and 2019. For the territorial classification we used the NTCA taxation-based grouping. Companies in the capital are those that sent their respective tax returns to the North Budapest, East Budapest, South Budapest as well as the Large and General Taxpayers' Tax and Customs Directorates. Fewer than 15 enterprises were in the latter two categories.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

One quarter of innovative gazelles also sell in international markets (Chart 5-13). A company was considered an exporter if at least one tenth of its net sales revenues originated from exports. One in every four of the innovative firms that grew fast between 2016 and 2019 were also considered exporters. These firms remain innovation-driven enterprises in the 'subsequent' years as well, even if they are unable to maintain their rapid growth rate. On the whole, 59 percent of the Hungarian innovation-driven enterprises were exporters, whereas this ratio remained below 6 percent among all the companies in 2019.

Chart 5-13: Distribution of Hungarian innovation-driven enterprises by type and export status



Note: Companies growing between 2016 and 2019.
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

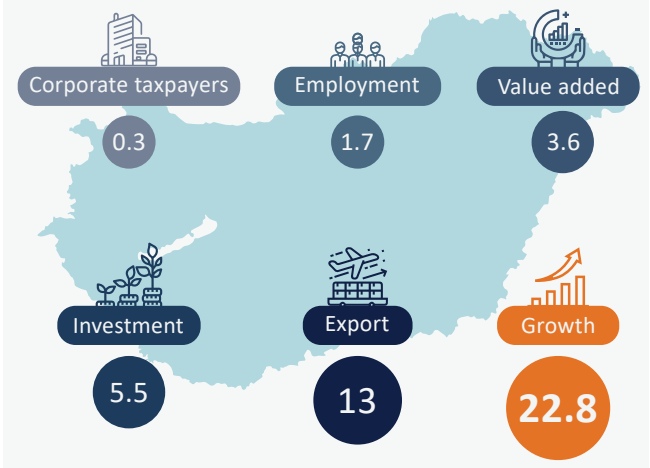
5.5 Macroeconomic weight of innovation-driven enterprises and role of production chains

5.5.1 CONTRIBUTION OF HIDES TO NATIONAL ECONOMIC AGGREGATES

Due to the (economic) cycle-independence of the claims, the contribution indicators are expressed as an annual average over the entire study horizon (2009–2019). This is because growth, investment activity, the tightness of the labour market, external market efficiency and the spread of innovative solutions are exposed to the fluctuations of business cycles.

While the innovation-driven enterprises identified accounted for 0.3 percent of all active Hungarian enterprises, they accounted for 13 percent of gross exports and 22.8 percent of economic growth in the national economy (Chart 5-14). HIDEs employ 1.7 percent of the total number of employees, they account for 5.5 percent of investment in Hungary and produce 3.6 percent of total value added. While the level of value-added output in Hungary is strongly influenced by the size of the enterprise (Czinkán, 2017), the SME segment accounts for the bulk of economic growth year after year, and thus has a strong impact on future growth prospects (Bauer and Endrész, 2018). This reinforces the economic role of HIDEs – their contribution to real growth in the economy was nearly 23 percent.

Chart 5-14: Macroeconomic weight of Hungarian innovation -driven enterprises



Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

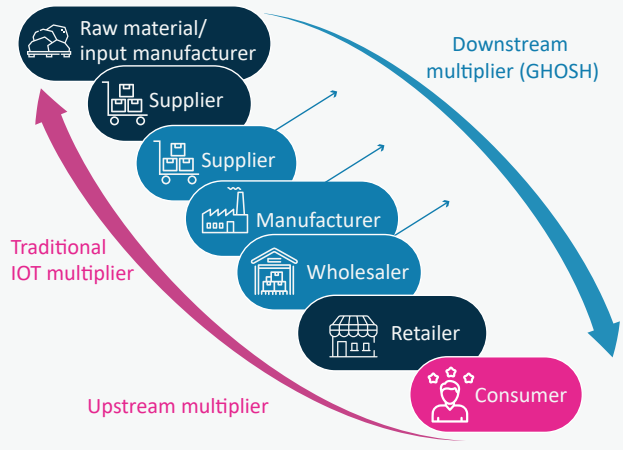
5.5.2 ROLE OF PRODUCTION CHAINS AND THE GHOSH MULTIPLIER

Where available finite resources are focused is crucial to the efficiency of economic policy. It makes sense to spend these in places where they can make a big impact with a small investment of resources based on the principle of leverage. To identify these critical points, such as the potential of the creative industries, it is helpful to analyse sectoral linkages, taking into account the multiplier effects that spill over to other sectors through trade links.

