NATIONAL INNOVATION OFFICE

RDI Mirror

3. Regional characteristics of RDI in Hungary

2013

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This publication was made under the auspices of the National Innovation Office RDI Observatory Department.

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Executive Summary

This is Part 3 of the RDI Mirror series written under the auspices of the National Innovation Office RDI Observatory Department. It is common knowledge and often cited that Hungary is extremely Budapest centric in many ways. The purpose of this publication is therefore to fill an existing gap and by doing so its writers aspire to restore a degree of balance at least in one of these areas by describing the geographic features of RDI in particular.

By analysing Hungary's RDI activity in geographic terms we are attempting to highlight existing regional differences within Hungary's innovation system and potential strictly based on facts, and we hope that stakeholders of the Hungarian RDI sector will find this publication useful for developing a better understanding of the Hungarian situation.

We explore a number of phenomena that are vital for placing the country's RDI policy on a solid footing, and in doing so we go beyond merely describing existing differences in development between the Hungarian capital Budapest and rural regions on the one hand, and the country's eastern and western regions on the other (which in their turn also have an impact on RDI), especially since descriptions of this kind tend to be an oversimplistic account of the bare facts. Even though nobody disputes that Central Hungary – and especially Budapest – are distinguished by outstanding performance, the RDI characteristics of other counties and regions are often indicative of a rather diverse scene, and so the dominance of Budapest appears to be less poignant in a number of respects.

In terms of geographic concentration, one of the key findings of our analysis is that indicators which directly measure R&D (total R&D expenditure and total number of researchers) show a far greater geographic concentration than other economic indicators (such as the turnover of R&D companies or the aggregate tax payments of companies). Central Hungary owes its R&D dominance (it employs 60% of researchers and 66% of R&D expenditure is concentrated here) almost entirely to Budapest, given that the relative weight of Pest County is rather insignificant compared to Budapest. Apart from Budapest, Hajdú-Bihar and Csongrád counties in particular stand out due to their exceptionally high R&D expenditure to GDP ratio, whereas for nine other counties the same ratio does not exceed 0.5%; and if we compare various regions, then we find that the R&D expenditure to GDP ratio only reaches 1% in respect to Central Hungary, the Northern Great Plain and the Southern Great Plain. All these data are indicative of very large disparities between the country's various regions.

From the point of view of the RDI, Hungary has a peculiar geographic structure, as two RDI-relevant factors demonstrate largely unrelated geographic patterns. One of these factors is the range of innovative economic activities, and the other is higher education. While for Budapest, the two dimensions are interrelated, for the rest of the country this is far from being the case. While Western Transdanubia is, for example, clearly stronger in terms of its economic indicators, the catchment areas of the universities of Pécs, Debrecen and Szeged (county and region) have better higher education indicators. Often there is only a loose connection between the two dimensions, as a bi-directional and levelled relationship between the economy and higher education has still not developed everywhere in Hungary, even though this is what is making highly developed countries so successful in innovation. R&D expenditure of the business enterprise sector started to grow dynamically from the second half of the 2000s and the same trend continues, however this growth was not accompanied by an expansion of ties with the higher education sector at a desired rate.

If we take a look on the allocation of relevant RDI subsidies sector by sector, then we find significant disproportions, of which the greatest one seen in the allocation of funding under the Seventh Framework Programme (FP7). While Central Hungary's share of total available funding exceeded 78%, at the same time Northern Hungary's share was less than 1%, which represents a stark warning in respect to the 2014-2020 period. 60% of KTIA (Research and Technology Innovation Fund) resources were awarded to stakeholders from Central Hungary, with Csongrád and Hajdú-Bihar being the only other counties that managed to secure a substantial chunk of available grants and subsidies. There is less of a gap in the allocation of grants and subsidies under GOP (Economic Development Operative Programme), KMOP (Central Hungary Operative Programme) and AIK (Accredited Innovation Cluster) tenders compared to the previous scenarios: Central Hungary secured one-fourth of the grants and subsidies awarded in total, while Southern Great Plain and Northern Great Plain regions also received substantial pay-outs.

Focusing on the regional aspect is particularly useful in order to understand the underlying dynamics of the RDI sector, because it is vital to become absolutely clear about the current state of concentration, the various dimensions of existing disproportions and the processes leading up to them, before we can start thinking about ways of setting up sustainable innovative hubs outside Budapest. This is what this analysis aspires to make a small contribution to by presenting facts and data promoting a better understanding of the above.

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Introduction

This third part of the RDI Mirror series looks at the state of research, development and innovation (RDI) in Hungary from a geographical perspective. Our objective is to provide an analysis of the R&D and innovation related performance and potential of particular regions, based on comparative facts and data. By presenting this with the RDI-focused regional analysis, the RDI Observatory operating under the auspices of the National Innovation Office wishes to raise awareness among stakeholders of the regional aspect of RDI in Hungary. Hence the regional focus of this study, which presents the characteristics of particular regions both in absolute terms and in mutual comparison. Please note that this analysis, which explores several aspects of the subject matter, is substantially extended version of the situation analysis part of Hungary's strategy stemming from the so-called 'Smart Specialization Strategy (S3)', the full reproduction of which could not be accommodated within the scope of S3 due to its volume.

The purpose of this publication is to survey as broad a spectrum of the innovation potential of various regions as possible. Pending the availability of relevant data, provided that these were a useful source of information, this study presents county level findings too, since doing so can promote a deeper and more precise understanding of regional differences. A separate chapter is devoted to Central Hungary and Budapest respectively: something that was necessary both in view of the statistical methods used, as well as in the interests of the reliable interpretation and presentation of underlying statistical data. Subsequent chapters are devoted to comparing data on other regions and counties, even though Budapest and the Central Hungary region are mentioned in this part, and moreover, in several chapters. Pest County cannot boast of outstanding economic or RDI indicators, therefore - for the sake of a better comparison - in a number of instances we presented them among county level data streams.

Our analysis uses the latest available data: in the case of R&D this covers 2011, however regional GDP data for 2011 are only preliminary data; other labour market data relate to 2012, or were taken from census findings for 2011. We also deploy a number of regional econometric methods, the findings of which provide some general lessons about the regional disparities faced by Hungary.

It should be noted here that we defined corporate research units as companies that included in their accounts both research and development personnel expenses and R&D expenses in the subject year. This definition is slightly different from the one that is used research and development, in the sense that according to the HCSO definition, a research unit means any corporate entity engaging in research, whether or not it employs any researchers; it could be the case that it employs R&D support workers only, or employs staff under assignment contracts (HCSO 2012, p. 106). This accounts for the slight discrepancy between the data we present in Chapters 1.4 and 3.7 on the one hand, and HCSO data on the other.

Census statistics provide a treasure trove of comprehensive data for our analysis, and in our view show a strong correlation with innovation potential, examples of which are foreign language proficiency, the percentage rate of higher education graduates within the total population, and labour activity data in general. We also did some correlation and regression analysis of innovative sectors/industries, in order to better understand the innovation aspect of RDI trends (something that is harder to quantify than R&D performance).

This paper also includes a comparison of the geographic distribution of socio-economic phenomena with an innovation and/or R&D aspect, to highlight any regional differences in the area. We also present some regional aspects of the Accredited Innovation Cluster to key RDI stakeholders, e.g. higher education institutions. We compress the data streams analysed into complex indicators, in the course of which we treat the infrastructural and human resource aspects of innovation separately. This kind of analysis provides numerous interesting findings.

Our analysis once again confirmed and provided warning about the existence of regional disparities within Hungarian R&D, namely that with the exception of Central Hungary, we are practically unable to correlate sectoral and regional data for any other region in a way that would ensure compliance with the statistical golden rule on the traceability of the data provider. There are so few R&D stakeholders working in relevant sectors and industries of the national economy within the regions concerned that often no more than 3 or fewer data providers made up a group of this kind, and so pursuant to prevailing regulations we were not allowed to display their data. This in itself clearly illustrates the current state of research and development in Hungary: stakeholders are very thinly spread in many regions and sectors/industries, as RDI is very heavily concentrated both in the organisational and geographic sense of the word. Being the case this has unfortunately limited our ability to include more data than what finally ended up on these pages, as a result of which the depth of sectoral data suffered most of all. If this publication therefore gives the impression that it does not provide a comprehensive account in respect to the regions outside Central Hungary, then it should be noted that the relevant data do exist, but they cannot be made public due to the above reasons.

As it was impossible to display the full array of relevant RDI data in the core text of this document many of the tables, graphs and diagrams providing useful information to those who take a deeper interest in the subject matter, were therefore included in the Annexes.

1 The position of Central Hungary within the RDI landscape of Hungary

1.1 Disproportions within RDI – measuring concentration

Measuring the regional distribution of particular socio-economic parameters is an essential tool for demonstrating the existence of regional disparities (a wide range of related methods and approaches are presented by Nemes-Nagy, 2009). The concentration test[1], from the possible methods of which we are using the Herfindahl-Hirschman index[2] here, clearly illustrates the regional distribution of certain characteristics. Based on the data of 19 counties and of Budapest itself for 2010, we may conclude that the concentration values of indicators for directly measuring R&D (0.4 in terms of total R&D expenditure and the actual number of researchers alike) indicate a much higher value than other economic indicators (defining concentration in terms of turnover at 0.22, and in terms of taxes in total[3] at 0.1). R&D activity is distributed in an extremely uneven way in a national economy which is characterised by regional over-concentration in any case (something which is also confirmed by Rechnitzer's overall conclusion, 2005).

> R&D ACTIVITY SHOWS AN EVEN HIGHER CONCENTRATION IN CENTRAL HUNGARY THAN ALMOST ANY OTHER ECONOMIC INDICATOR.

This chapter focuses on the Central Hungary region and Budapest, given that their indicators analysed here far exceed the corresponding indicators of every other Hungarian region, moreover, they are on a totally different scale compared to the latter. Available data indicate a high concentration in most cases: according to preliminary data for 2011, the per capita GDP (calculated by purchasing power parity) of Budapest is more than double the national average (EUR 16,484 per capita), representing EUR 35,583 per capita. For the same reason, the per capita GDP of Central Hungary (EUR 26,574) is significantly above the national average. Pest County (with EUR 13,973 per capita) is below the national average.

Of the 36,945 researchers who were employed in Hungary in 2011 in total, 20,828 were based in Budapest, and together with the additional 1,453 researchers employed in Pest County 60.3% of the total number of researchers were concentrated in Central Hungary. We find even higher concentration levels by looking at FTE (full time equivalent)[4] employment: nearly two-third (65.8%) of all researchers (FTE) were employed in Central Hungary, and 61.4% of those found employment in Budapest.

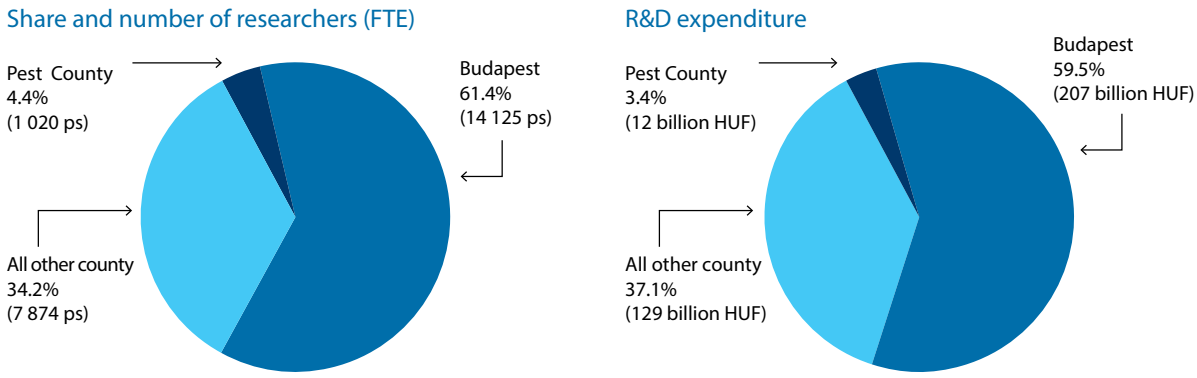

Figure 1-2: Distribution of researchers (FTE, 2011) and R&D expenditure (2011, billion HUF) between Budapest, Pest County and the rest of Hungary. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data[5]*

The GERD[6]/GDP index for Central Hungary (1.63%) is significantly above the national average (1.21%); mostly due to Budapest, where the same index stands at 1.98%. Central Hungary also emerged as the undisputed winner of national migration[7]; thanks to migration the population of Pest County increased by 151 thousand, whereas the population of Budapest expanded by 30 thousand people during the period between 2001 and 2011.

Over 60% of all researchers are employed in the Central Hungary region, and their proportion is even higher when converted to FTE. Such a high level of concentration has come about as a result of a number of well-known historical and structural causes. It is sufficent to point out here what is probably the main factor hindering the elimination of the current level of over-concentration, namely the very strong desire of leading universities and research centres to be in physical proximity to each other, a fact which has been noted many times by regional academics based on the findings of network research (see Csizmadia, Grósz, 2011 among others). As a result, a high concentration of these institutions has developed over the years, especially in Budapest.

Based on the above, the question arises: what correlations can be found between the R&D intensity of a certain region and co-operation models between firms belonging to the innovative sectors and other stakeholders (e.g. universities). It was this research dilemma, which prompted further research e.g. by Csizmadia-Grósz (2011, p. 221): it verified (ebd. p. 224) that - outside Central Hungary - Central Transdanubia was the only region with highly impressive RDI network indicators. In all the other regions appear to be weaker ties between RDI stakeholders.

CENTRAL HUNGARY AND CENTRAL TRANSDANUBIA HAVE THE STRONGEST RDI NETWORKS, WHEREAS EVERY OTHER REGION IS CHARACTERISED BY WEAKER TIES BETWEEN RDI STAKEHOLDERS.

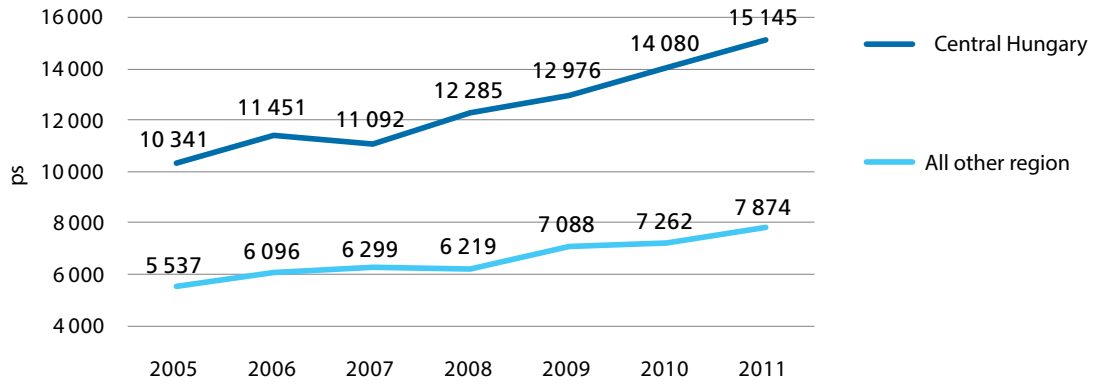

Figure 3: Development of the number of researchers (FTE) in Central Hungary and other regions respectively, in 2005-2011. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO and Eurostat data*

[1] The concentration index ranges from 0 to 1; an index greater than 0.4 is indicative of strong concentration, especially when we are talking about such a large number of elements as in the example, i.e. statistics comprising the unique data of 19 counties and Budapest. Concentration converging to 0 indicates a diffuse, even distribution of objects designated by the indicator in question. Concentration converging to 1 indicates an extremely high concentration.

[2] The Herfindahl-Hirschman index (HHI) is one of the best ways to measure concentration. The Herfindahl-Hirschman index is defined as the square sum of the respective share of firms or geographic units making up a certain market from a particular socio-economic indicator. HHI can range from 0 to 1.

[3] Total tax payments of business enterprises operating in the county in question (including local business tax as well as centrally levied taxes).

[4] FTE: headcount calculated on the basis of a full time equivalent.

[5] The thematic maps, diagrams, graphs and tables presented in this document contain data of various aggregation levels, on the understanding that these data are not always absolute figures. The possibly most detailed and absolute data are usually found on the National Innovation Office RDI Observatory's website: http://www.kaleidoszkop.nih.gov.hu/ (provided that their publication is not prohibited due to data protection)

[6] Gross Expenditure on Research and Development: means the total research and development expenditure of companies.

[7] Migration balance: means the net balance of immigration and emigration during the period under review.

IN 2011 NEARLY 2/3 OF THE COUNTRY'S TOTAL R&D EXPENDITURE WAS CONCENTRATED IN CENTRAL HUNGARY.

In 2011 62.9% of the country's total R&D expenditure was concentrated in Central Hungary, which is a somewhat lower figure than the R&D FTE headcount calculated at 65.8, but nevertheless indicative of a high degree of concentration.

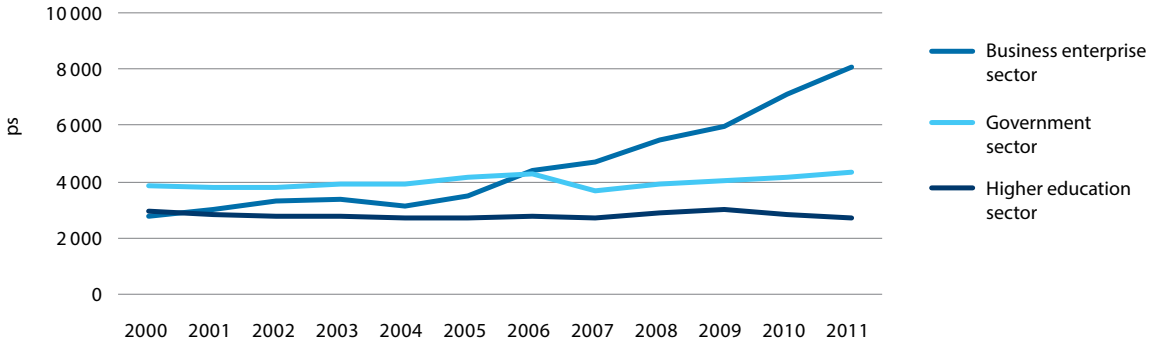

Figure 4: Development of the number of researchers (FTE) in the three main sectors in Central Hungary in 2000-2011.
Source: Eurostat

It is clear from Figure 4 that the number of researchers (FTE) expanded considerably since 2004 thanks to the business enterprise sector. As analysed in detail by our publication entitled 'Status Report on Enterprise RDI[8], which came out in 2012, the introduction of fiscal (taxation-driven) and demand driven (tender-based) incentives played a major role in bringing about a multi-digit growth in corporate R&D expenditure over the previous decade both in nominal and in real terms.

GOVERNMENT INVOLVEMENT IS NEEDED TO REDUCE APPARENT REGIONAL DISPARITIES WITHIN RDI.

In summary the question that arises is whether the high concentration in the number of researchers observed in Central Hungary is problematic in itself, given that it does significantly boost the competitiveness of this region, and is a source of positive economic and social influence at local level. At the same time it would evidently be better if R&D were not so heavily concentrated in the environs of the capital city alone. The solution is obviously not going to come from evenly distributing the existing pool of researchers across the country's various regions, since the objective is rather to find methods to facilitate the development of regions outside Central Hungary in such a way that this would draw nothing away from the central region yet ultimately lead to a more leveraged regional distribution of an altogether greater number of research units being created.

[8] The publication can be downloaded from the homepage of Kaleidoszkóp: http://kaleidoszkop.nih.gov.hu.

1.2 R&D expenditure sector by sector in Central Hungary

R&D expenditures are used by three (statistically distinct) sectors: the business enterprise, the government (institutional) and higher education sectors. It is clear from the following figure, that in the Central Hungary region two-third of R&D expenditure is linked to the business enterprise sector, which roughly corresponds with the national distribution ratio.

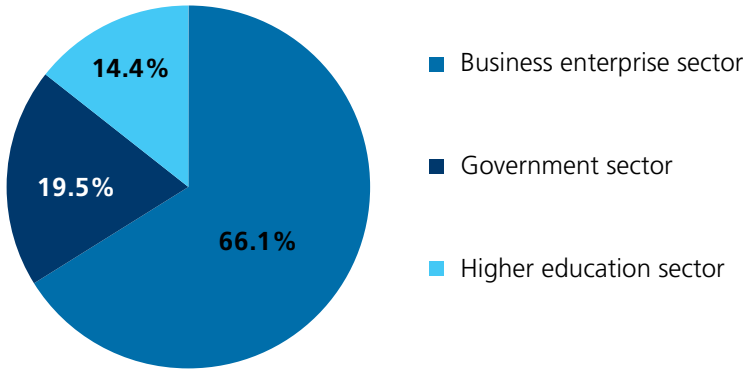

Figure 5: The relative share of individual sectors of R&D expenditure within Central Hungary in 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

> IN CENTRAL HUNGARY 2/3 OF TOTAL R&D EXPENDITURE IS USED BY THE BUSINESS ENTERPRISE SECTOR, WHICH CORRESPONDS WITH THE NATIONAL AVERAGE.