Innovation has become a key enterprise activity requiring significant resources (Lev, 2001), and the potential drivers of economic development are the sectors that can act as catalysers by leveraging their interconnections. This impacts through customer sales and supplier orders.

Innovation and productivity primarily flow downstream in the production chain, towards consumers, and create spill-over effects in the economy from the supply side (Chart 5-15). The growth of a company stimulates the economy through its relationships with suppliers and customers on both the supply and demand sides. The relative size of the two effects depends on where enterprises are located in the production chain. HIDEs operate in the early, high-value-added stages of the production chain, far away – from a production perspective – from the (final) consumers. This allows Hungarian innovation-driven enterprises to generate greater supply-side effects.

Chart 5-15: The ability of sectors to strengthen supply and demand in the production chain

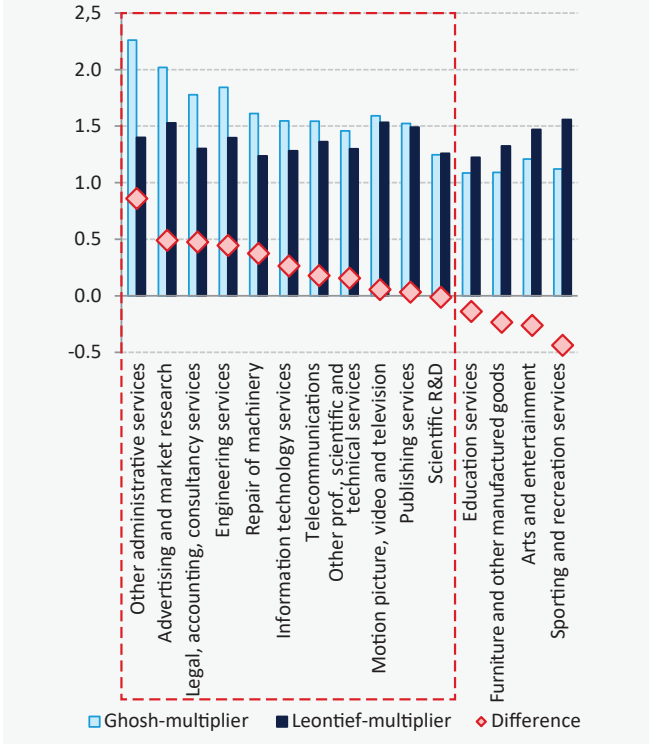


Source: MNB.

Multiplier supply and demand effects of industries are quantified using input–output tables. The demand effect – also known as backward linkage – shows the extent to which an increase in production in a given sector – through higher consumption demand – also stimulates its supplier sectors to expand their production (Leontief, 1941, 1966). The supply effect – also known as forward linkage – measures how sales opportunities must increase for a sector to increase its output (Ghosh, 1958).

In Hungary, supply effects exceed demand effects to the greatest extent in the support services sectors (Chart 5-16). Supply effects outweighed demand effects in consulting services, IT services and creative activities, as well as in wholesale trade. In the scientific R&D sector, the two effects are almost identical. This sector includes three types of research work: basic research, applied research and experimental development. It is important whether those buying the sector's outputs are located closer to or further away from the consumers in the production chain. What is special about the sector is that it can sell its results at all stages of production, depending on whether customers commission product strategy innovations, intermediary tasks or customer-focused R&D results. As we saw in a detailed breakdown in Section 5.3.2, most HIDEs were active in the sectors of the listed production branches.

Chart 5-16: Output multipliers for selected sectors



Source: MNB based on Eurostat 2019 IO tables.

5.6 Innovation and entrepreneurship capabilities of Hungarian enterprises

5.6.1 I-CAP AND E-CAP IN DATABASES

In addition to innovation performance, we aim to identify additional characteristics that make innovation-driven enterprises stand out. In other words, in addition to the innovation performance observed, what factors can support the growth potential of innovative enterprises.