In summary we may conclude that the R&D expenditure to headcount ratio of the business enterprise sector underwent dynamic growth in the second half of the 2000s and the same trend continues. The only question is whether we are seeing an adverse shift in the balance of publicly funded basic research and industrial applied technological research (e.g. towards too specialized 'industry driven' research).

This is a problem to be addressed by the phrase 'post-academic' science (Kutrovátz et al, 2008, p. 121), the bottom line of which is that science no longer shapes its own future dimensions, since these are defined rather by applied technological research programmes, various interest groups and capital investment. This is typically observed in countries that have a rather sophisticated professional background but do not have sufficient capital resources at their disposal like those handled by countries characterised by strong technological innovation, and so they redirect their outsourceable processes to these countries and away from their own innovation centres. Besides the well-known advantages this might, however, pose a risk in the sense that it is much easier to replace such a relatively more subordinated partner with the stroke of a pen from the parent company headquarters. It is a worthwhile exercise to draw a comparison between the former and Hägerstrand 's (1952) innovation-diffusion theory, according to which certain products/methods/services spread in peripheral areas only after they have started to decline in the central zone – and we know that the cost effectiveness motivated process of repeated production site changes follow the same geographic pattern. In connection with this, the question arises as to what extent the existing technological gap between various countries and global economic regions will keep widening due to accelerating technological changes. With the advance of infocommunication technologies, some traditional schemes seem to be crumbling as more and more innovative SMEs (often coming into being on the periphery or semi-periphery of the global economy) start to gear their production directly to the global marketplace – and so in certain market niche areas they are able to surpass even 'blue chip' companies (for more detail see for example: LBS, 2013). This should also give hope to Hungarian innovative companies.

1.3 The share of the Central Hungary from the key indicators of innovative sector companies engaging in R&D

This chapter analyses the concentration of economic sectors/industries with an RDI focus in Central Hungary. The data presented here[9] demonstrate the weight of certain indicators characterising companies engaging in R&D within the central region (we also included data for Budapest and Pest County separately).

For the purpose of this analysis innovative sectors include those where at least 30% of active companies are innovative. According to the findings of a CIS survey carried out in 2010[10] the list of economic sectors and industries with a minimum 30% share of active companies implementing technological innovation include the following; we made a sectoral breakdown within the manufacturing industry (C) of the national economy:

- CF Manufacture of pharmaceuticals
- CI Manufacture of computer, electronic and optical products
- CL Manufacture of transport equipment
- CJ Manufacture of electrical equipment
- D Electricity, gas, steam and air conditioning supply
- E Water supply; sewerage, waste management and remediation activities
- M Professional, scientific and technical activities
- J Information and communication services
- K Financial and insurance activities

It is clear from the Figures (6-12.) below, that Central Hungary weighs very significantly within the following innovative sectors and industries:

- Information and communication services
- Manufacture of pharmaceuticals
- Manufacture of computer, electronic and optical products

We may also conclude that Central Hungary does not have a significant weighting within the following sectors/industries:

- Manufacture of electrical equipment
- Manufacture pf transport equipments (at least in manufacture of motor vehicles)

[9] This section presents the corporate aspect of R&D, and we included data for Budapest and Pest County separately.

[10] The Community Innovation Survey (CIS) commissioned by the European Union every two years analyses the innovation activity of companies. In 2011 HCSO conducted the most recent survey in relation to the 2008-2010 period, this is to be referenced as CIS 2010 throughout this document.

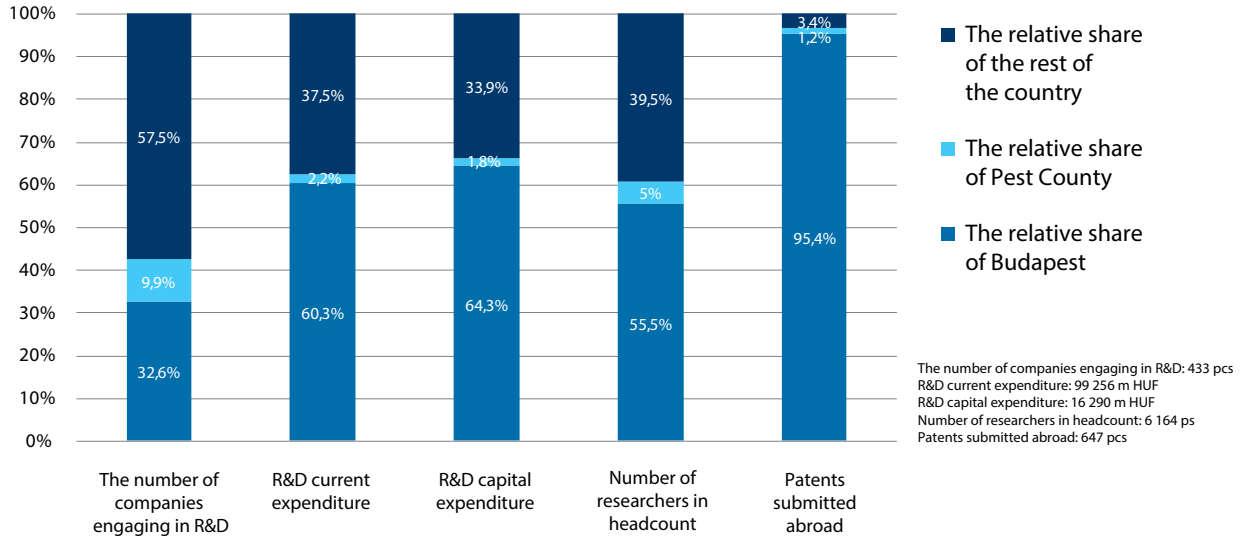

Figure 6: The relative share of Budapest, Pest County and the rest of the country from the key indicators of companies engaging in R&D and active in manufacturing sector of the national economy (2011).
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data

The overall dominance of the Central Hungary Region across the manufacturing industry is by and large in conformity with general R&D indicators, with percentage rates ranging roughly between 40 and 70% for particular indicators. However, the position of Central Hungary is nevertheless differs widely in different sectors, as will later become clear.

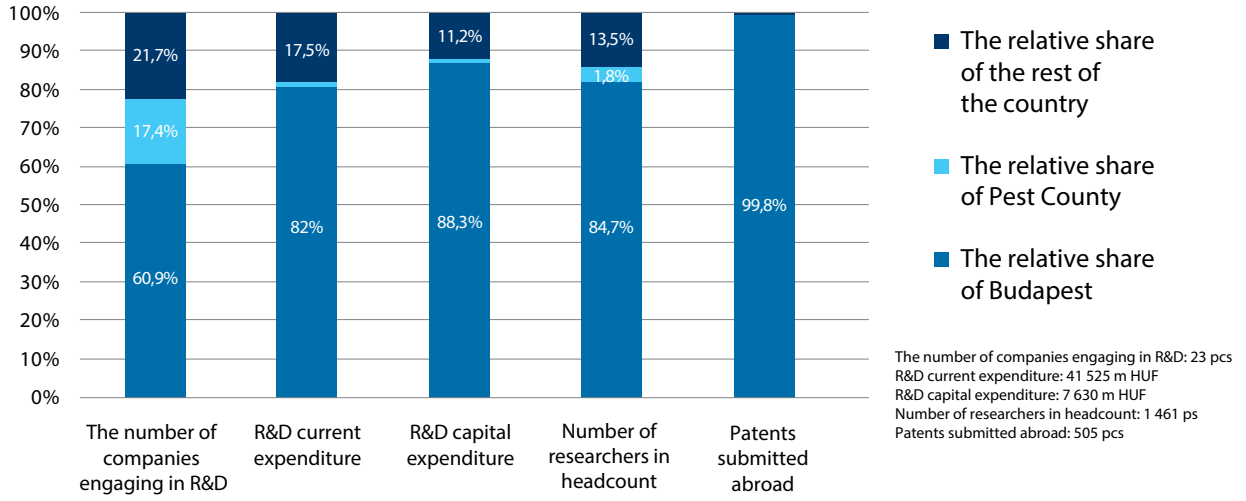

Figure 7: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in manufacture of pharmaceuticals (2011). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

MANUFACTURE OF PHARMACEUTICALS SHOWS EXTREMELY HIGH LEVELS OF CONCENTRATION, WITH 4/5 OF COMPANIES ENGAGING IN R&D FOUND IN THE CENTRAL HUNGARY REGION, AND WITH EVEN HIGHER RATES OF CONCENTRATION RECORDED IN THE ABOVE R&D INDICATORS.

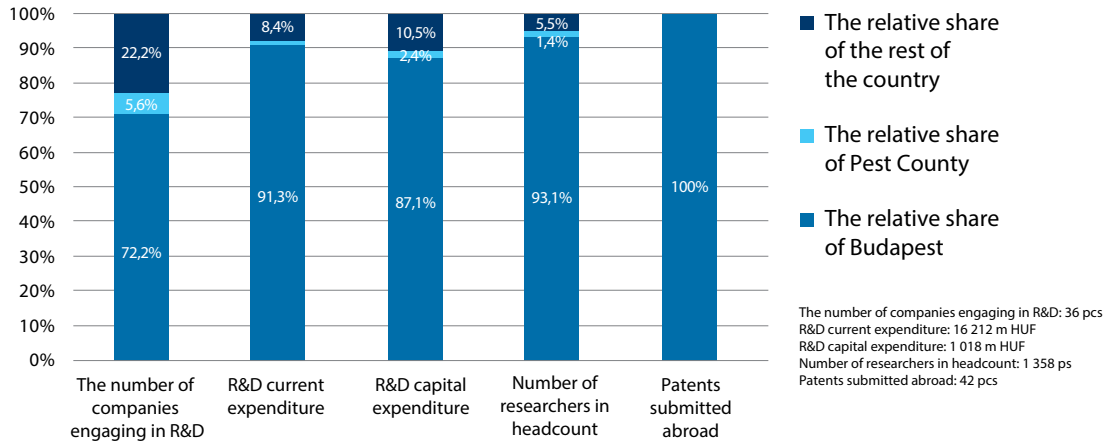

Figure 8: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in the manufacture of computer, electronic and optical products sector, 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

The manufacture of computer, electronic and optical products sector is characterised by similar distribution ratios to manufacture of pharmaceuticals: four-fifth of stakeholders are concentrated in Budapest, and Central Hungary has a roughly 90% or greater share of other R&D indicators.

CENTRAL HUNGARY SIGNIFICANTLY DOMINATES THE MANUFACTURE OF COMPUTER, ELECTRONIC AND OPTICAL PRODUCTS COMPARED TO THE COUNTRY'S OTHER REGIONS.

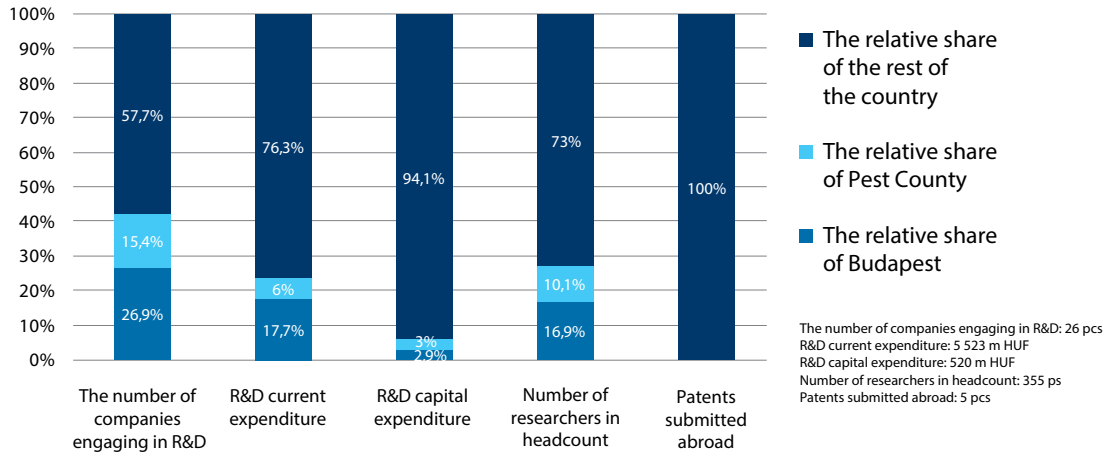

Figure 9: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in the manufacture of electrical equipment sector of the national economy, 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

By national comparison, Budapest and Pest County do not have a significant weight within R&D performance associated with the manufacture of electrical equipment: although the relative weight of these two regions appears to be dominant based on the total number of companies involved, but when we also look at every other indicator we find that these tend to be relatively small companies or companies which do not carry out significant R&D activity.

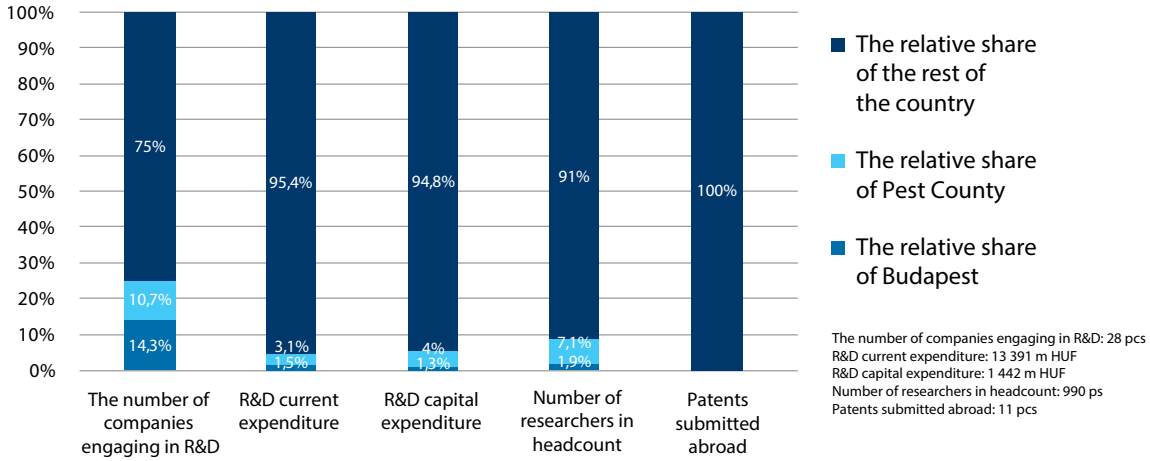

Figure 10: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in the manufacture of transport vehicles, 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

In respect to the transport vehicle manufacturing sector the Central Hungary Region is a relatively lightweight player by national comparison. There is nothing surprising in this, if we just consider in which areas large automotive manufacturers and their suppliers tend to be concentrated.

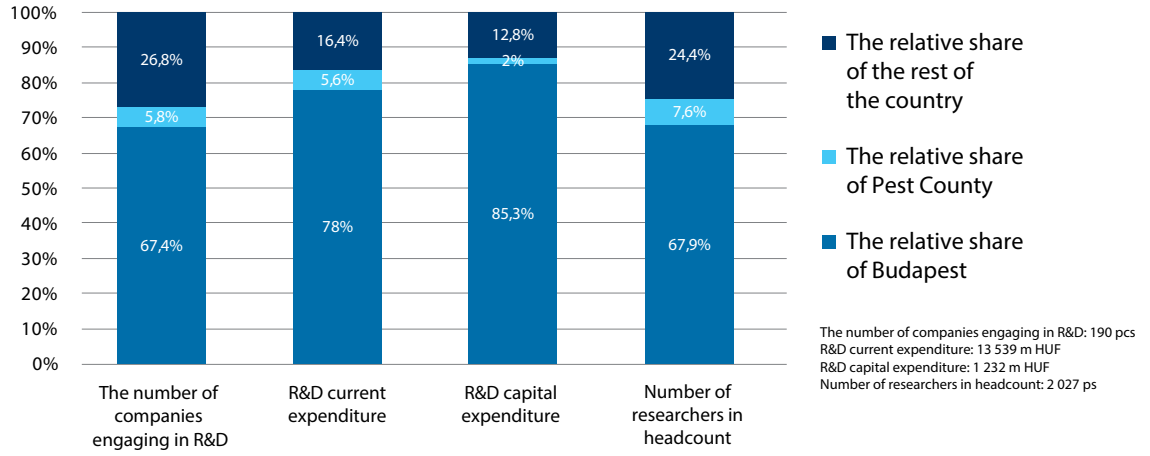

Figure 11: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in the information and communication sector of the national economy, 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

[BUDAPEST HAS A DOMINANT POSITION WITHIN THE R&D PERFORMANCE OF THE INFORMATION AND COMMUNICATION SECTOR OF THE NATIONAL ECONOMY.

As it does not require a lot of space or start-up investment, infocommunication is a typically fast changing, dynamically developing sector heavily geared towards big cities.[11] Its stakeholders like to be in close proximity to each other, as is confirmed by the studies mentioned previously and dedicated to analysing the internal dynamics of such networks. Silicon Valley is a classic example (which also has a high concentration of ICT companies), but nearly all clusters build upon understanding this law of dynamics.

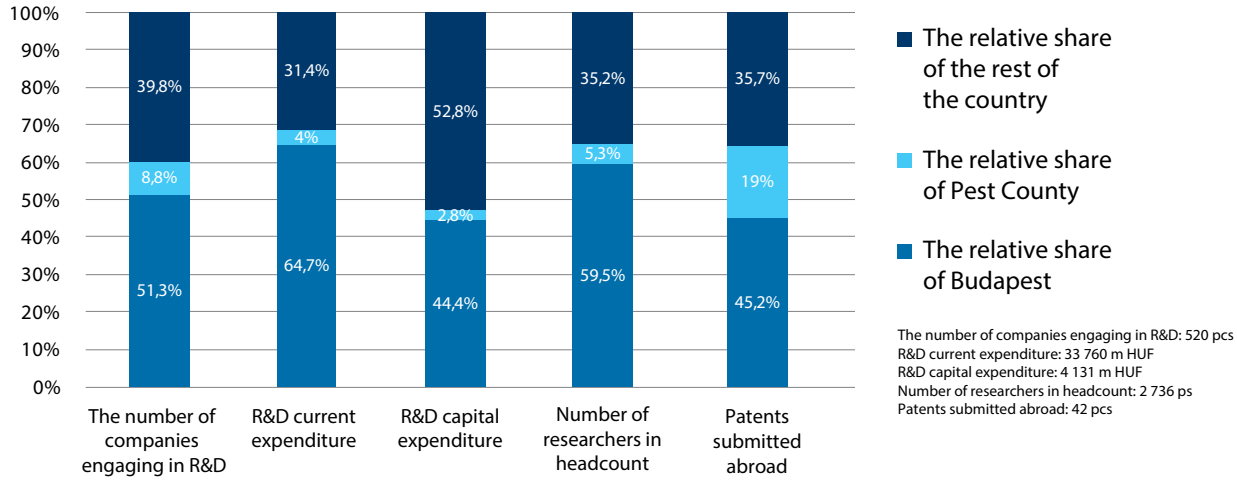

Figure 12: The relative share of Budapest, Pest County and the rest of the country of the key indicators of companies engaging in R&D and active in the professional, scientific and technical activities sector of the national economy, 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

The Central Hungary region accounts for a significant proportion of professional, scientific and technical activities and although it might come as somewhat of a surprise, we find that this region has the lowest level of concentration in R&D investment, going hand in hand with a considerably higher share of both an actual R&D headcount and R&D costs.

In this chapter we endeavoured to demonstrate the dominance of the Budapest region compared to the rest of the country in terms of R&D potential and in a breakdown according to the innovative sectors. In the above we provided an analysis of the status of regional concentration characterising the manufacturing industry (more particularly of manufacture of pharmaceuticals, the manufacture of computer, electronic and optical products, the manufacture of electrical equipment and the manufacture of transport vehicles), information and communication, and professional, scientific and technical activities. We observed that, with the exception of the manufacture of transport vehicles and the manufacture of electrical equipment, the Central Hungary region represents considerable weight within the R&D performance of innovative sectors and industries.

The findings of our regional analysis confirmed the hypothesis concerning the dominance of Central Hungary and Budapest in particular (which is not a surprising conclusion, yet as we observed, the scale of this dominance often takes on surprisingly large proportions). The overall conclusion from the above is that in the case of the Hungarian national economy, which is characterised by a high degree of concentration in any case, indicators linked to activities with an RDI focus demonstrate an even greater degree of concentration in Central Hungary than general economic indicators. It is also striking how particular research and development centres (technology firms and universities) can have a huge impact on the RDI performance of a whole region (see for instance the GERD/GDP indicator for Hajdú-Bihar or Csongrád counties). All these correlations ultimately point to one thing, namely that in terms of RDI-related socio-economic indicators, Central Hungary has a greater competitive edge than the country's other geographic units.

[11] We explored this sector, its significance for the national economy and its RDI implications in our publication entitled RDI Mirror 1: Review of the ICT sector, which can be downloaded from our website at: http://kaleidoszkop.nih.gov.hu/

Capturing a snapshot of Central Hungary and Budapest is only part of the regional aspect of RDI, but in order to see the full picture it is vital to include a description of every region. Even though Budapest is characterised by a significant degree of dominance, by analysing the comparative indicators of other individual regions – and in some cases measuring how these compare with the same indicators for Budapest – we can draw additional important conclusions.

2.1 Per capita GDP by regional comparison

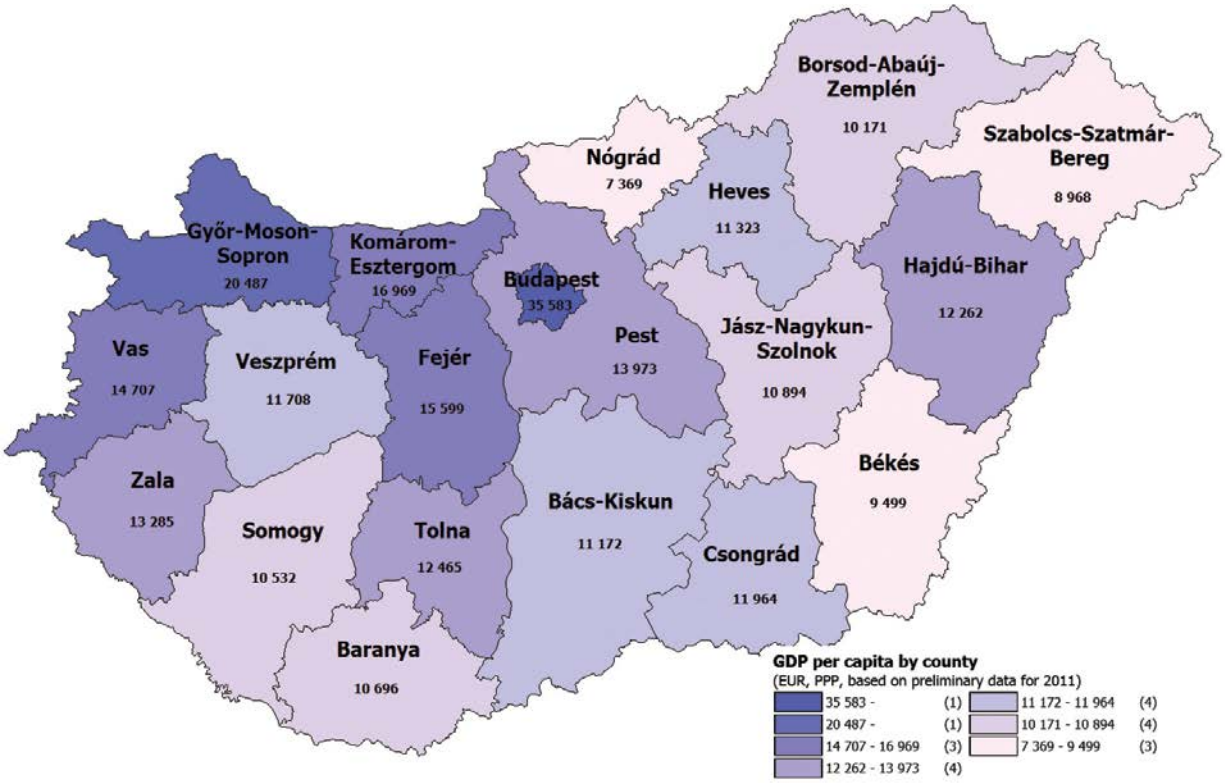

Figure 13: GDP per capita by county (EUR, PPP based on preliminary data for 2011).
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.

It is common knowledge that there are big differences between various regions based on their per capita GDP (adjusted for purchasing power parity). Apart from Budapest only two other counties, Győr-Moson-Sopron and Komárom-Esztergom exceeded the national average (i.e. EUR 16,484 based preliminary HCSO data for 2011). If we look at individual regions, then we find that Western Transdanubia is above the national average, even if only marginally so -, whereas the per capita GDP of Northern Hungary is less than ten thousand EUR.

2.2 Baseline characteristics relevant to R&D

2.2.1 R&D expenditure as a percentage of GDP

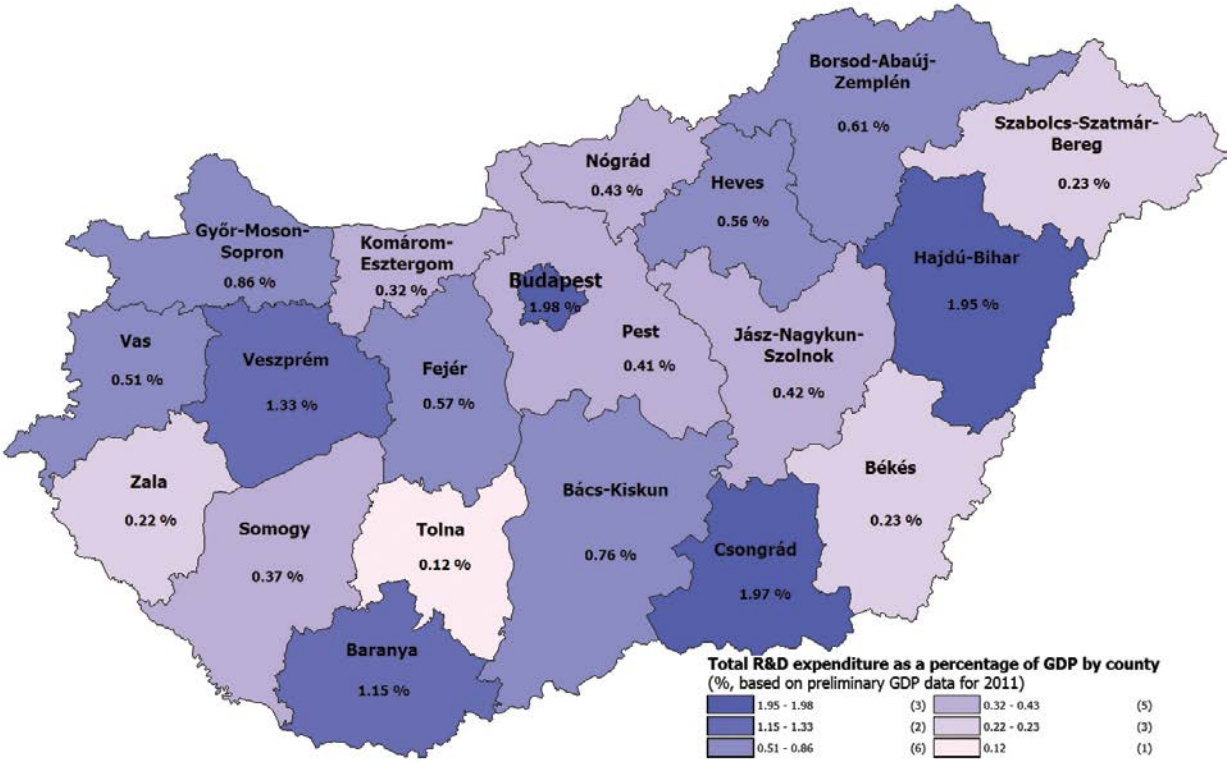

Figure 14: Total R&D expenditure as a percentage of GDP by county (based on preliminary GDP data for 2011).
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.

Analysing the GERD to GDP ratios of different counties for 2011, allows us to conclude that only three counties were above the national average (excluding Budapest) of 1.21%, namely Csongrád (1.97%), Hajdú-Bihar (1.95%) and Veszprém counties (1.33%). It is interesting that without these three counties and Budapest the GERD/GDP index of all other counties would be 0.55% in total, i.e. less than half of the national average. By comparing the same data at a regional level, we find that apart from Central Hungary only the two Northern and Southern Great Plain regions reached a ratio of 1% due to the above average performance of the two outstanding counties - Hajdú-Bihar and Csongrád - mentioned previously. Every other region delivered a largely similar performance ranging from 0.57% to 0.68% in 2011.

FOR GERD/GDP RATIO ONLY THREE COUNTIES - APART FROM BUDAPEST - EXCEEDED THE NATIONAL AVERAGE: CSONGRÁD, HAJDÚ-BIHAR AND VESZPRÉM. THE AVERAGE OF EVERY OTHER COUNTY IS LESS THAN HALF OF THE NATIONAL AVERAGE.

2.2.2 Gross average earnings

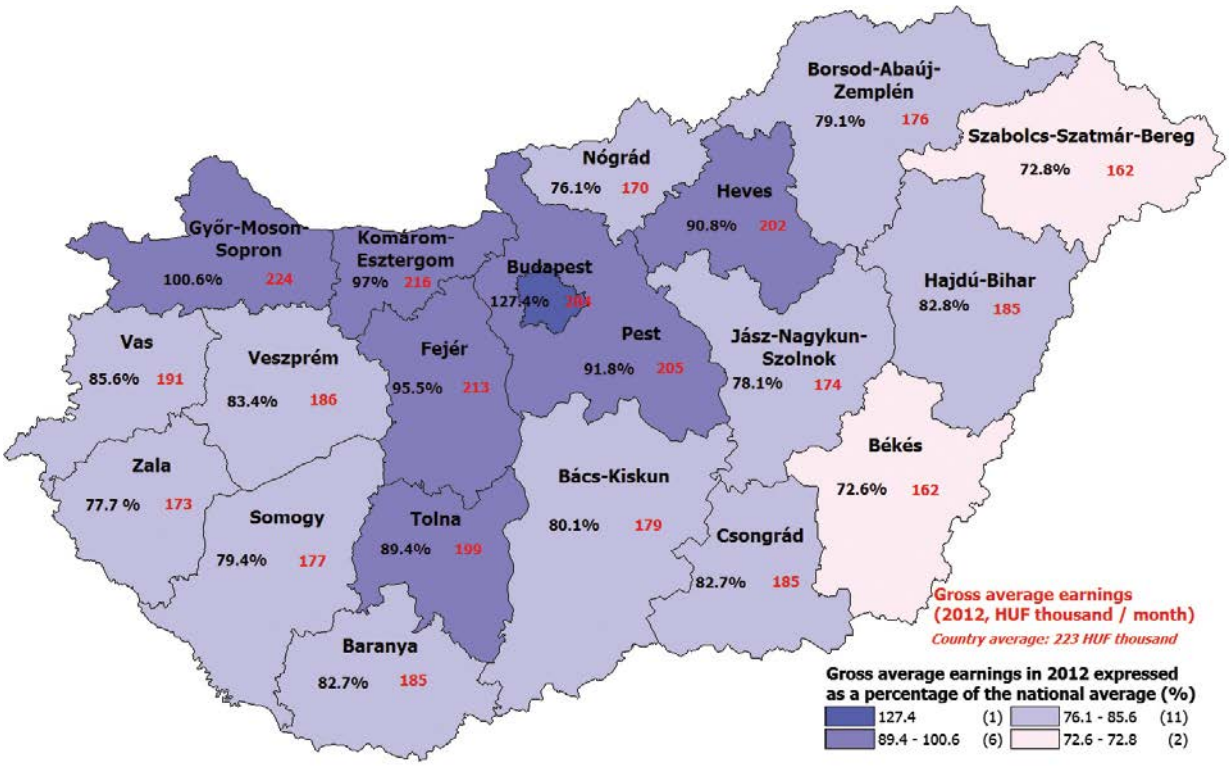

Figure 15: Gross average earnings[12] in Hungary expressed as an annual average (HUF thousand / month), and as a % of the national average by county (2012). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.*

Presenting gross average earnings in comparison with the national average is an important pillar for analysing regional differences, as these indicators can tell us more about real living standards than GDP or any other macroeconomic data. In 2012 gross average earnings amounted to HUF 223 thousand in Hungary. Apart from Budapest, only Győr-Moson-Sopron County slightly exceeded this average: while other counties lagged behind this level. Fundamentally, we are able to observe a West to East earnings slope outside Budapest. The only exceptions to this include Heves County with a somewhat better result (91%), as well as Zala and Somogy counties with ratios below 80%. We can also observe that from among Hungarian counties with large university towns (Pécs, Debrecen, Győr, Miskolc, Szeged and Budapest) only Győr-Moson-Sopron and Budapest can boast of impressive specific results, whereas other counties hosting university centres are somewhere in mid-field position on this list.

[12] Gross average earnings is a broader term than wages and is used to describe people's income. It means: earnings; other income from employment; social welfare costs; flat rate benefit payments (allowances, contributions); statutory benefit and contributions paid by the employer into various funds; social welfare contributions paid under a collective agreement, sectoral agreement or ad-hoc work contract; social welfare benefits paid directly to the employee and social welfare contributions paid on behalf of employees.

2.2.3 FTE headcount of researchers by county

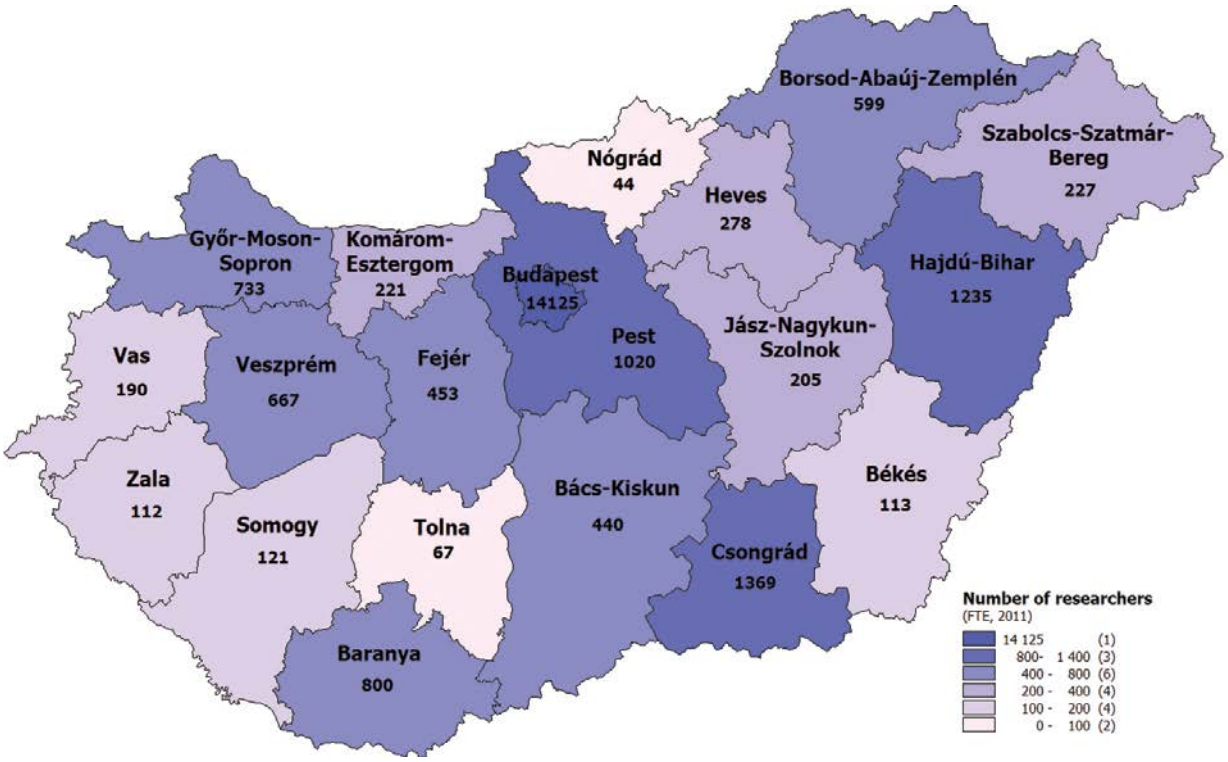

Figure 16: Number of researchers (FTE, 2011) *Source: The National Innovation Office RDI Observatory's map imaging based on HCSO data.*

Regions other than Central Hungary employ no more than 40% of all Hungarian researchers (what is more, this value goes down to 34.2% when converted into FTE), and strong disparities exist even between these counties and regions.

> THE NUMBER OF RESEARCHERS EMPLOYED IN BOTH GREAT PLAIN REGIONS IS SIGNIFICANTLY ABOVE THE SAME INDICATOR FOR WESTERN TRANSDANUBIA, AN OTHERWISE HIGHLY DEVELOPED REGION.

At the same it needs to be pointed out that it is not the country's highest GDP generating regions that employ the most researchers: the total number of researchers working in Csongrád, Hajdú-Bihar and Baranya counties (not FTE) is in excess of 1,500 people. In terms of FTE employment the same three counties are in the lead, but Pest already has overtaken Baranya County. By regional comparison, the number of researchers employed in the Northern and Southern Great Plain regions is significantly above the same indicator for Western Transdanubia, an otherwise highly developed region.

2.2.4 R&D expenditure

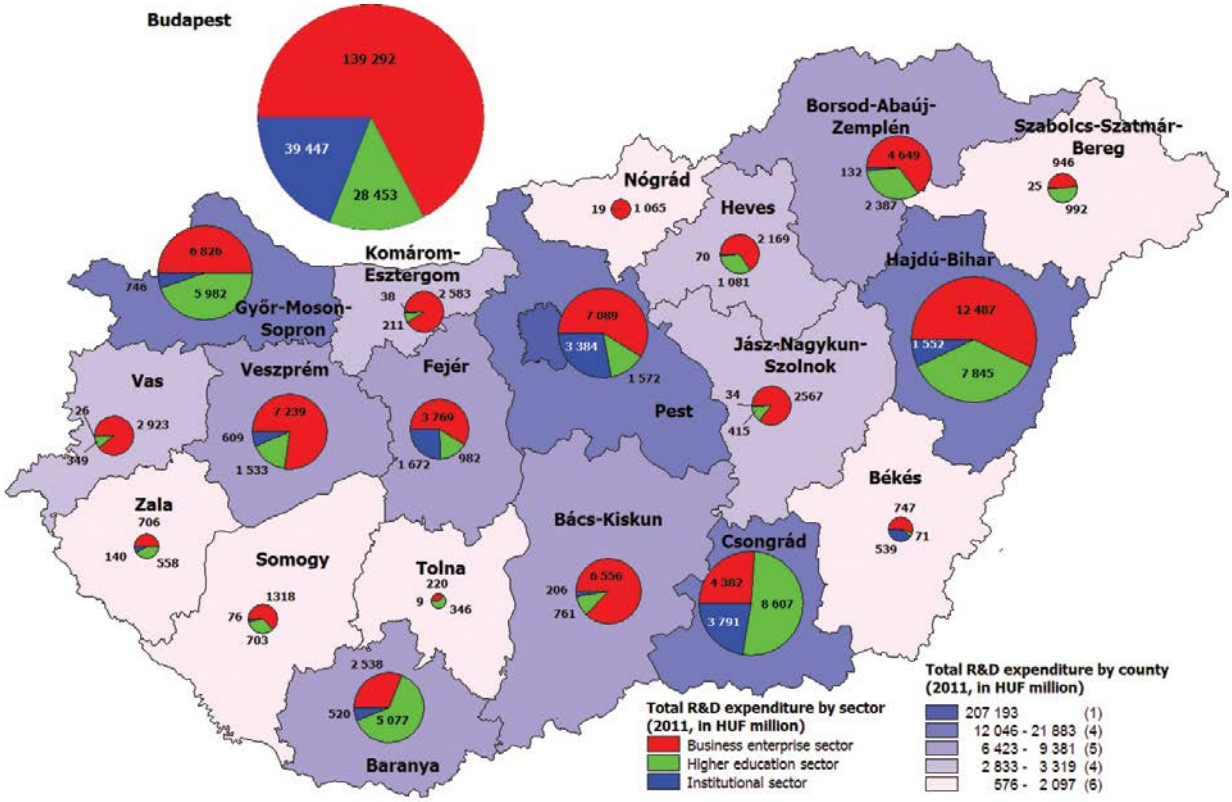

Figure 17: Total R&D expenditure in a breakdown according to county and sector (2011, in HUF million)

Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former. The pie chart for Budapest has a 2.3 times larger scale than the one presented here.[13]

Stakeholders outside the Central Hungary region have only just over a one-third of total national R&D expenditure at their disposal. The relative share of Hajdú-Bihar and Csongrád, as well as the Northern and Southern Great Plain regions is particularly high in this area too - similarly to the headcount of researchers-, as opposed to Northern Hungary and Southern Transdanubia, both of which are heavily underperforming in this respect.