International experience shows that the growth potential of an enterprise depends on many variables that are difficult to perceive: the internal characteristics of the company, the personal ambitions of the founder, the resources available, the financial background and the business-demographic characteristics. In addition, the growth potential is also highly dependent on the environment. Hoff (2012) identified the elements that can play a role in the growth of a company. The first and most important is the innovation attitude. In addition, since not all firms want to grow, a key factor is the intention to grow per se, such as growth ambition and entrepreneurial attitude. Another critical factor is what resources the given company has. The skilled workforce the company can draw on and the financial background are clear growth factors. It is also relevant how long a firm has been operating in its market segment, as demonstrated by the results presented in the previous section. In addition to the above, another specific factor is the environment in which the given company operates. Via intensity of competition, this is a feature of the industry itself. Similar results were found by Lopez-Garcia and Puente (2012), who found that the variables that determine growth include scope of activity (industry), region, novelty of the company, access to external finance and the human resource practices of companies.

We estimate that the share of intangible assets and the export status increase the likelihood that an innovative enterprise will be able to grow rapidly. The higher the ratio of intangible assets to fixed assets, the greater the probability that an innovative enterprise will become a HIDE (Table 5-3).

However, there is a negative probability associated with the age and size of the company and its equity to total assets ratio (Table 5-3). The age of innovative enterprises

has a negative impact on growth. Hoff (2012) explained this observation by saying that older companies are more reluctant to change or deviate from the way they operate, and that it is more important for them to maintain their existing market position. The size of the company, even accounting for its age, also reduces the likelihood of HIDE status, but due to the HUF 50 million annual sales revenue threshold (Section 1.2.6), no significant difference between micro and small enterprises was observed. A high equity ratio is also associated with a negative probability. The equity ratio shows the share of equity in total equity and liabilities. If the ratio is above 50 percent, the majority of the enterprise is financed by equity.

Finally, the industry of the organisation is also a key growth factor. As shown in Section 5.3.2, the incidence of innovation-driven enterprises in Hungary is highly concentrated at the industry level.

Table 5-3: Estimation results of innovation-driven operation

Dependent variable: **whether the company is innovation-driven**	Effect
Is it exporting	+
Share of intangible assets in fixed assets	+
Firm age	-
Size (base: micro enterprise)	
Medium-sized enterprise	-
Large enterprise	-
Equity as a percentage of balance sheet total	-
Observations	3745
Pseudo R-square	14.5
Sensitivity*	25.9

*Note: Probit specification with industry dummy variables. The sample year of the estimation is 2016. *Sensitivity indicates the matching rate obtained with the estimating equation.*
Source: MNB calculation based on administrative sources of tax authority, intellectual property office, innovation office, statistical office, ministry of justice and data of crunchbase and the Central Bank of Hungary.

5.6.2 I-CAP AND E-CAP – BASED ON QUESTIONNAIRE SURVEY

To map the I-CAP and E-CAP capabilities, which are not observable from the database of Hungarian innovative and innovation-driven enterprises, a primary questionnaire survey was conducted. The questionnaire asked 40 questions on 5 topics of the companies selected from our linked database. The 5 topics covered were: the innovation-economic environment (1), the role of human capital (2) and finance (3), market competition (4) and cultural-motivational factors. The results presented below are based on responses from 182 innovative and innovation-driven enterprises.

Responses from Hungarian innovative enterprises indicated a fierce, highly competitive environment, which may be related to the observed clustering of sectors. In line with international findings (see Section 5.5.1), the industrial environment is seen as an important growth factor. Despite the fierce competition, respondents considered the market size to be appropriate.

The desire to be independent as an entrepreneur was an important motivation for starting a business (Chart 5-17). As described above, one of the strong motives for innovation is keeping up in a competitive situation. The innovative enterprises were launched with the intention of being independent, drawing on experience gained in the previous field of activity, which may also contribute to their good knowledge of their customer base. In this context, starting a business based on knowledge gained is associated with satisfaction regarding entrepreneurial skills within the enterprise.