[13] We had to distort the scale of the pie chart somewhat in order to enhance it's demonstrative power: had we not done this the pie chart section for Budapest would have been so massive that it would have been impossible to show anything else. This alone provides an indication of the extraordinary concentration of R&D expenditure.

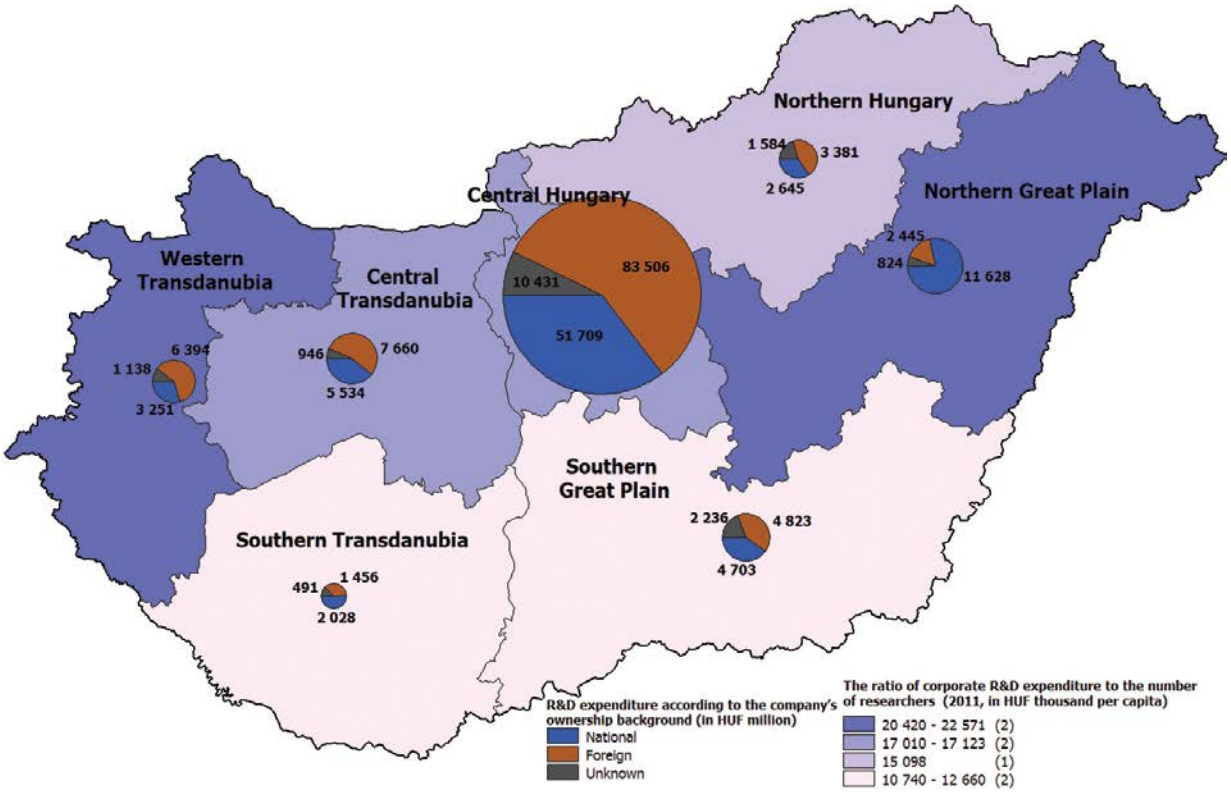

Figure 18: The ratio of corporate R&D expenditure to the number of researchers (2011, in HUF thousand per capita); in a breakdown according to region and proprietor. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.*

Corporate R&D expenditure per researcher is at its highest in two regions that are in two opposite ends of the country: in Western Transdanubia and in the Northern Great Plain. The two southern regions have the lowest relative index in this regard. Of course disproportions in the scale of R&D expenditure do not necessarily mean a correspondingly significant disparity in the salary scale of researchers, as the evident existence of significant disproportions - which can be as much as twofold at a national level - can also be explained by structural differences between the regional economies concerned. In regions where RDI is driven mostly by infrastructure (see Chapter 5 for our complex index which is relevant to the former), R&D expenditure will of course be higher.

There are also major regional disproportions according to the role of foreign companies within R&D: foreign companies consume a significant amount of expenditure in Central Hungary both in absolute and relative terms, and likewise they spend over 50% of the corporate R&D expenditure of Transdanubian regions.

2.2.5 Development of the R&D headcount of various sectors

There are significant regional disproportions both in the R&D headcount and in how that headcount is distributed between various sectors. In some areas, for example in Pest County, the business enterprise sector has an outstanding share of the headcount of researchers. In other counties however, typically those with big university centres, the higher education sector far outweighs the business enterprise sector. This is exactly the impact that the universities of Pécs, Szeged and Debrecen have on their respective counties. In Veszprém and Borsod-Abaúj-Zemplén counties – even though they also have universities – the R&D headcount of the business enterprise sector far outweighs the same index of the higher education sector. The institutional sector has a relevant share in only a few geographic areas: and among these Budapest stands out by far, given that it has a concentration of the predominant majority of the country's research institutes. In counties with a college only, R&D headcount comes to no more than 100-200 people, i.e. they are in a peripheral position.[14]

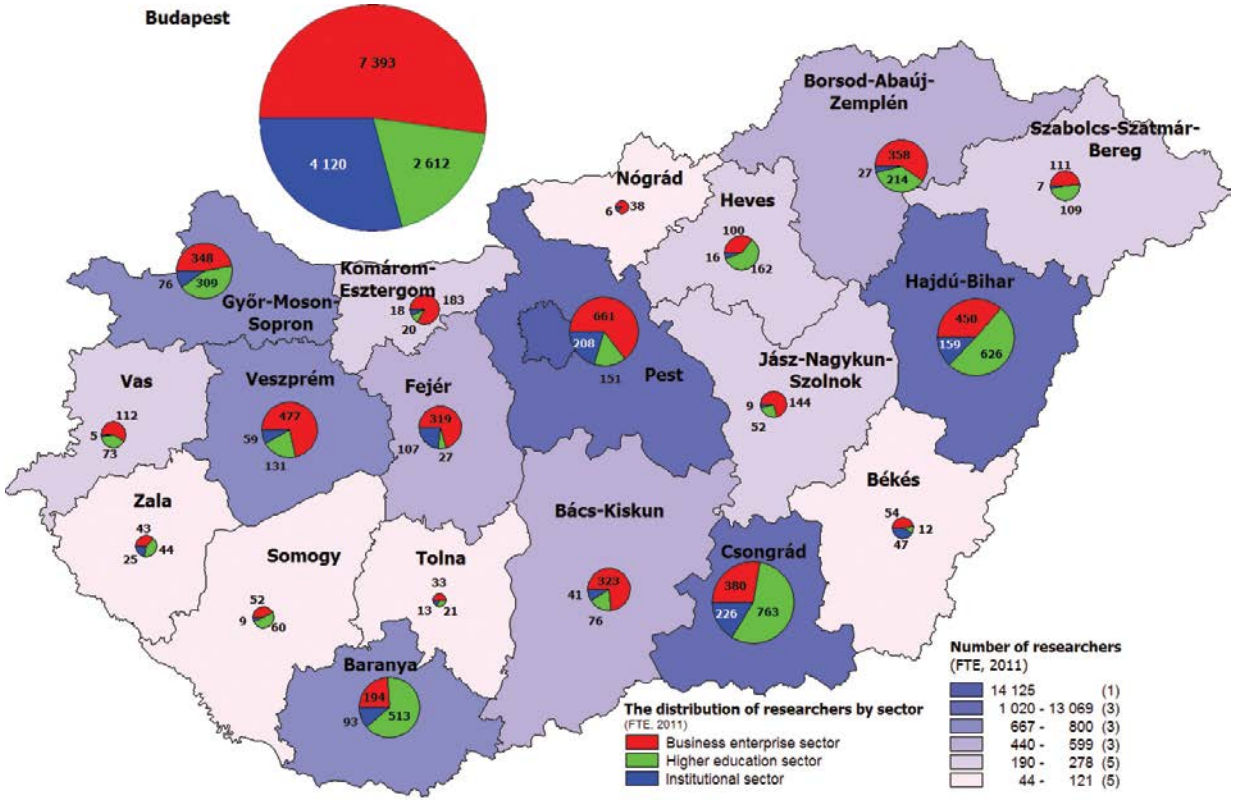

Figure 19: Number of researchers (FTE, 2011) and its breakdown according to sectors in Hungary.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former. The pie chart for Budapest has a 1.5 times larger scale than the one presented here.[15]

[14] For detailed information about the FTE headcount of individual sectors in 2000-2011 see Annex 2.

[15] It is partly because of the above reasons that it was necessary to distort the scale of the pie chart.

3 Innovation potential

We believe that the following are important albeit not exclusive factors determining innovation potential: the qualitative and quantitative indicators of unemployment, the key indicators of higher education, the regional distribution of innovative sectors and the migration balance. This report was written to analyse these indicators in order to understand the innovation potential of various counties.

3.1 Unemployment

The size of the available workforce is a key consideration for potential investors, and indeed is even more important than other labour market indicators. In this chapter we will therefore analyse in detail some of the available employment indicators in a breakdown by county, such as the rate of unemployment and the number of unemployed graduates.

Six of the seven counties marked by the highest rates of unemployment are part of Northern Hungary (unemployment rate: 15.8%) and Northern Great Plain (13.6%), respectively. Western Transdanubia has the lowest rate of unemployment (8.1%), which is even lower than that of Central Hungary (9.4%). It should be noted that there are major disparities in this region in respect to this particular employment indicator. Győr-Moson-Sopron (5.8%) and Vas (6.3%) counties have the lowest rates of unemployment; on the other hand, unemployment is particularly high in Zala County (13%), which is practically on the same level as the counties of the Northern Great Plain region. Fundamentally, it all boils down to regional differences: the rate

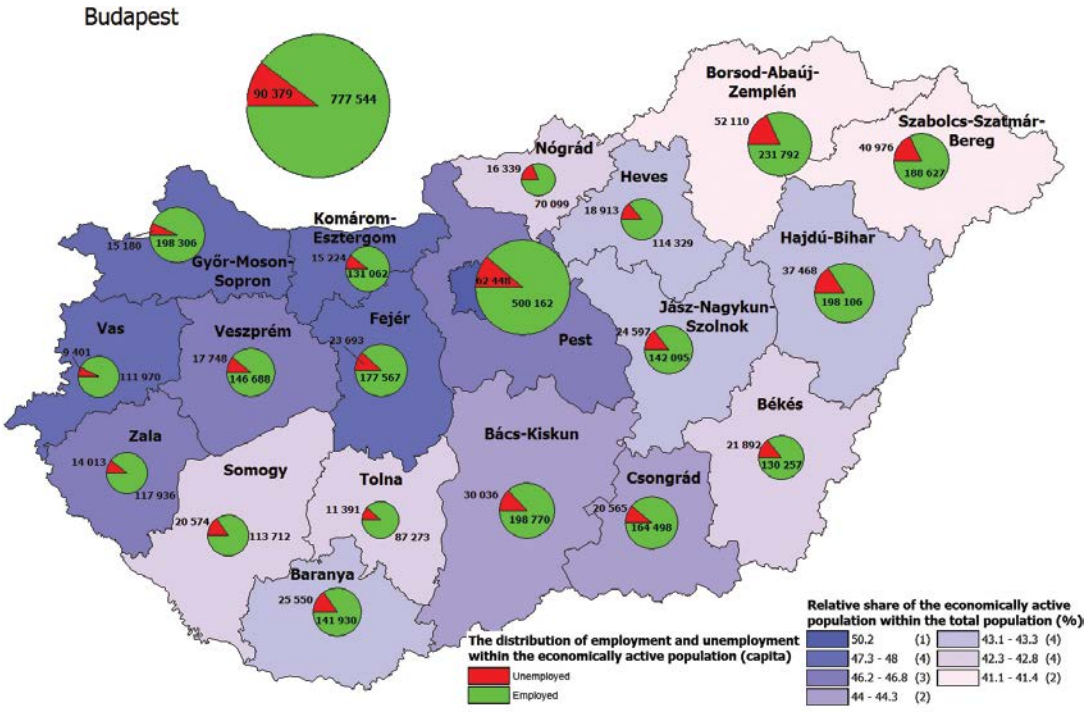

Figure 20: Employment, unemployment and economic activity statistics (2011).
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.

of unemployment is significantly lower for counties of the Transdanubian region than for counties located east of the River Danube.

In respect to innovation potential, the number of registered unemployed with a higher education degree is of paramount importance, and Figure 21 demonstrates the regional disparities reflected by this indicator.

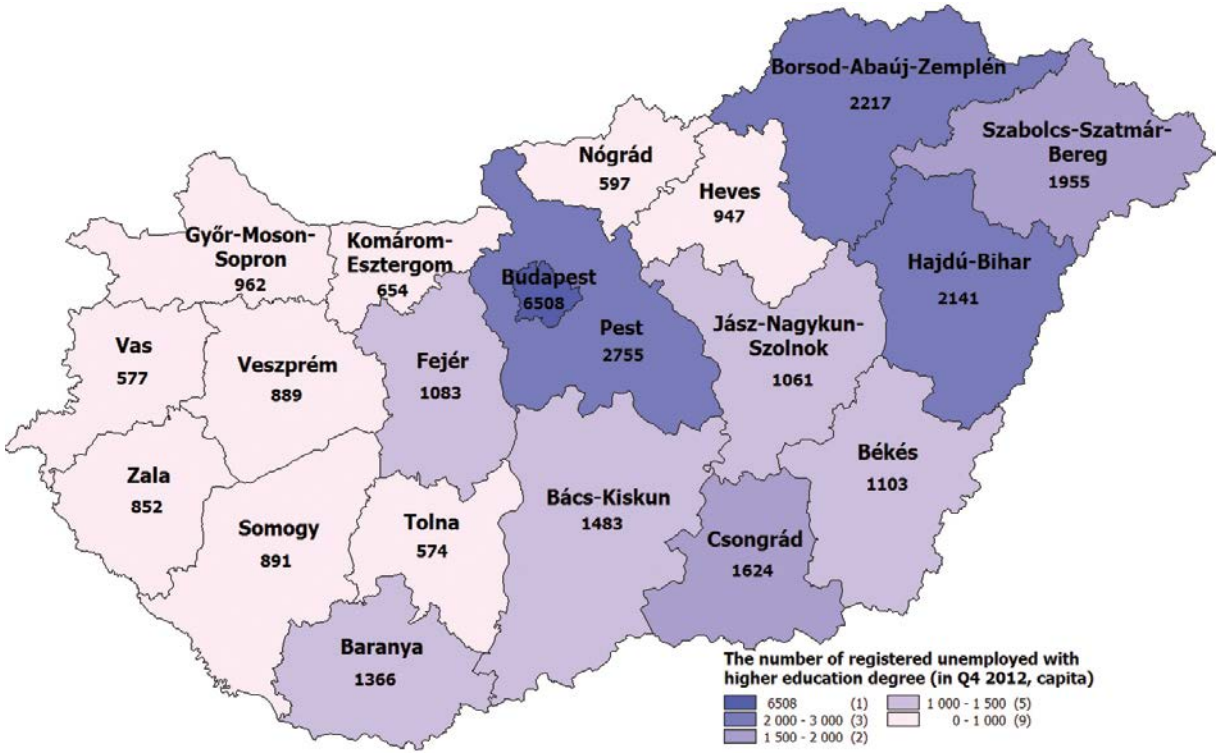

Figure 21: The number of registered unemployed with higher education degree in Hungary, in Q4 2012.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.

As a general rule, the more highly developed a county is, the more unemployed graduates there are in it (even though neither the size, nor the level of a county's development can conclusively explain the underlying causes). There is no apparent connection between this indicator and unemployment as such, however, part of the explanation must be that in highly developed regions there are many more job seekers with a degree, not to mention the brain drain phenomenon, i.e. the movement of highly skilled labour away from less developed regions towards more highly developed regions (or to foreign countries). In order to stop this trend, several towns and cities (e.g. Szolnok and Szombathely) launched so-called 'welcome back' programmes in order to motivate locally born graduates who acquired their degrees from a university somewhere else to return to their home town for work. More (long-term) research is needed to analyse the conflicting regional effects of the brain drain on the one hand and 'welcome back' programmes on the other.

3.2 Percentage of higher education degree holders and those with foreign language knowledge

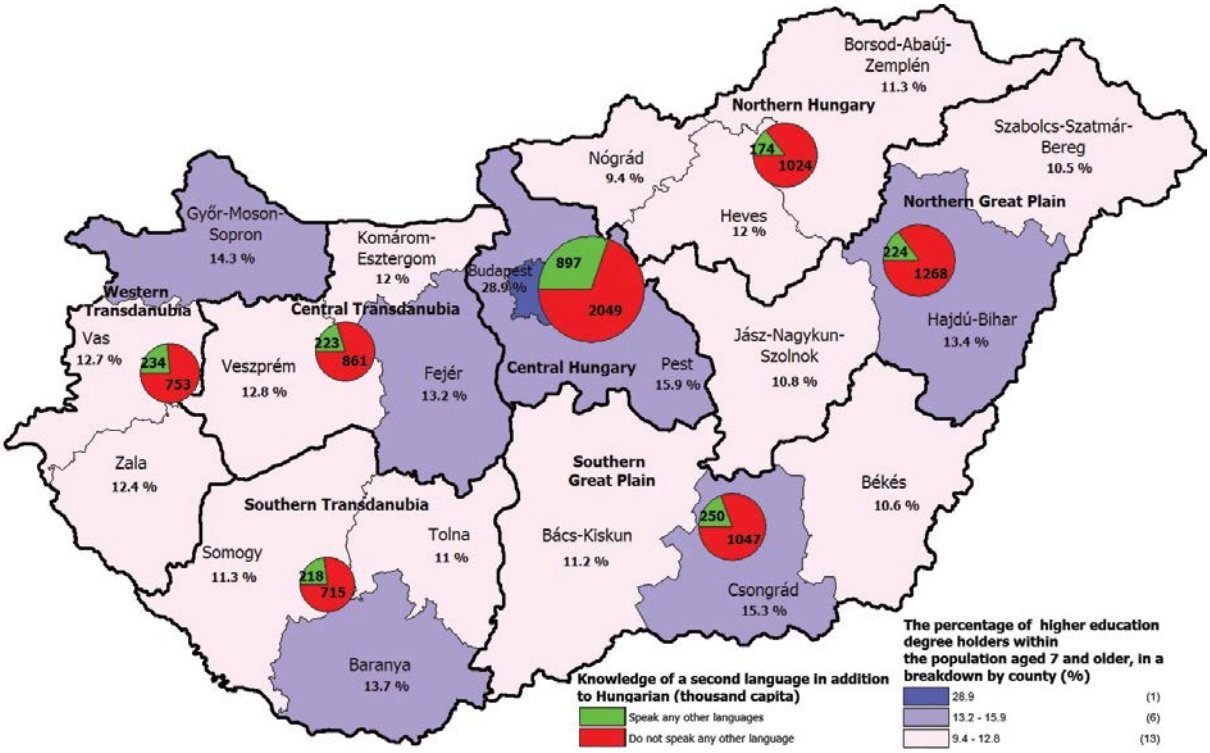

Figure 22: The number of higher education degree holders in a breakdown by county (%) and the regional percentage rate of those with knowledge of a foreign language (%). *Source: The National Innovation Office RDI Observatory's own calculations based on the Census for 2010, and map imaging of the former.*

> THE DISTRIBUTION OF GRADUATES AND THOSE PROFICIENT IN A FOREIGN LANGUAGE FOLLOWS VERY DIFFERENT PATTERNS: WHILE THE FORMER IS CHARACTERISED BY DOTTED SPATIAL PATTERN, I.E. ONE THAT IS LINKED TO HIGHER EDUCATION CENTRES, (TOWNS AND CITIES), FOREIGN LANGUAGE PROFICIENCY IS CHARACTERISED RATHER BY REGIONAL DIFFERENCES, ON A SCALE WHICH BECOMES INCREASINGLY NARROWER FROM WEST TO EAST.

These two indicators taken from the 2011 census clearly demonstrate the human resources status of individual geographic units. Both indicators suggest geographically rather consistent results for the whole country; i.e. counties with one or more universities have a higher percentage of graduates, so this indicator is linked to dotted facilities, such as university towns and cities. In contrast with this, foreign language proficiency can be presented as a regional slope slanting from west to east, and only the Central Hungary region interrupts this evenly graded curve. Figure 22 nicely illustrates the different geographic patterns of these two indicators.

> COMPETENCE LEVELS ARE SIGNIFICANTLY INFLUENCED BOTH BY SETTLEMENT LEVEL AND BY REGIONALITY.

The competence assessment, which was carried out by the Educational Authority (2013) - and which is closely linked to the subject matter of this report - highlights many interesting facts. It is interesting to note, that the average level of competence is defined not only by regionality but also by settlement level: 'Average results presented in a regional breakdown indicate the good performance of the Western Transdanubia and Central Hungary regions, and the weak performance of the Northern Hungary and Northern Great Plain regions' (Educational Authority, 2013, p. 15).

Settlement level examination of the same subject a similarly interesting key finding: 'Similarly to previous surveys, the competence assessment carried out in 2012 reveals sharp differences between various types of settlements: the scores of year 6 and year 8 pupils show a difference of 123 and 136 points in maths and a difference of 134 and 155 points in comprehension, respectively, depending on where they go to school: in a rural location or in Budapest. Such differences are explained by the different economic and social characteristics of various types of settlement' (Educational Authority, 2013, p. 16).

3.3 Higher education

In 2011 there was a total of 69 higher education institutions in Hungary, 39 of which were headquartered in the Central Hungary region, and the Central Transdanubia region appeared to have a greater than average presence. At the same time, it must be pointed out that for statistical purposes education institutions are taken into account based on where their seat is located, and only having external faculties in other regions will change the percentage rates below to a certain extent.

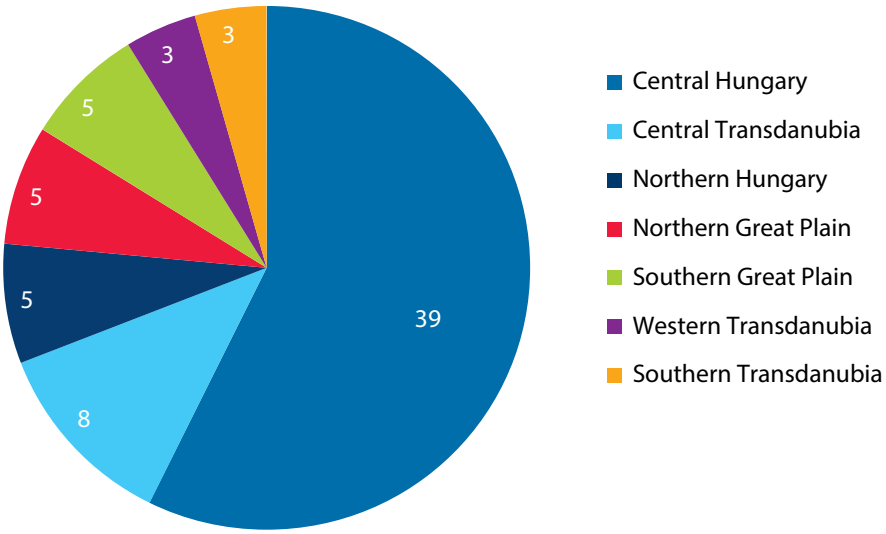

Figure 23: Regional distribution of higher education institutions in 2011, according to their main seat (pcs).
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

Over 50% of lecturers worked and over 50% of students studied in education institutions located in Central Hungary. Any disparity in the percentage rate of students and lecturers (and differences in the ordering of teacher and student percentages) is probably explained by the size of the institutions concerned and their faculties.

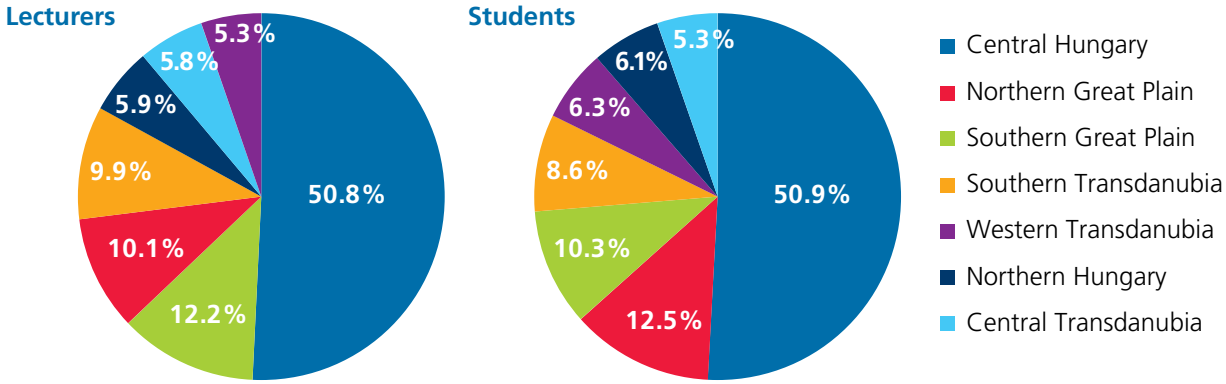

Figure 24: Regional distribution of higher education lecturers and full time students in 2011.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.

There is a lot of regional disparity in the distribution of academic title holders, with the share of Central Hungary just exceeding 50% in 2011. The relative weight of other regions cannot always be correlated with the above orders of importance, with the relatively good performance of the Northern Great Plain region, due to the influence of Debrecen, being worthy of note for example. Northern Hungary also scores a low percentage rate in this area. No conclusive trend has emerged in recent years, with a constantly fluctuating number of graduates in most regions, the only exceptions being the Southern Great Plain and Western Transdanubia regions (in both the percentage of scientific title holders increased significantly). It is noteworthy in respect to this academic indicator that in respect to RDI it serves to distinguish the 'internal space' of two different phenomena[16] existing in Hungary. One is linked to innovative economic activities, while the other is linked to higher education. While for Budapest the two dimensions are interrelated, for the rest of the country this is far from being the case. While Western Transdanubia is for example clearly stronger in terms of its economic indicators, the catchment areas of the universities of Pécs, Debrecen and Szeged (county and region) have better higher education indicators. Often there is only a loose connection between the two dimensions, as a bi-directional and levelled relationship between the economy and higher education has still not developed everywhere in Hungary, even though this is what makes highly developed countries so successful in innovation.

> THERE IS A SPATIAL SEPARATION BETWEEN INNOVATION AND HIGHER EDUCATION; CENTRAL HUNGARY BEING THE ONLY REGION WHERE WE CAN OBSERVE A REALLY CLOSE INTERRELATION BETWEEN THE TWO.

The Joint Research Centre (JRC) Programme was started by the European Commission as a possible solution (2013) to this problem, as it is designed to facilitate a closer relationship between universities and corporations. Universities need to build a strong relationship with companies that use the latest technologies, yet the economic crisis forced most companies to cut back their spending on innovative activities. The JRC Programme provides an entry point for building synergies with university research units, which always welcome new opportunities for innovation. JRC is committed to getting the latest technologies out into the market as soon as possible, even if they have not been tried and tested, as this opens up the way for all the researchers concerned to add their own knowledge and ideas to the innovation in question. This kind of market liberalisation – taken to the highest level – will provide parties participating in technology transfers opportunities which could prove crucial in times of crisis.

[16] József Nemes Nagy's (2009) study tangibly presents a fundamental paradigm of regional science, namely the juxtaposition of 'external space' (meaning spatial objects which we can physically detect with our sensory organs), versus 'internal space' (an imprint of the inner dynamics of any kind of social sphere, e.g. a company).

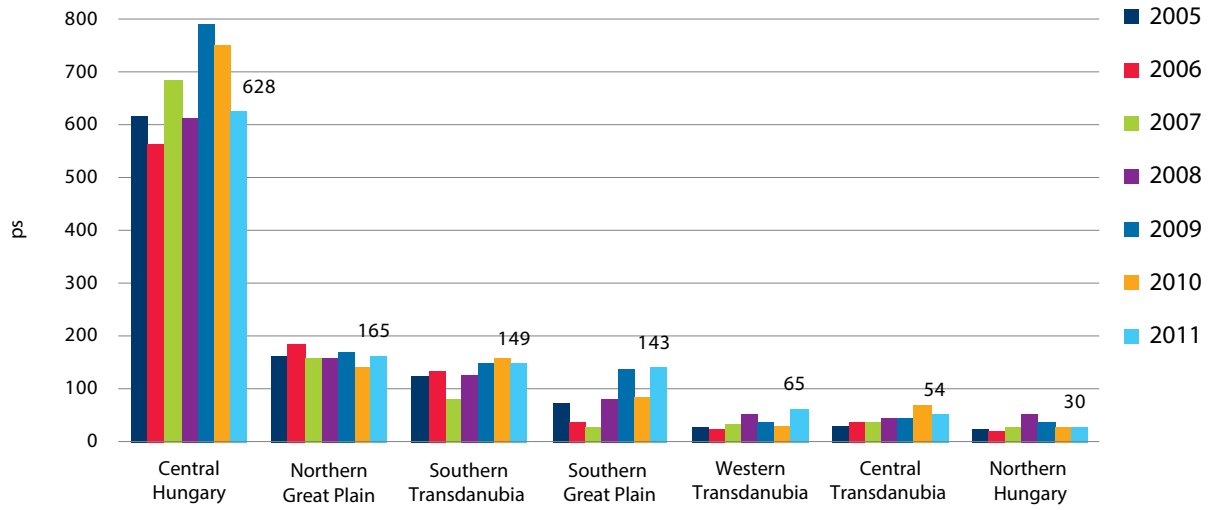

Figure 25: The number students earned a PhD or DLA title between 2005 and 2011 in a breakdown by region (capita; 2011 especially highlighted). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

3.4 The link between national migration and R&D

In recent years, national migration has brought about significant changes between counties. Figure 26 illustrates how the demographics of individual counties changed over a 10 year period (1 February, 2001 - 1 October, 2011), data including both domestic and international migration statistics). Central Hungary has already been mentioned, other than that - compared to other counties - Győr-Moson-Sopron stands out with an impressive positive migration balance, and it is obvious from the migration data, that most counties with a positive balance are in the western part of Hungary, whereas the majority of those with a negative balance are in the east.

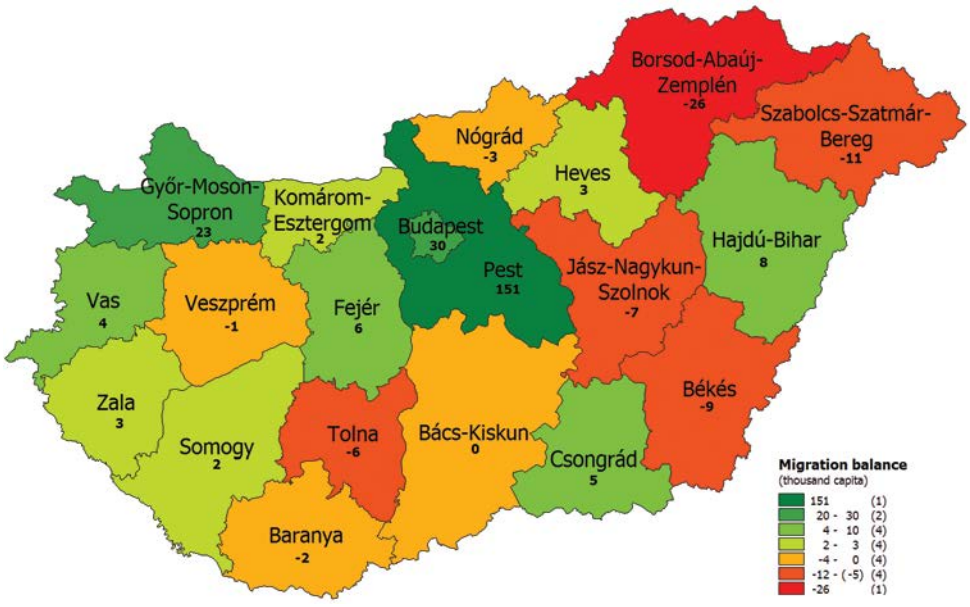

Figure 26: Domestic and international migration balance (the net difference of immigration and emigration) between 1 February, 2001 - 1 October, 2011. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.*

THERE IS A MEDIUM-STRONG POSITIVE CORRELATION BETWEEN THE SCALE OF R&D EXPENDITURE AND A POSITIVE MIGRATION BALANCE.

It is important to investigate the relationship between R&D activity and migration processes towards and away from counties (immigration and emigration). Without speculating too much about the causes of an interconnection between the two things, we can ascertain that there is a clear positive correlation between the scale of R&D expenditure and positive migration balance.

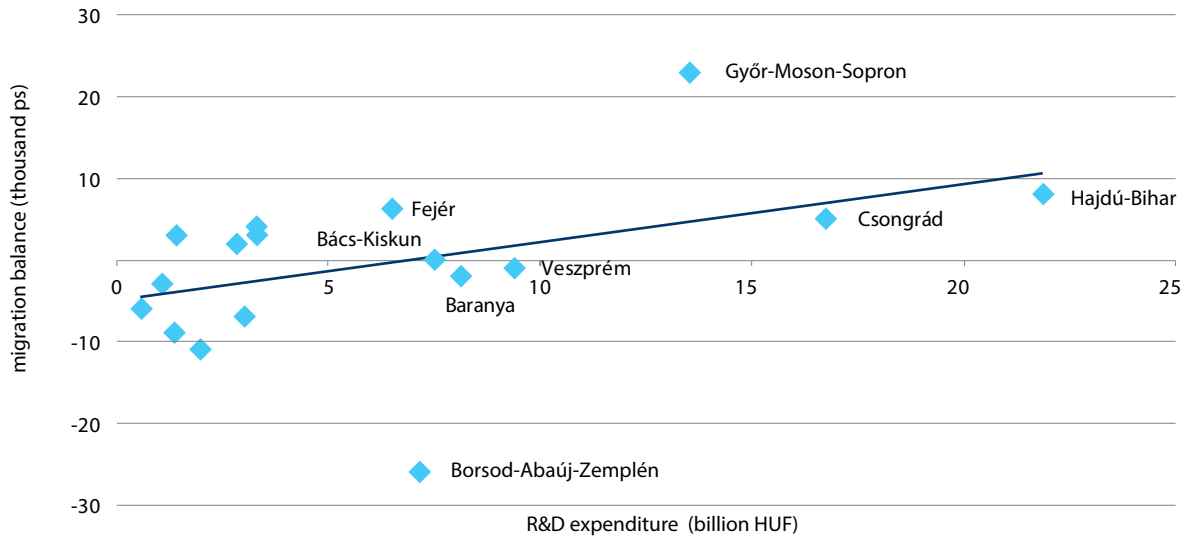

Figure 27: Interconnection between the net migration balance and R&D expenditure in Hungarian counties (excluding Budapest and Pest County). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*[17]

We may conclude that Pest County stands out with a positive migration balance, whereas Budapest has R&D expenditure on a whole scale higher than every other county. (Please note that we completed the same calculation for regions too, but we could not define a clear tendency that would be applicable to the country as a whole, therefore the findings of this calculation were not included here.)

3.5 Regional disproportions within innovative sectors

Using similar methods to the ones presented in Chapter 1.3, we looked at sectors and manufacturing industries, where over 30% of all companies introduced some kind of technological innovation:

- CF Manufacture of pharmaceuticals
- CI Manufacture of computer, electronic and optical products
- CL Manufacture of pharmaceuticals
- CJ Manufacture of electrical equipment
- D Electricity, gas, steam and air-conditioning supply
- E Water supply, sewerage, waste management and remediation
- M Professional, scientific and technical activity
- J Information and communication
- K Financial, insurance activity

We can form an idea of the innovation-oriented specialisation of particular regions as reflected by these sectors. From a professional point of view this well complements Borsi, Mikita's (2013) approach, which analysed the interconnection between the EU's R&D framework programmes and regional indicators relevant to R&D and concluded that the regional concentration of participation in such framework programmes was higher than the concentration of all other relevant R&D indicators.

This sub-chapter deals with the regional distribution of companies involved in the above industries/sectors (for a detailed table see Appendix 5). In several instances we left Budapest out of the calculation, because it has such high indicators that they would have distorted the calculation results and would have unduly suppressed differences between other regions to a point whereby they would simply not be visible.

> THE DOMINANCE OF CENTRAL HUNGARY IS ALSO APPARENT IN THE INNOVATIVE INDUSTRIES/SECTORS, WHERE THE NUMBER OF RELEVANT COMPANIES IS 6.5 TIMES HIGHER THAN THE AVERAGE OF OTHER REGIONS.

The dominance of Central Hungary is also apparent in the context of innovative industries/sectors, where the number of such companies is 6.5 times higher than the average of other regions. In pharmaceutical manufacturing and in the information communication sector this ratio is more than tenfold. Budapest least stands out among other geographic units in the vehicle manufacturing, financial, insurance and water supply sectors; in the first case due to the unique geographic distribution of the automotive industry, and in the other two due to a necessity to follow the population's geographic concentration patterns.

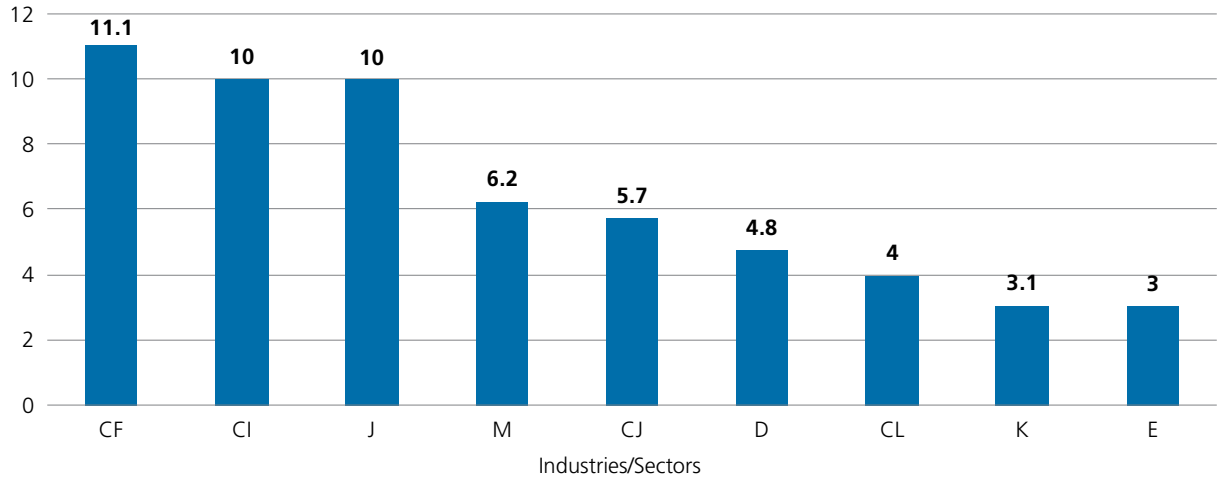

Figure 28: Relative weight of Central Hungary within specific innovative industries/sectors: how many times is the number of companies involved in Central Hungary's nine innovative industries/sectors higher than the average of other regions.
Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data for 2010. (CF Manufacture of pharmaceuticals; CI Manufacture of computer, electronic and optical products; CL Manufacture of transport equipment; CJ Manufacture of electrical equipment; D Electrical energy, gas and steam supply, air conditioning; E Water supply; M Professional, scientific and technical activity; J Information communication; K Financial, insurance activity)

Even if it is not directly linked to innovation, the economic position of regions is heavily influenced by their distance from Budapest (given the Hungarian capital's economic weight). The following figure shows the average time it takes to get to Budapest by road from various county settlements.[18]

[17] Budapest and Pest County's positive migration balance and high level of R&D expenditure would make the correlation shown on the Figure attached significantly stronger. Figure 27 lists counties with an annual R&D expenditure in excess of HUF 5 billion.