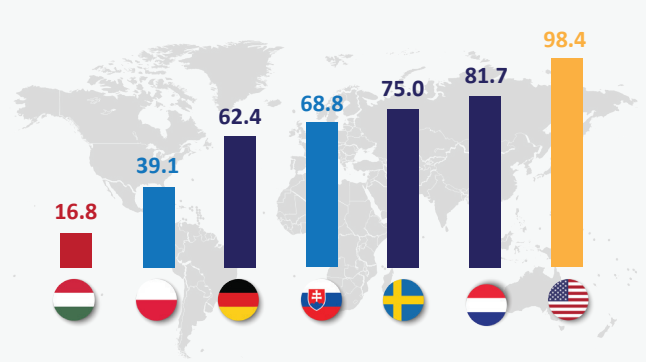
Chart 5-17: Variables with high agreement among innovating enterprises

Note: On a scale of 1-6 the respondents chose whether they agree with the given assertion of the survey completely (6), mostly (5) or rather agree (4), or the opposite (1, 2, 3). They could refuse to answer individual questions, or they could make reference to a lack of information on a subject.
Source: MNB based on MIT – IDE project questionnaire survey.

Innovative enterprises also strongly agreed that the risk of making mistakes is accepted, i.e. they chalk mistakes made within their companies up to experience, deeming them part of a learning and development process. This perception is not common among those who want to set up a business (Chart 5 18). The willingness to start a business in Hungary is strongly influenced by the fact that only 16.8 percent of the Hungarian adult population (almost one in six respondents) who see a good opportunity in starting a business are not afraid of the potential failure of becoming an entrepreneur. This is very low by international comparison. In the Visegrad Group, the corresponding Polish rate was 39.1 percent and the Slovak rate 68.8 percent in 2021. Entrepreneurial risk appetite in developed

European countries is high at over 70 percent, but these rates also seem to lag behind the 98.4 percent rate in the United States (Chart 5-18).

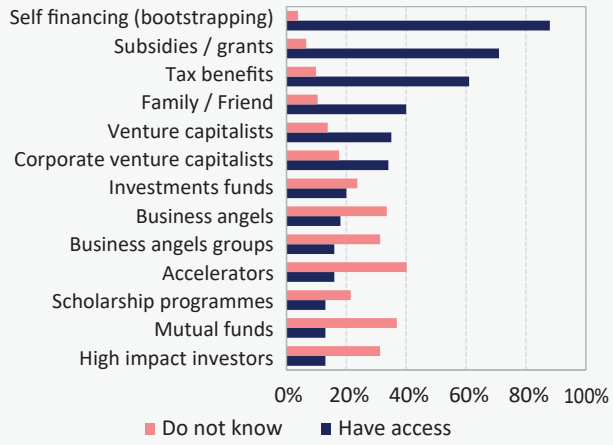
Chart 5-18: International comparison of entrepreneurial risk appetite



Note: As a proportion of adult population who see good entrepreneurial opportunities.
Source: MNB, based on Global Entrepreneurship Index.

Self-financing (88 percent), various types of grants (71 percent) and tax credits (61 percent) are the fundraising options available for most enterprises (Chart 5-19). One form of *self-financing* is bootstrapping, where newly created enterprises reinvest the revenue generated after starting up back into development, and grow out of self-effort. This type of in-house financing, which can also be used for new core innovations, received 160 affirmative responses (80 percent). Growth is related to the equity ratio based on an analysis of enterprise data (Section 5.5.1), and raising funds from external partners is seen as an opportunity for the enterprises interested in innovation to grow faster than they could on their own. On the one hand, the high availability rate of grants suggests that the range of grants is wide, while on the other hand, the low number of those not aware about the grant possibilities shows that enterprises interested in innovation are well informed about the grants available for their business. Although the size of the enterprise and the place of implementation are not limitations in the eligibility criteria for tax allowances, only those who can prove they have carried out R&D activities in their own field of activity can submit a claim. The unauthorised use of *tax allowances* can result in severe tax penalties. To prevent this, the enterprises must obtain – with added administrative bureaucracy – a decision from the Hungarian Intellectual Property Office, in which the Office classifies the submitted project and decides whether it qualifies as R&D within the enterprise's own field of activity. If the taxpayer has the certificate of the Office, its validity is not contested by the National Tax and Customs Administration.

Chart 5-19: Average response scores for forms of financing among resondents



Note: The respondents chose on a scale of 1-6 whether they agree with the given assertion of the survey completely (6), mostly (5) or rather agree (4), or the opposite (1, 2, 3). They could refuse to answer individual questions or they could make reference to a lack of information on a subject. Light colours indicate instruments with less than 100 responses.
Source: MNB based on MIT – IDE project questionnaire survey.