[18] According to the methodology used by TEIR, the following rules apply to time-distance calculations: in the case of ferries: 7 km/h + 30 mins average waiting time, in built-up areas: 40 km/h (except for Budapest, where it is 25 km/h) when travelling by main road outside towns and cities: 70 km/h when travelling by carriageway: 90 km/h (except on the M0, where it is 80 km/h) when travelling by motorway: 110 km/h. https://teir.vati.hu/teir_adatmodszertan/GeoX%20Kft..pdf

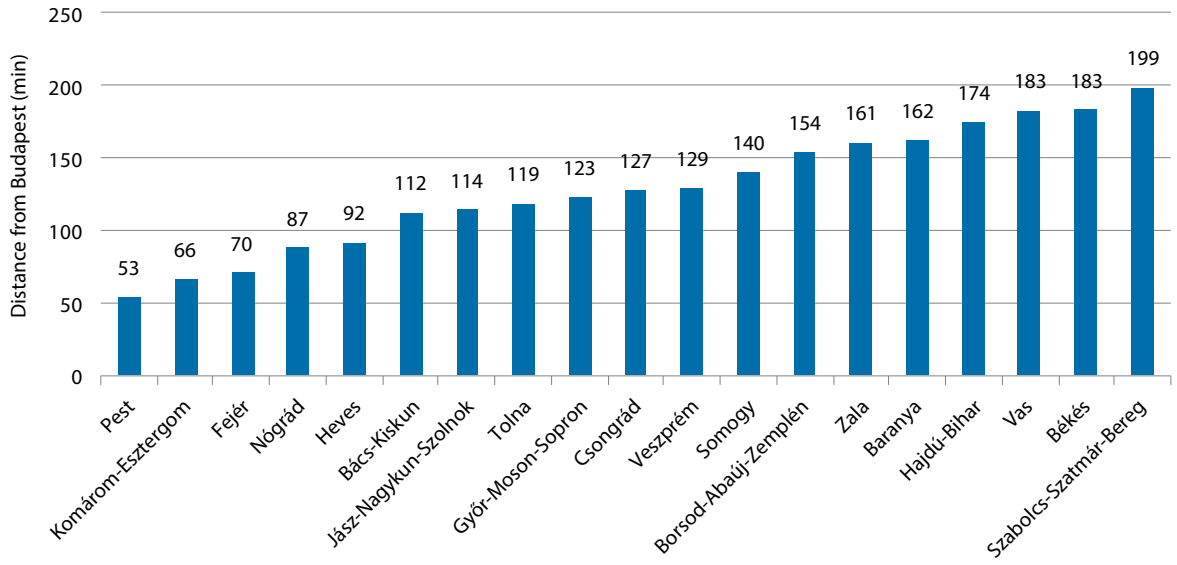

Figure 29: Using time optimization, the duration of the fastest journey in minutes to Budapest, 2011. (the average of settlements). Source: GEOX Kft.

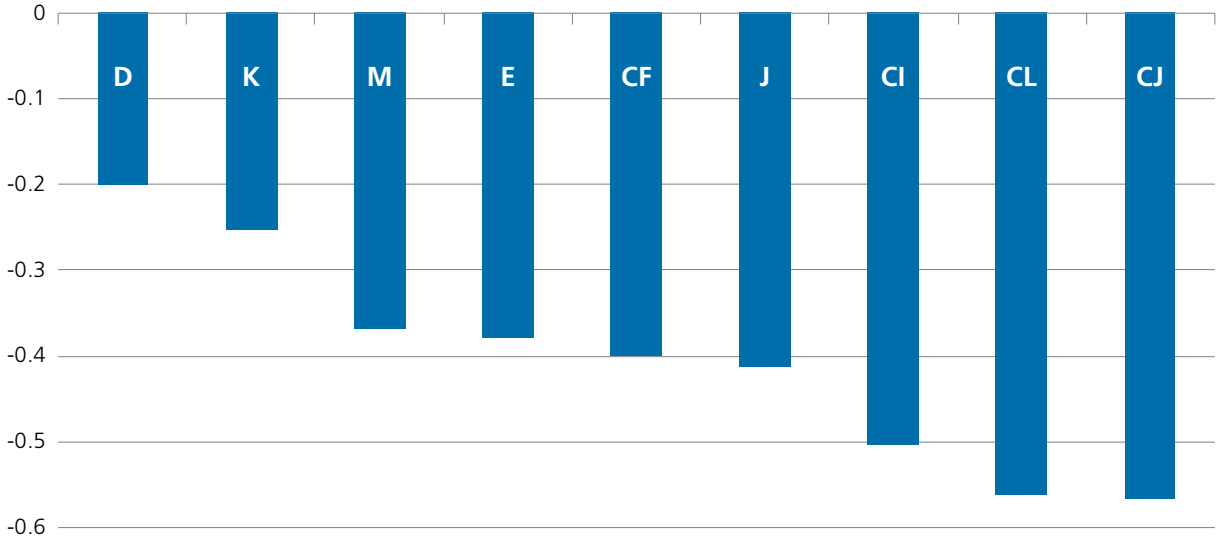

Figure 30: Correlation between the number of companies engaged in innovative industries/sectors and their distance from Budapest (the average distance of every settlement in a county based on the fastest journey, expressed as time). Source: County level correlation analysis based on GEOX and HCSO data for 2010. (CF Manufacture of pharmaceuticals; CI Manufacture of computer, electronic and optical products; CL Manufacture of transport equipment; CJ Manufacture of electrical equipment; D Electrical energy, gas and steam supply, air conditioning; E Water supply; M Professional, scientific and technical activity; J Information communication; K Financial, insurance activity).

THE MORE DISTANT A COUNTY IS FROM BUDAPEST, THE FEWER COMPANIES THERE ARE ENGAGED IN THE INNOVATIVE MANUFACTURING SECTORS.

Figure 30 shows what a powerful negative correlation exists between time-distance from Budapest and the number of companies engaged in the nine innovative industries/sectors. The diagram shows clearly to what extent each innovative industry/sector is influenced by its distance from Budapest. From this it is evident that those sectors of the national economy which satisfy public requirements, such as electrical energy, gas and steam supply, air conditioning; water supply; and financial and insurance activity, are less susceptible to their distance from Budapest, in contrast with the production focused manufacturing sectors.

There can be big differences between various counties and regions, depending on how many companies engaged in the above defined innovative sectors are found on their territory.

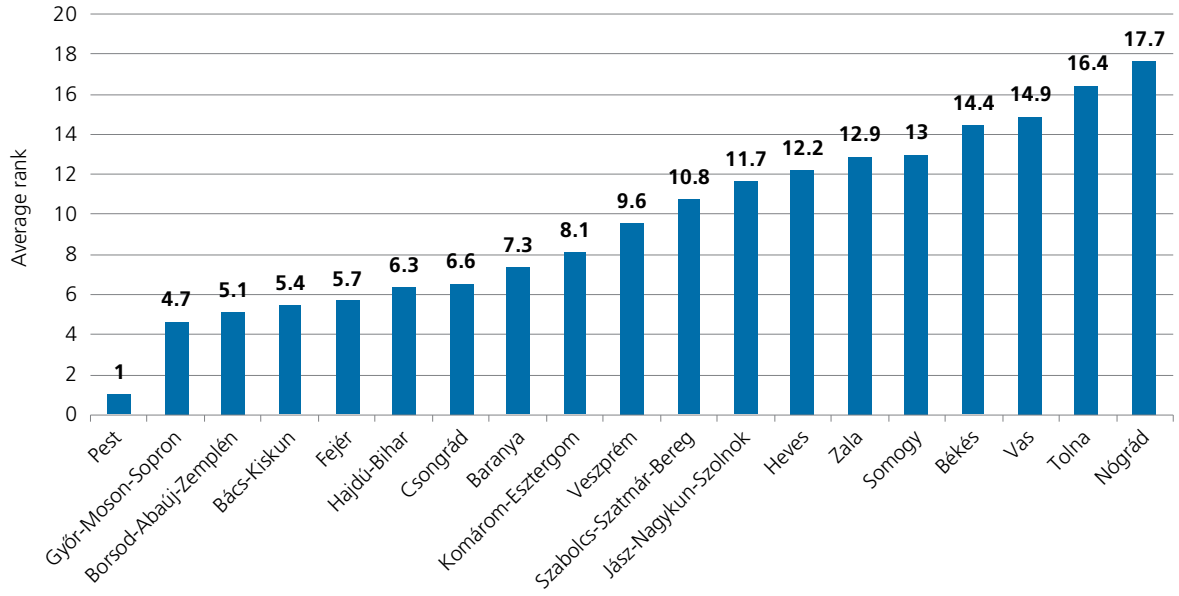

Figure 31: Ranking of counties based on the number of their innovative companies: the average ranking of specific counties in the ordering of counties according to the number of their companies engaged in the nine innovative industries/sectors. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data for 2010.*

Figure 31 is based on the following indicator: we ranked Hungary's counties according to the number of their companies engaged in the nine innovative industries/sectors, gave them a serial number each, then took the average of these nine results, which gave us an average ranking for every single county.

In other words, we established the ranking of counties for each industry/sector, and then we took into account the average of their various rankings. Pest County came out on top in every single industry/sector,[19] followed by Győr-Moson-Sopron, Borsod-Abaúj-Zemplén and Bács-Kiskun counties, whereas Vas, Tolna and Nógrád counties were at the bottom of the table in this respect.

Győr, Miskolc, Kecskemét, Székesfehérvár, Debrecen, Szeged and Pécs (in this particular order) are engines pulling their counties forward; recognition for the impressive rankings of the geographical units concerned should go primarily to the companies based in the main city of each region respectively.

[19] Budapest was not included in this examination.

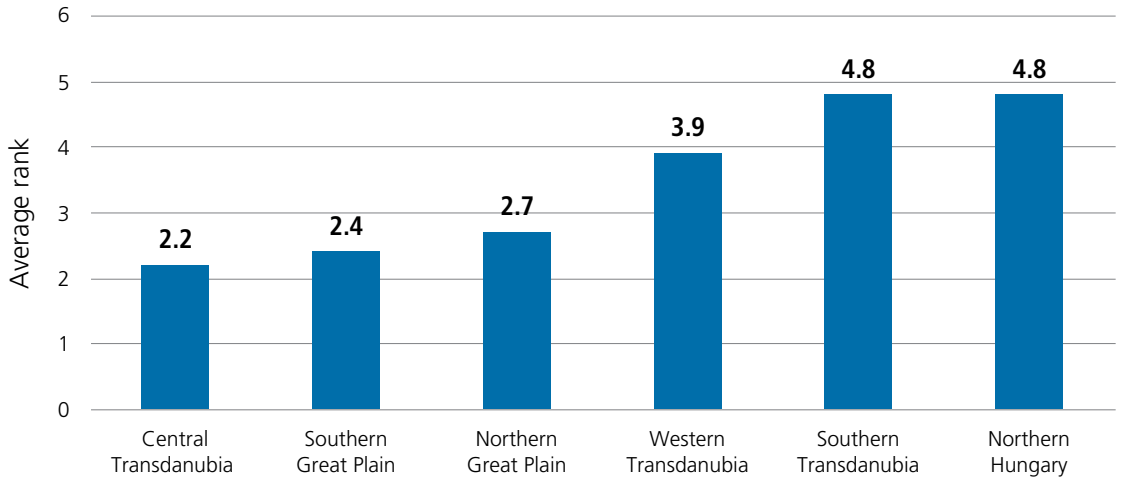

Figure 32: Ranking of regions based on the number of their innovative companies: the average ranking of specific regions in the ordering of regions according to the number of their companies engaged in the nine innovative industries/sectors. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data for 2010.*

As Figure 32 indicates, Central Transdanubia, the Southern Great Plain and the Northern Great Plain lead the ranking in terms of the number of innovative business enterprises on their territory, as opposed to the two Transdanubian regions and Northern Hungary, which are lagging behind in the region ranking according to the number of companies engaged in the innovative sectors.

3.6 Spearman's rank correlation

In the following we summarise similarities in the geographical distribution of companies involved in various innovative sectors. The key question is which one is stronger: the regional influence (sectors display similar distribution patterns), or the sectoral influence (regionality does not have a major influence on the geographic distribution of companies). For more detail about Spearman's[20] correlation matrices see Appendix 4.

> THE SPATIAL STRUCTURE OF PHARMACEUTICAL MANUFACTURING INDICATES THAT IT IS THE FURTHEST REMOVED FROM THE SPATIAL STRUCTURE OF EVERY OTHER INNOVATIVE SECTOR.

According to the findings of rank correlation analysis, the distribution patterns of the pharmaceutical industry indicate that its is the furthest removed from the disparities of other sectors. The reason for this is that the overwhelming majority of companies belonging to this sector operate in Budapest (Budapest was left out of the above matrix), and the spatial distribution of the remaining couple of dozen companies is determined by other characteristics.

[20] Spearman's rank correlation. The correlation calculation is a procedure used to determine how close the correlation is between various probability variables (indicators and/or data). The essence of and the decisive step within the correlation calculation is to express the closeness of this interconnection through a complex index, i.e. a correlation coefficient. Every linear correlation coefficient can range within a finite interval between -1 and +1. If r is close to 0 (|r|<0.4), then it indicates that there is no correlation between two variables or there is only a weak correlation between them. If r is close to to +1 (-1) (|r|<0.7), then it indicates that there is a close positive (negative) correlation between two variables. (Linear correlation: refers to straight-line relationships between two variables (just as the values of one variable change so do the values of the other variable increase/decrease). Spearman's rank correlation allows us to compute the coordinated movement of characteristics measured on an ordained (ranked) data scale (or transformed into such a data scale). In the example we ranked various innovative industries/sectors according to which counties have the highest number of companies meeting our criteria, and then we computed a correlation from the ranking scores thus defined. A higher correlation coefficient between two industries/sectors indicates that they are very similar in terms of their geographic location (the distribution of the population among various counties).

The county by county distribution of companies engaged in the sectors of the national economy such as the manufacturing of computer, electronic and optical products, electrical energy, gas and steam supply and air conditioning, water supply, professional, scientific and technical activity as well as information communication and financial and insurance activity shows very strong similarities, which is also confirmed by the correlation matrix provided in Appendix 4. Even though strong similarities also exist in the county by county distribution of companies engaged in vehicle manufacturing and the manufacture of electrical equipment sectors, these appear to have different geographic patterns compared to other sectors.

In summary we may conclude that according to their geographic distribution we can distinguish three different types of innovative corporate environments within the industries/sectors covered here:

Type 1:

- Manufacture of pharmaceuticals

Type 2:

- Manufacture of transport equipment
- Manufacture of electrical equipment

Type 3:

- Manufacture of computer, electronic and optical products
- Electricity, gas, steam and air-conditioning supply
- Water supply, sewerage, waste management and remediation
- Professional, scientific, technical activity
- Information and communication
- Financial, insurance activity

For the purposes of our analysis we exclusively took into account geographic distribution. In order to be able to provide a more detailed description of individual types, we would first need to specifically analyse the sectors and companies driving particular regions. There are a lot of similarities in the geographic distribution of the industries/sectors belonging to a certain type, at the same time they are significantly different from the spatial structure of other types. The spatial structure of pharmaceutical manufacturing is very different from that of every other innovative sector.

The tendencies previously noted in respect to counties become even more clearly accentuated in the context of regional rank correlation analysis. In this context, the pharmaceutical industry displays a significantly negative correlation with other industries/sectors; so it can be regarded as proven that its spatial structure is completely different from other innovative sectors.[21]

[21] The regional correlation matrix, shown in the Appendix 4, is based on the same governing principle as the county correlation matrix, with the only difference being that the regional calculation is based on regional data.

3.7 Corporate sector research units

54% of the corporate research units[22] that were registered in Hungary in 2011 were in the Central Hungary region. Please note that the Southern Great Plain has more than twice as many (154) corporate research units compared to Southern Transdanubia (74). If we look at the headcount of researchers working at corporate research units (12,276 people in total) then we discover even greater disparities between regions. 69% of all corporate researchers are employed by companies in Central Hungary. The Southern Great Plain again comes second (929 people, 7.6%), whereas the fewest corporate researchers (481 and 370 people or 3.9% and 3% of all corporate researchers) are found in Western Transdanubia and Southern Transdanubia, respectively.

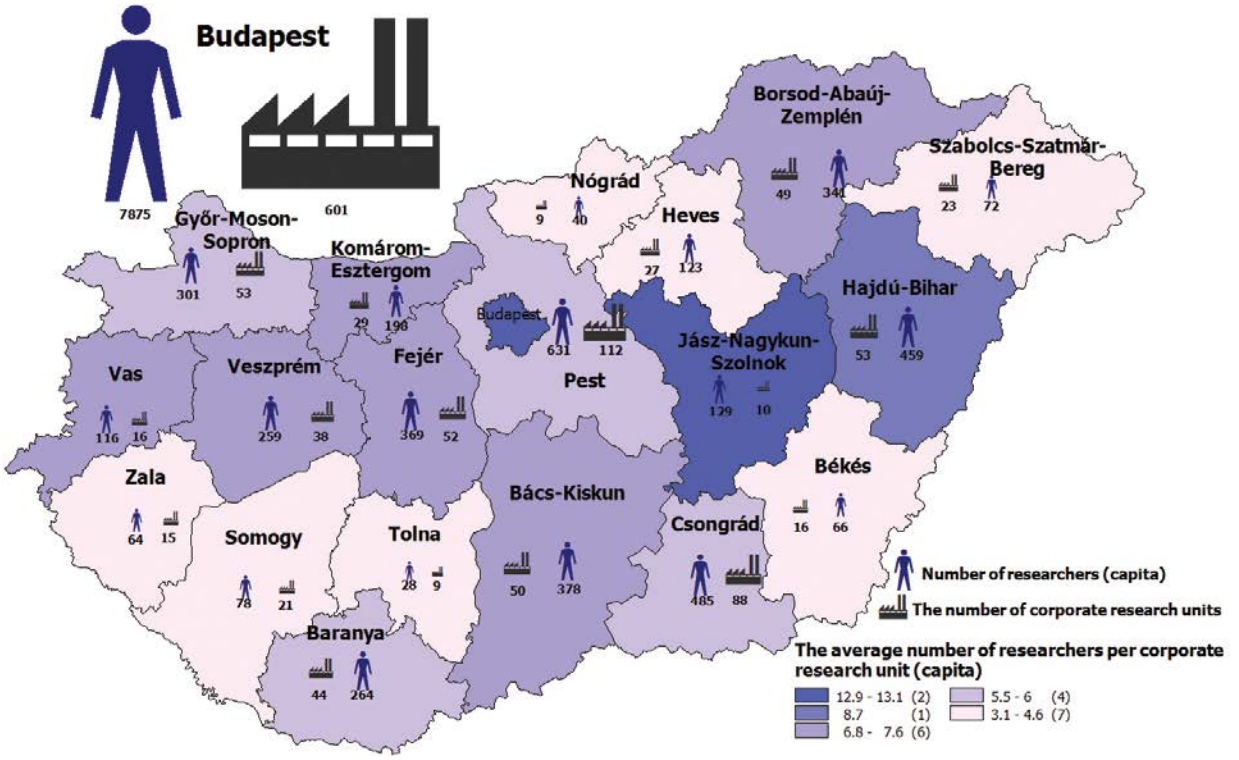

Figure 33: The number of corporate research units and corporate researchers, and the average headcount of researchers per corporate research unit in 2011. Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data and map imaging of the former.

[22] We defined corporate research units as any and all companies which stated in their accounts both research and development personnel expenses and R&D expenses in the subject year. This definition is slightly different from the one that is used by the HCSO, in the sense that according to the HCSO definition, a research unit means any corporate entity engaging in research, whether or not it employs any research and development scientists; it could be the case that it employs R&D support workers only, or employs staff under assignment contracts (HCSO 2012, p. 106). This accounts for the slight discrepancy between our own and HCSO data.

The number of researchers employed per corporate research unit in Central Hungary is relatively higher than in other regions (11.9 people), the indicators of other regions lagging behind the national average (9.3 people). On average, we find the lowest headcount of researchers employed by companies in Southern Transdanubia (5 people). There are massive differences in the number of researchers employed by companies in Hungarian and in foreign ownership: while Hungarian companies engaging in R&D employ an average of 6.5 researchers each, companies in foreign ownership employ 28.3 scientists respectively.[23] There are also big differences at regional level: Hungarian companies based in Central Hungary employ an average of 7.7 researchers, whereas for Northern Hungary this figure is only 3.8. The number of researchers per research unit in foreign ownership is again the highest in Central Hungary (34.7 people), and it is the lowest in Southern Transdanubia (9.4 people).

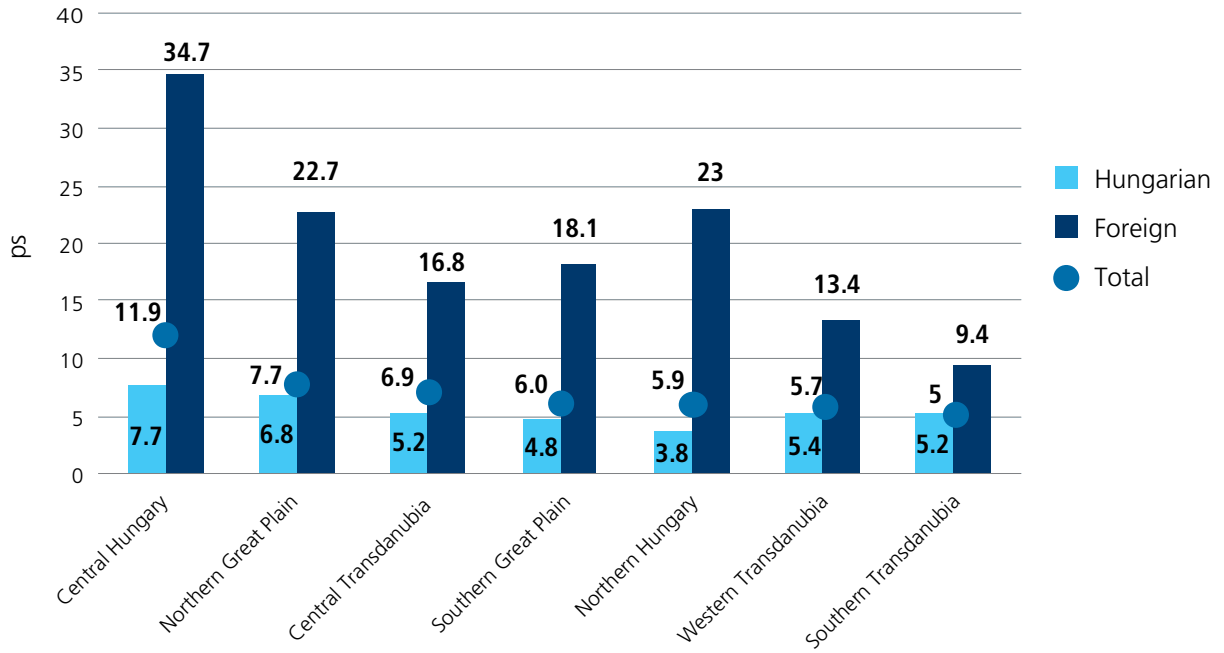

Figure 34: The average number of researchers per corporate research unit, in a breakdown according to their ownership background (2011). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

In 2009 over a quarter of companies engaging in R&D increased their turnover by over 150% in the following year. The largest turnover growth was generated by companies carrying out research in Northern Hungary, where 54% of them increased their turnover by at least 20%. Turnover growth was the slowest in the case of companies engaged in R&D in the Northern Great Plain, where only 30.9% of companies increased their turnover by at least 20%.

COMPANIES CARRYING OUT RESEARCH IN NORTHERN HUNGARY ACHIEVED THE LARGEST TURNOVER GROWTH IN COMPARISON WITH COMPANIES ENGAGING IN R&D IN THE COUNTRY'S OTHER REGIONS.

[23] It must be noted that we do not know if nearly 20% of the companies engaging in R&D are in Hungarian or foreign ownership.

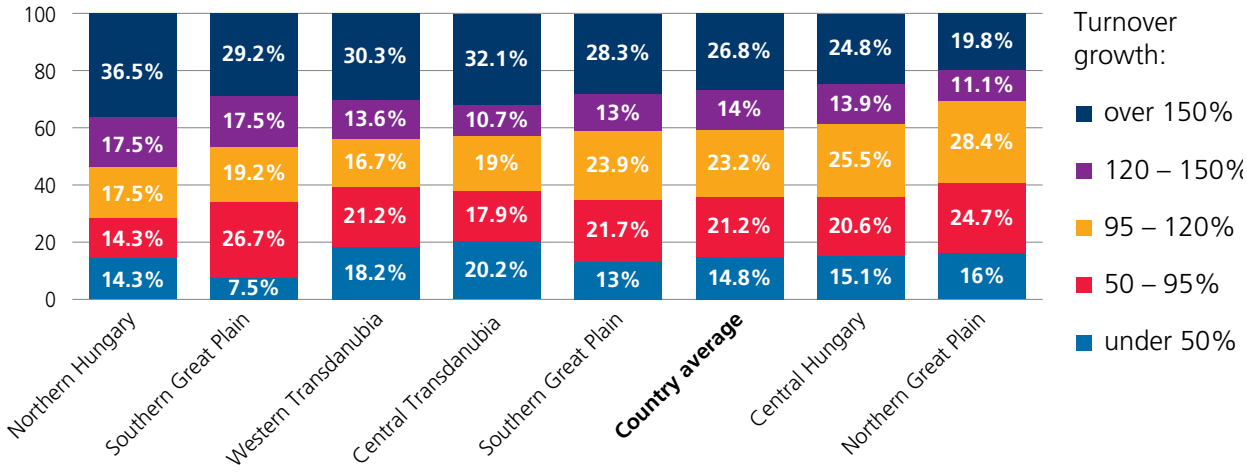

Figure 35: Development of the turnover of companies engaged in R&D in 2009, in a breakdown by region over the period between 2009 and 2011 (as a % of all companies). *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

3.8 Accredited Innovation Clusters

The title of Accredited Innovation Cluster is awarded to co-operation networks distinguished by outstanding employment, innovation and export performance by regional comparison, and whose cluster members work together to achieve better efficiency in order to implement large scale development projects.

> WE FIND THE MOST ACCREDITED INNOVATION CLUSTERS IN THE SOUTHERN GREAT PLAIN.

Currently there are 21 such clusters in Hungary, and according to our analysis of their regional distribution we may conclude that there are more (7) of these clusters in the Southern Great Plain (5 of the 7 clusters are all found in Csongrád County) than in the whole of Transdanubia (there are 4 clusters in Central Transdanubia, 2 in Southern Transdanubia, and none in Western Transdanubia). The Transdanubia region also lags behind in terms of the average size of its clusters (with 31.8 members/cluster on average) both in comparison with the eastern regions (39 members/cluster) and in comparison with Central Hungary (41.5 members/cluster).

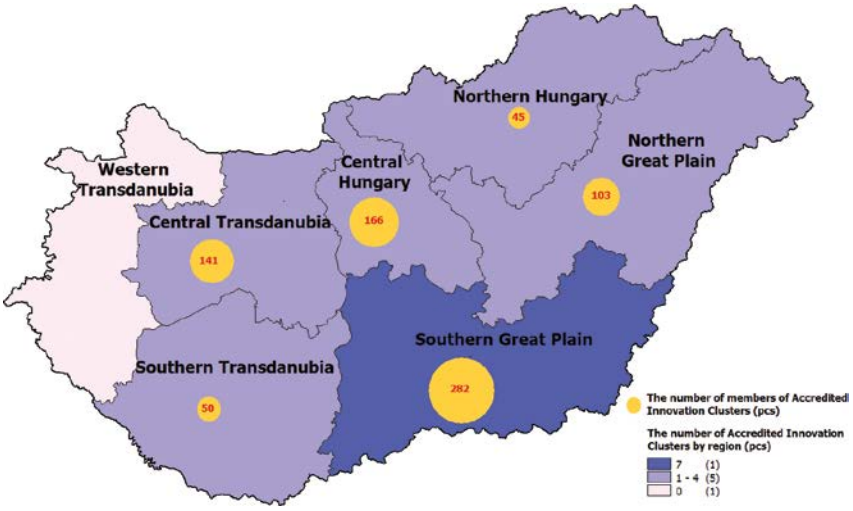

Figure 36: Number of Accredited Innovation Clusters by region, with an indication of how many members they have. *Source: The National Innovation Office RDI Observatory's own calculations based on MAG (Hungarian Economic Development Centre) data and map imaging of the former.*

4.1 Grants and subsidies awarded under GOP, KMOP and AIK tenders

The following data show the regional distribution of tender amounts awarded under GOP, KMOP and AIK[24] innovation and R&D tenders and the underlying dynamics of the former in the period from 2008 to first quarter of 2012.

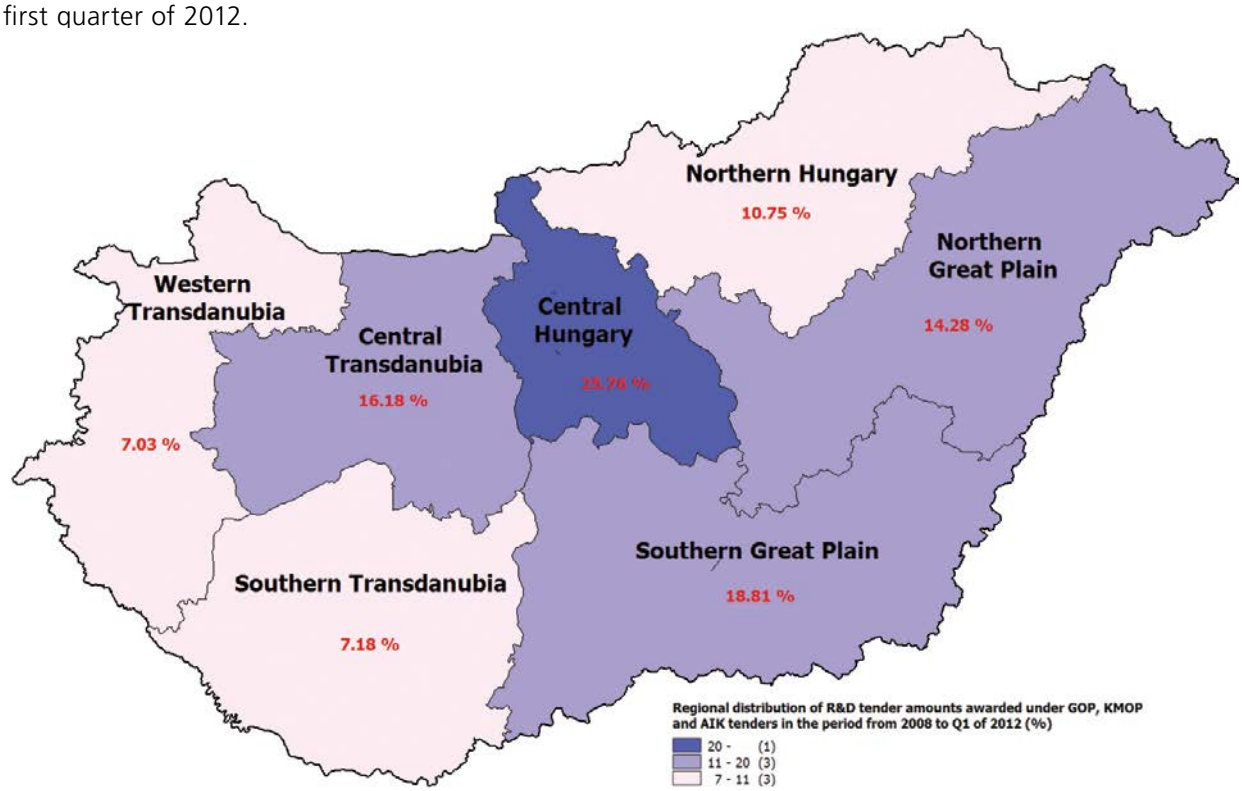

Figure 37: Regional distribution of R&D tender amounts awarded under GOP, KMOP and AIK tenders in the period from 2008 to Q1 of 2012 (%). *Source: The National Innovation Office RDI Observatory's own calculations based on EMIR (European Market Infrastructure Regulation) data and map imaging of the former.*

Figure 37 clearly illustrates the percentage breakdown of grants and subsidies awarded under GOP, KMOP and AIK tenders. We found no big surprises analysing these data, and we again came to the conclusion that Central Hungary stands out among other regions, in the sense for example that it accounts for a quarter of all awarded grants and subsidies (even if we know that grants and subsidies are much less evenly distributed under other tenders). Applicants from the Northern Great Plain, the Southern Great Plain and Central Transdanubia also had their successes in respect to winning tender funding for innovation and R&D. On the other hand, Western Transdanubia and Southern Transdanubia received less than 10 percent of grants and subsidies each.

[24] GOP: (Economic Development Operative Programme); KMOP: (Central Hungary Operative Programme); AIK: Accredited Innovation Cluster support programme.

4.2 Grants and subsidies awarded from the Research and Technology Innovation Fund

One of the main objectives of creating the Research and Technology Innovation Fund (KTIA) was to promote Hungarian innovative business enterprises, boost the performance of the research and development sector, and facilitate international co-operation models. The KTIA's mission statement also includes assisting the emergence of a new generation of researchers and academics, and developing R&D infrastructure and related services. Figures 38-39 show the regional distribution of KTIA grants and subsidies by individual years during the 2004-2011 period, as well as in total.

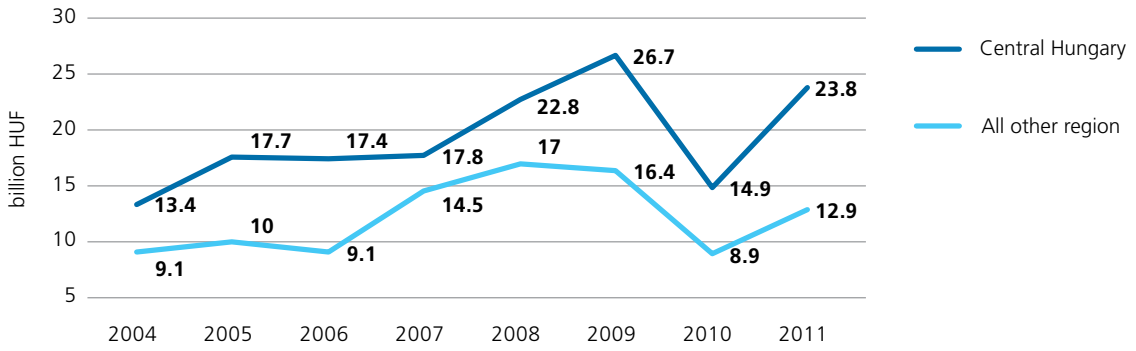

Figure 38: The distribution of KTIA grants and subsidies between Central Hungary and other regions (2004-2011).
Source: Evaluation of the utilisation of the tender portfolio financed from the Research and Technology Innovation Fund of the National Innovation Office (NIH), The National Innovation Office RDI Observatory's own calculation based on p.70.

From this we may conclude that the Central Hungary region received more funding every year than all the other regions combined. During the period under review, Central Hungary's share of grants and subsidies ranged from 55% to 65%, and if we also take into account the 60% ratio spread across the entire period then we find that there were no spectacular regional differences in terms of KTIA pay-outs over these years.

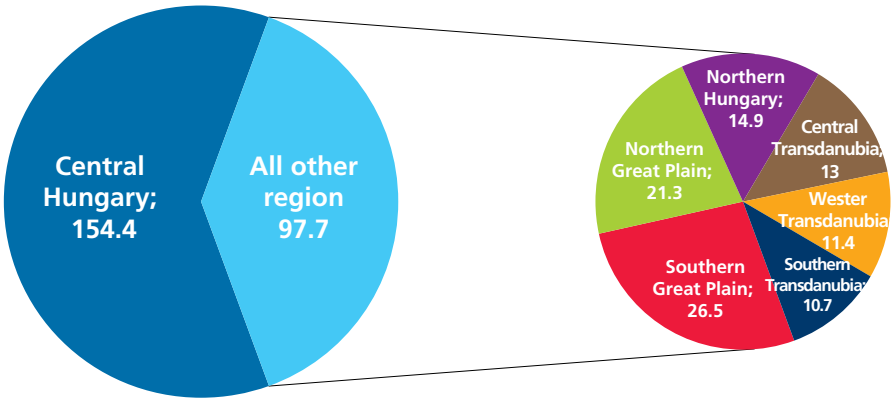

Figure 39: The distribution of KTIA grants and subsidies between Central Hungary and other regions (2004-2011) in HUF billion. *Source: The National Innovation Office RDI Observatory's own calculations based on PKR.*

We may conclude that during the period of 2004-2011 over 60% of all KTIA grants and subsidies went to the Central Hungary region. This might be explained by previously shown R&D concentration in and around Budapest, including its catchment area.

CSONGRÁD AND HAJDÚ-BIHAR ARE THE RECIPIENTS OF SUBSTANTIAL KTIA GRANTS AND SUBSIDIES.

It is worth mentioning that the Northern Great Plain and Southern Great Plain regions also account for a high proportion of grants and subsidies. These two regions are the recipients of a substantial amount of grants and subsidies as compared to the country's other geographical units primarily due to Csongrád and Hajdú-Bihar counties' respective positive roles. The aforementioned two counties, as we saw in previous chapters, have really been outstanding in the area of research and development both in terms of R&D expenditure and the number of researchers. We have reason to assume that science universities founded in county seat towns do have a considerable impact on the scale of awarded grants and subsidies.

The number of tender applications submitted by these two sectors is highly indicative of the intensity of co-operation between private / corporate and non-corporate stakeholders (government, non-profit and other organisations). On closer examination we can ascertain what proportion of KTIA tender applications submitted between 2008 and May 2013 (10,975 in total) were from private/corporate and non-corporate sector applicants.

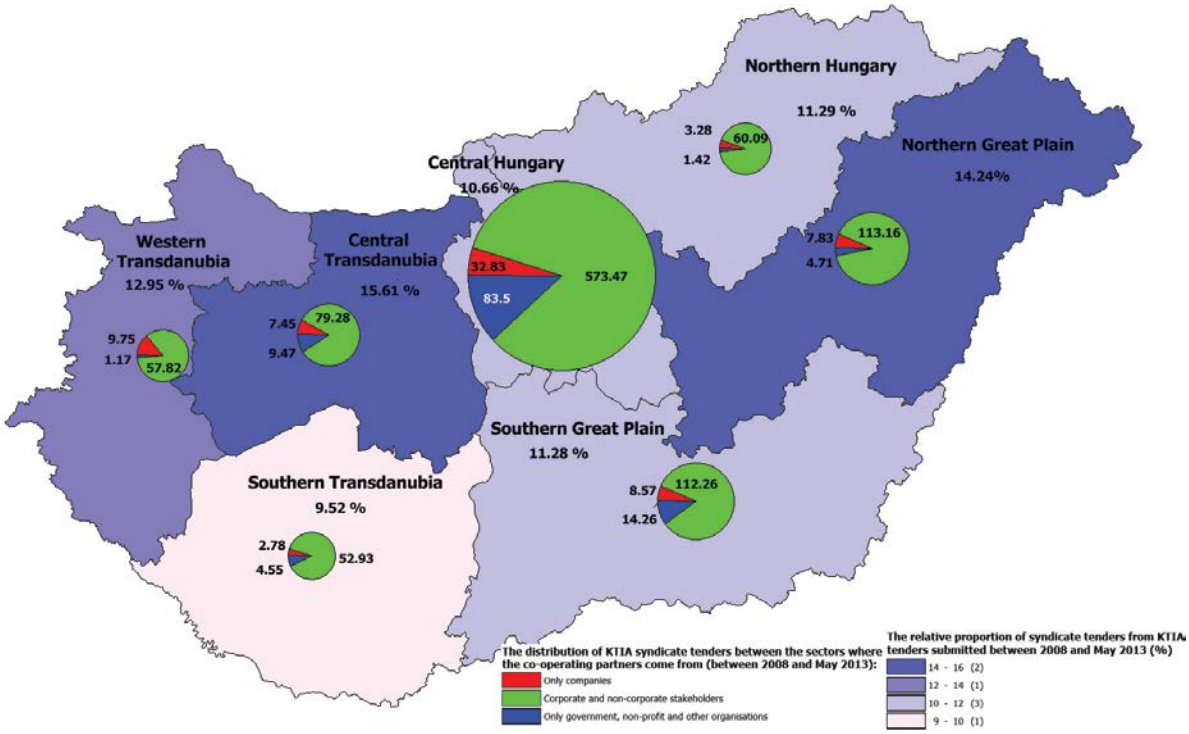

Figure 40: The proportion of KTIA Syndicate tenders and the distribution of syndicate tenders between the sectors where the co-operating partners come from (between 2008 and May 2013). *Source: The National Innovation Office RDI Observatory's own calculations based on PKR data and map imaging of the former.*

A total of 1,304 syndicate tenders were submitted (11.9% of all tender applications) over the previous period of almost five and a half years, and over half (52.9%) of these involved applicants from the Central Hungary region.[25] The central region is followed by the two Great Plain regions, namely the Southern Great Plain (10.4%) and the Northern Great Plain (9.6%) region.