Alternative forms of corporate financing are difficult for innovating enterprises to access, which is also because they are not widely known among companies. Alternative forms of fundraising are accessed by less than half of the innovating enterprises (Chart 5-19). Potential capital-raising through family ties (40 percent) sits ahead of other third-party financing. Just over a third of the companies surveyed identified risk capital as an available option. As mentioned in Sections 4.5.1 and 5.2.1, initial risk capital financing plays a central role in MIT's approach because the (early) development phase is costly in the life cycle of a product. Additional non-borrowing finance was identified as an available option by 13–20 percent of enterprises. These include: investment funds, business angels, accelerators, scholarship schemes and other investors. Typically, the availability of finance was lowest in areas where the innovating enterprises surveyed were less aware of the given option. Accelerators (40 percent), business angels (32 percent) and investment funds (30 percent) are the least known.

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6 Key conclusions

The design and implementation of a successful economic development strategy depends to a large extent on the quality of the strategic underpinning. On the one hand, selecting the most appropriate and at the same time most realistic strategy points for success will boost economic activity in critical areas even in the short term. These interventions are practical action elements that should be put in place as soon as possible. In a term borrowed from business literature, these are called "must-win battles". However, winning these "battles" is a well-chosen and necessary part of an "operational plan" for a long-term sustainable growth strategy. So it is also part of an optimal strategy to seek to influence growth conditions according to the objectives in a reasonable way and to a reasonable extent in the medium term as well. The focus should be on measures that have a comprehensive and also necessary yield, but cannot immediately be implemented. It is also important that in the medium term, it is not enough to systematically measure progress and implementation; the fine-tuning that will lay the foundations for long-term success must also be repeated as necessary.

6.1 Battles winnable in the short term, smart money

The key strategic challenges are lack of trust, cooperation, entrepreneurial ambition as well as awareness and use of smart money. The lack of trust in venture capital (VC) investors in the start-up ecosystem hinders the development, since stakeholders often look for other alternative financing solutions. This behaviour is partly because, in many cases, owners and managers are not familiar with how venture capital financing works within institutionalised frameworks. On the other hand, venture capital operators themselves have a risk-averse attitude, partly because many investors come from traditional financial intermediation (often with a risk management background). This hampers business growth, as risk-taking and risk-sharing are inevitable in a fast-growing enterprise. However, the infrastructure capacities do exist. Financial statements are readily available to venture capital investors from public databases.

Smart money is largely unknown to innovative companies. This is partly due to the legal system, which has significant white spots compared to the best practice. Regulatory and financial fine-tuning is needed to ensure that innovative entrepreneurs are properly funded.

Fast and flexible investment structures are particularly important for pre-seed stage innovators. In addition to friends and family as well as crowdfunding, business angels and venture capital firms investing in early stage startups can also be a way for innovators to invest, but "traditional" capital raising is often trust-based, time-consuming and involves significant additional costs (e.g. legal, advisory) that early-stage innovators can not take on. In addition, agreeing on an appropriate business valuation can be tricky for a start-up. In line with international best practices, specialised alternative financing instruments such as convertible notes and SAFE (Simple Agreement for Future Equity) notes have been created to provide simple and flexible financing without the burdens of more traditional capital raising.

In Hungary, the most important alternative investment instruments (convertible notes and SAFE notes) were not established in the past. This is mainly due to weaknesses in the current legal and accounting framework. Under Hungarian financial regulation, the regular granting of business loans and credits is subject to a licence from the Magyar Nemzeti Bank. The provision of convertible business loans would also fall under this regulation, and obtaining such a licence from an angel investor can certainly not be expected.

Improving the regulatory framework for convertible and SAFE notes can strengthen the funding base for domestic innovation potential. The proposed legislative framework recommends exceptions to the above rule based on certain limits on the value of an investor's cumulative outstanding convertible note portfolio – while preventing the circumvention of the exceptions.

The proposal for the amendment of Act XXXIV of 2004 on Small and Medium-sized Enterprises and Support for their Development, developed with government and market actors, coordinated by the Ministry of Culture and Innovation,

proposes the introduction of the above-mentioned innovative financing solutions into the domestic legal system. Both proposed financial instruments are based on an adaptation and combination of existing civil law instruments for easier integration into the Hungarian legal system.

Rethinking the role of public venture capital investment: based on international experience changes to the public approaches to venture capital investment should be considered, a co-investment approach would be more appropriate. The Lithuanian public financing practice could be a good example, where the public venture capital investor does not invest independently, based on its own processes, but typically as a co-investor, jointly with a market player on the same terms. This could reduce the bureaucratic burdens for both start-ups and public venture capital investors, and even speed up decision-making processes.

A state veto on foreign acquisitions is necessary in many areas, but rationalising it could increase investor valuations of domestic companies: a state veto on foreign acquisitions may be justified in a number of areas (e.g.: defence industry, cybersecurity), but the current regulation provides an overly broad framework for this, which may reduce the investor valuation of Hungarian innovation-driven enterprises and the ability to implement new capital-raising rounds. Rationalising the state veto, either on a sectoral or size basis, would mitigate this risk, and could also prevent domestic innovators from setting up start-ups based abroad because of this risk.

6.2 Medium-term development directions

At the heart of the innovation-driven ecosystem, there is the cooperation of five stakeholders (government, corporates, universities, risk capital and entrepreneurs). The effectiveness and output of the system is determined by the quality of the stakeholders and the relationships between them. Our track record shows that we have reliable institutions and have implemented a number of best practices that can facilitate the start-up of innovation-driven enterprises. The number and quality of stakeholder interactions in Hungary can be increased. Increasing synergy between stakeholders is of key importance in the medium term. It is important to create platforms where the key players of the Hungarian innovation ecosystem can establish an active and continuously expanding network of contacts.

We need to shape the mindset of young talents to increase risk-taking and entrepreneurship. Our results show that Hungary lags significantly behind its regional peers and developed countries in terms of risk appetite. Meanwhile, our survey results show that the leaders of successful, innovation-driven and fast-growing enterprises are more tolerant of risk, and the fear of failure is much less pronounced. It is a long process to change the mindset of society, and schools and education, like other significant changes, have a major role to play.

Based on international examples demand-side instruments can be important elements to support innovation. A significant proportion of Hungarian companies cited weak demand as the reason for lack of innovation. Through innovative public procurement, the state can be directly involved on the demand side of innovation. There are two options here: firstly, instead of a specific product, the contracting authority buys R&D services for a product, service or process that does not yet exist, as a solution to a given problem. In the second case, instead of procuring widely available products, the contracting authority, as an early adopter, buys a product, service or process that is new to the market and has essentially novel characteristics. The contracting authority can realise its innovative procurement needs through a variety of procedures, with negotiated procedures and innovation partnerships specifically aimed at achieving innovative procurement needs facilitating successful procurement. To encourage innovative solutions, the European Union is also paying increased attention to supporting innovative public procurement.

List of charts and tables

Count István Széchenyi

(21 September 1791 – 8 April 1860)

Politician, writer, economist, minister for transport in the Batthyány government whom Lajos Kossuth referred to as 'the greatest Hungarian'. His father, Count Ferenc Széchényi established the Hungarian National Museum and Library; his mother, Julianna Festetich was the daughter of Count György Festetich, the founder of Georgikon, an institution for the teaching of agricultural sciences.

With his ideas – whose message remains relevant even today – and his activities both as a writer and a politician, István Széchenyi laid the foundation for modern Hungary. He is one of the most eminent and significant figures in Hungarian politics whose name is associated with reforms in the Hungarian economy, transportation and sports. He is also known as the founder and eponym of numerous public benefit institutions, a traveller all across Europe and an explorer of England as well as the champion of economic and political development at the time. István Széchenyi recognised that Hungary needed reforms in order to rise, and considered paving the way for a Hungary set on the path of industrialisation and embourgeoisement to be his calling in life.

Published in 1830, his Credit outlined the embourgeoisement of Hungary and summarised its economic and social programme. Count Széchenyi intended this writing to make the nobility aware of the importance of the country's desperate need for a social and economic transformation. Another work of his, Stádium [Stage of Development] (1833) listed the cornerstones of his reform programme in 12 points, including the voluntary and compulsory liberation of serfs; the abrogation of avicitas (inalienable status of noble property); the right of possession for the peasantry; and the freedom of industry and commerce. This work of Széchenyi already conveyed the idea of equality before the law and the general and proportionate sharing of taxation.

After the revolution in 1848 István Széchenyi joined the Batthyány government and as minister embarked vigorously on implementing his transportation programme.

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