[25] It was quite typical of some syndicate tenders to have their members representing several regions. When a tender application was submitted by applicants forming a syndicate made up of several regions, we applied a weighting proportionate to the number of syndicate members in each region to make sure that result would not be distorted due to the difficulty of classifying the tender under one region or another. This is why there are several examples when the number of tenders submitted in certain regions is in fact a fraction, not a whole number.

Having said that, the relative proportion of syndicate tenders within all tender applications was not the highest in these regions, but rather in Central Transdanubia (15.6%). (In the case of R&D tenders, intensive co-operation with research units should, of course, play a key role. In light of this, even this indicator is not that impressive. Interestingly enough, Central Hungary's relevant indicator (10.7%) is among the weakest, and only Southern Transdanubia scores even lower in terms of the percentage rate of syndicate tenders (9.5%).

> TENDER SYNDICATES FORMED JOINTLY BY THE PRIVATE SECTOR AND THE PUBLIC SECTOR WORK WITH THE GREATEST INTENSITY IN NORTHERN HUNGARY AND IN THE NORTHERN GREAT PLAIN.

The number of syndicate tender applications submitted jointly by private sector (corporate) and public sector (non-corporate) stakeholders accounted for 82.4% of all syndicate tender applications. The joint tender applications of these two sectors represented the highest percentage rate within total tender applications for Northern Hungary (92.7%) and for the Northern Great Plain (90%). Companies tend to cooperate with each other – on tenders – most intensely in Western Transdanubia. In this region 14.2% of all syndicate tender applications were submitted by partnerships made up only of corporate members (as compared to a national average of 6.8%). Also in Western Transdanubia the least intense co-operation is observed between government, non-profit and other organisations, accounting for only 1.7% of all syndicate tenders (compared to a national average of 10.8%). Public sector (non-corporate) stakeholders co-operate most intensely in Central Hungary (12.1%) and in Southern Transdanubia (10.5%).

4.3 Regional distribution of grants and subsidies awarded under the Seventh Framework Programme

The EU's research focused Seventh Framework Programme (FP7) is the number one research funding tool of the European Union. Statistical data of FP7 participants who signed a grant agreement during the period

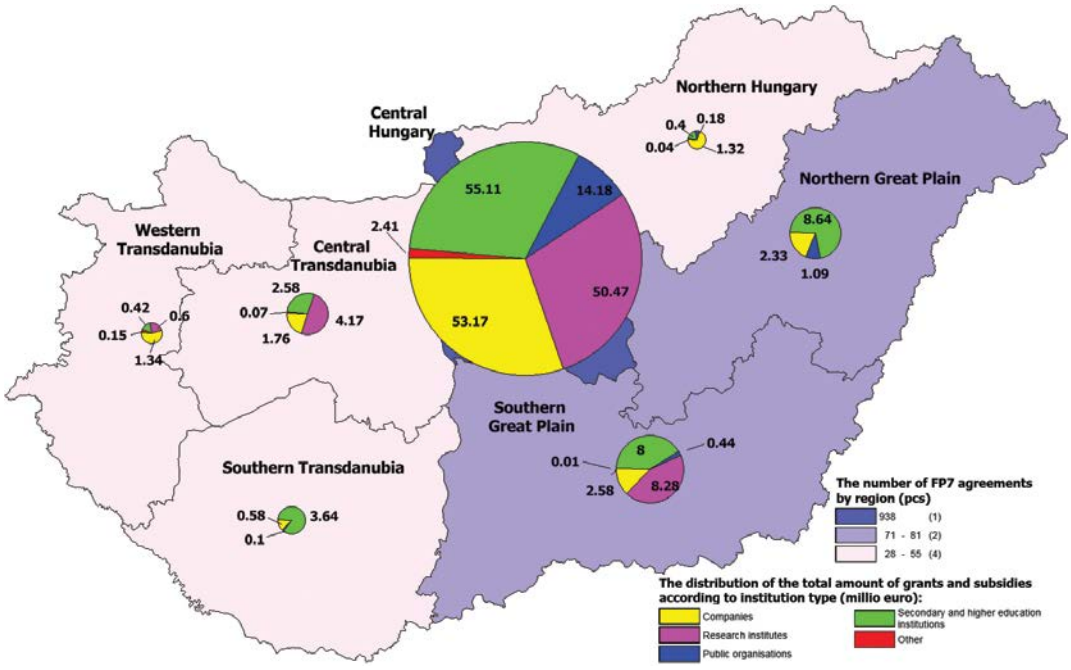

Figure 41: Distribution of grants and subsidies awarded under the Seventh Framework Programme and the number of agreements signed between 2007 and February 2013. *Source: The National Innovation Office RDI Observatory's own calculations based on E-CORDA data and map imaging of the former.*[26]

starting from the launching of the framework programme (2007) and lasting until the end of February 2013 on the one hand and on subsidies on the other indicate very sharp regional disparities. 1,257 grant agreements were signed during this period, totalling EUR 224.1 million.

Nearly three-fourth of all signed agreements and 78.2% of all grant amounts were awarded to Central Hungarian applicants. As far as other regions are concerned, the relative share of even the relatively successful Southern Great Plain and Northern Great Plain regions was only 8.6 and 5.4% from grant amounts respectively, with Western Transdanubia's share just exceeding 1% and Northern Hungary's share not even reaching this amount. This is indicative of a regional disparity much deeper than any other RDI relevant regional disproportion, something which ought to be treated as a warning sign for the 2014-2020 period.

> THERE ARE MASSIVE REGIONAL DISPROPORTIONS IN GRANTS AND SUBSIDIES AWARDED UNDER THE FP7, WHICH IS PARTICULARLY NOTEWORTHY IN RESPECT TO THE 2014-2020 PERIOD.

There are also big differences between regions in terms of what types of institutions were able to secure grants and subsidies. In the Southern Great Plain education institutions and research institutes have a higher share, whereas in Northern Hungary business enterprises take the lead. Education institutions are also in a dominant position in Southern Transdanubia, and they play a major role in the Northern Great Plain too. In Western Transdanubia business enterprises have greater weight, whereas in Central Transdanubia research institutes received more funding than other stakeholders. In comparison, in Central Hungary the relatively equal weight of the three main stakeholder groups (education institutions, research institutes and business enterprises) creates a structural equilibrium.

> THE MOST IMPORTANT INSTITUTIONS OF INDIVIDUAL REGIONS FUNDAMENTALLY DETERMINE THE AMOUNT AND DISTRIBUTION OF GRANTS AWARDED UNDER THE FP7.

The above of course is not unrelated to some of the factors already mentioned here, which can be linked to the spatial location of important stakeholders: for instance the presence of a large university (like in Szeged, Pécs or Debrecen) is also decisive for a stakeholder's ability to get access to grants and subsidies, whereas in regions characterised by strong corporate R&D (like in Western Transdanubia) it is the companies receiving funding that have decisive influence.

[26] Research institute: a legal entity founded as a non-profit organisation and engaged in research or technology development as a core activity.

Public organisation: any legal entity thus defined by national laws, or international organisation. A Public Organisation can either be an organisation created by the government, any of its ministries, government agencies or authorities, or a Public Benefit Organisation founded by the power of a statutory regulation, resolution or deed of foundation and subsequently incorporated in the Hungarian Treasury's official register. Research institutes and education institutions are not classed as public organisations.

Business enterprise: any kind of profit-oriented business enterprise not classed as a non-profit organisation, public sphere organisation, research institute or secondary / higher education institution. Commercial, profit-oriented research institutes are also included in this category.

5 The regional context of RDI in light of the RDI Observatory's complex indicators

The idea of this chapter was suggested by the EU's Regional Innovation Scoreboard (2012, p. 61.), which analyses six RDI-relevant data in three different years before creating a normalised complex index (by comparing it to the maximum value of the dataset). In contrast with this, we analysed a different – much wider – group of indicators that capture the complexity of RDI.

To make it easier to interpret various indicators, and to articulate the main characteristics of regional tendencies, we created two complex indicators from a range of contextualised indicators. These indicators are designed to reflect the human resource and infrastructural aspect of RDI.

The two indicators we used for our calculations are as follows:[27]

- **RDI Human Resource complex index:** this indicator expresses the human resource aspect of RDI, and comprises quantitative and qualitative data at the same time.
- **RDI Infrastructure complex index:** this index provides a clear indication of the availability of the material and non-material infrastructural resources needed for any kind of RDI activity.

In the table of basic data provided in Appendix 1 we made it clear which indicator is classed under which complex index, together with specific indicator values.

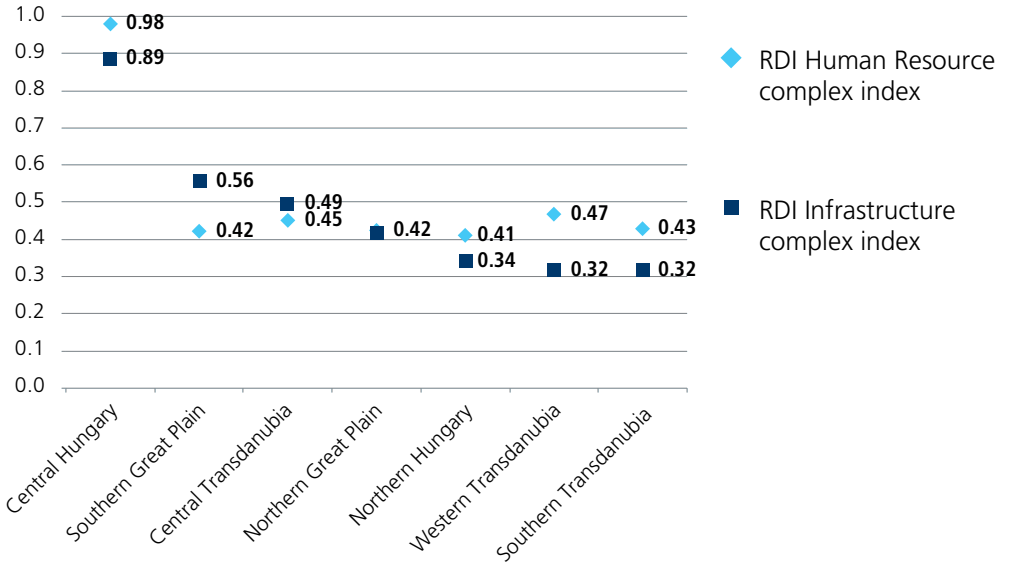

Figure 42: Regional comparison of the two dimensions of context-indicators (value set between 0 and 1: derived from the average of normalised values). *Source: The National Innovation Office RDI Observatory's own calculations based on the system of indicators.*[28]

[27] We created our indicators using the so-called normalisation method. This method basically defines every single value as a percentage of the maximum value of the dataset (i.e. data of that region whichever scored the highest value in the indicator in question), in other words the maximum value serves as a benchmark. We then computed the average of our numeric results, in other words for every region we ended up with 2 values (one for each dimension), indicating what percentage the region in question scores on average in each indicator compared to the corresponding score of the best performing region.

[28] Both indicators for the Northern Great Plain: 0.42.

The Observatory's complex indicators tell us the following; they show, on the one hand, that the Southern Great Plain and Central Transdanubia's RDI Infrastructure index is much higher than their RDI Human Resource index. On the other hand we can see that the above values don't show any similarity with the inner space of the corporate innovation sphere or the university sphere. Therefore the separation of the human resource and infrastructural aspect of innovation creates a boundary of a different kind (meaning a boundary within the inner space of the sphere in question), which can take shape in the organisational separation of R&D activity. We consider this to be a positive sign, as the existence of a boundary dividing a particular socio-economic sphere – along whatever dimensions – can have a detrimental effect on the organic and dynamic growth of the sphere itself. Still there are certain factors, which create other boundaries along other dimensions within the same sphere, and this can have a positive effect, because these factors can suppress the aforementioned dividing power – and sometimes even eliminate it completely. For example, if we take two simple facts, namely that the Southern Great Plain's RDI Infrastructure index is much higher than its RDI Human Resource index; and that this region is characterised by a more robust R&D higher education than corporate dimension, then these two factors can soften each other's segregating effect and by doing so promote the formation of an organic RDI space.

Summary

Our regional analysis scrutinised the economic, R&D-relevant, innovation related and sectoral characteristics of Hungary's regions (and of counties in most cases). Even though our findings confirmed the hypothesis concerning the dominance of Central Hungary and Budapest (not surprisingly but often to a surprising extent), the disparities found between regions provide many lessons.

One of the conclusions we reached was that the RDI characteristics of various regions do not depend only on their level of economic development (as expressed for example by per capita GDP), and that counties and regions similar in many other regards can have rather different R&D positions and innovation potential.

In terms of geographic concentration, it was interesting to observe that indicators that can directly measure R&D (total R&D expenditure and the total number of researchers) show a much starker geographic concentration than other economic indicators (such as the turnover of R&D companies or the aggregate tax payments of companies). In an economy characterised by over-concentration to begin with, R&D is spatially distributed even more unevenly in any case, thus conducting a regional analysis with an RDI focus is not only justified but of major significance.

With the exception of Central Hungary and Budapest, per capita GDP (adjusted by purchasing power parity) exceeds the national average only for Western Transdanubia, and at county level only for Győr-Moson-Sopron and Komárom-Esztergom counties. Central Hungary owes its R&D dominance (it employs 60% of researchers and 66% of R&D expenditure is concentrated here) almost entirely to Budapest, given that the relative weight of Pest County is rather insignificant compared to Budapest. Apart from Budapest, Hajdú-Bihar and Csongrád counties in particular stand out due to their exceptionally high R&D expenditure to GDP ratio, whereas for nine other counties the same ratio does not reach 0.5%; and if we compare various regions, then we find that the R&D expenditure to GDP ratio only reaches 1% in respect to Central Hungary, the Northern Great Plain and the Southern Great Plain. All these data are indicative of very large disparities between the country's various regions.

It is common knowledge that the unemployment data for different regions can vary greatly, and the number of unemployed graduates in different counties cannot be conclusively explained either by the size or the development level of the counties concerned. At the same time conducting further analyses at a local level could have a huge positive impact on these counties' future innovation potential. What our analysis made very clear, however, is that there is a clear interconnection between the scale of R&D expenditure and migration balance.

Different regions and counties have rather different economic structures, and in our analysis we illustrated this by showing the spatial characteristics of innovative sectors. Central Hungary is also in an evidently dominant position in this respect, and the location of innovative companies belonging to the manufacturing industry is less dependent on geographic distance in comparison with the innovative services sectors. In terms of which county hosts the most companies belonging to innovative sectors, the analysis concluded that Pest, Győr-Moson-Sopron and Borsod-Abaúj-Zemplén counties are in the lead, whereas Vas, Tolna and Nógrád counties are at the bottom of the ranking. We also found that Győr, Miskolc, Kecskemét, Székesfehérvár, Debrecen, Szeged and Pécs are of great importance for their respective counties and regions.

In respect to RDI point we can observe the 'internal space' of two different phenomena unfolding in Hungary. One is linked to innovative economic activities, while the other is linked to higher education. While for Budapest the two dimensions are interrelated, for the rest of the country this is far from being the case. While Western Transdanubia is for example clearly stronger in terms of its economic indicators, the catchment areas of the universities of Pécs, Debrecen and Szeged (county and region) have better higher education indicators. Often there is only a loose connection between the two dimensions, as a bi-directional and levelled relationship between the economy and higher education has still not developed everywhere in Hungary, even though this is what makes highly developed countries so successful in innovation.

In summary, we may conclude, that the R&D expenditure to headcount ratio of the business enterprise sector underwent dynamic growth in the second half of the 2000s and this same trend has not abated. The only question is whether we are seeing an adverse shift in the balance of publicly funded basic research and industrial applied technological research, in other words science no longer sets its own future directions, but instead they are defined by industrial technology research, economic interests and capital investment. This can typically be observed in countries with a relatively sophisticated professional background that do not have sufficient capital resources at their disposal similar to those handled by countries characterised by strong technological innovation. Outsourceable processes are therefore shifted to these countries instead of being managed at innovation centres. Besides the well-known advantages, this might, however, pose a risk in the sense that it is much easier to replace such a relatively more subordinated partner with the stroke of a pen from the parent company headquarters.

If we were to analyse the allocation of relevant RDI subsidies sector by sector, then we would once again find significant disproportions (which do vary from tender to tender). The greatest disproportions in respect to tenders can be observed in the allocation of funding under the Seventh Framework Programme (FP7): while Central Hungary's share from total available funding exceeded 78%, at the same time Northern Hungary's share was less than 1%. 60% of KTIA (Research and Technology Innovation Fund) resources was awarded to stakeholders from Central Hungary, with Csongrád and Hajdú-Bihar being the only other counties that managed to secure a substantial chunk of available grants and subsidies. There is less of a gap in the allocation of grants and subsidies under GOP (Economic Development Operative Programme), KMOP (Central Hungary Operative Programme) and AIK (Accredited Innovation Cluster) tenders compared to the previous scenarios: Central Hungary secured one-fourth of the grants and subsidies awarded in total, while the Southern Great Plain and Northern Great Plain regions also received substantial pay-outs.

Even more regional research needs to be carried out on stakeholders that drive the innovation system, as the scope of this analysis allowed us to cover Accredited Innovation Clusters only: the Southern Great Plain is clearly in the lead in this respect, whereas the performance of the Transdanubia region was considerably weaker, both in terms of the number and size of its clusters.

With the help of the complex indices we created (RDI Human Resources complex indicator: RDI Infrastructure complex indicator) allowing us to demonstrate that the separation of the human resource and infrastructural aspect of innovation creates a boundary of a different kind, which can take shape in the organisational separation of R&D activity, noting that this can even represent an advantage in respect to narrowing regional differences.

Appendices

1. The RDI Observatory's complex indices

The following table shows individual components of the RDI Human Resource (1) and Infrastructure complex (2) indices.

	Complex index components	Complex indicators HR (1) / Infrastructure (2)	Central Hungary	Central Transdanubia	Western Transdanubia	Southern Transdanubai	Northern Hungary	Northern Great Plain	Southern Great Plain
1	Per capita GDP adjusted by purchasing power parity (PPP EUR), 2011	**1**	26 576	14 722	16 920	11 075	9 996	10 671	10 966
2	Labour productivity (expressed in man-hours) (GDP (HUF mln)/number of persons employed (thousand people)), 2011	**1**	10 509	5 991	6 664	5 135	4 843	5 058	4 915
3	Migration balance (thousand people), between 1 February, 2001 and 1 October, 2011	**1**	181	7	30	-6	-26	-10	-4
4	Percentage of researchers engaged in R&D within the total workforce, 2011	**1**	1.79%	0.43%	0.51%	0.62%	0.47%	0.62%	0.75%
5	Percentage of researchers engaged in corporate R&D within the total workforce, 2011	**1**	0.74%	0.25%	0.15%	0.12%	0.15%	0.15%	0.20%
6	Number of corporate R&D research units, 2011	**2**	713	119	84	74	85	86	154
7	R&D expenditure per full time researchers (HUF million), 2011	**2**	14.48	13.90	17.64	10.94	12.56	16.11	13.35
8	FP7 Amount of awarded funding (EUR million), 2007-end of February 2013	**2**	175.35	8.58	2.50	4.34	1.93	12.06	19.31
9	Number of FP7 grant agreements (pcs), 2007-end of February 2013	**2**	938	55	39	45	28	81	71
10	Science and technology human resource index (HRST) as a percentage of the active working age population, 2011 (%)	**1**	45	27.5	28.5	29.5	28.7	28.7	28.7
11	Science and technology human resource education index (HRST- Education) as a percentage of the active working age population, 2011 (%)	**1**	33.7	17.8	18.5	20.7	19	20	20.2
12	Number of people employed by knowledge intensive manufacturing companies as a percentage of all manufacturing industry workers, 2011 (%)	**1**	40	49	49,2	32,4	49,5	30,2	25,5
13	Number of people employed by knowledge intensive services companies as a percentage of all service industry workers, 2011 (%)	**1**	54.6	49.4	48.2	55.4	54.6	56.4	51.5
14	Number of higher education lecturers, 2011	**1**	10 842	1 248	1 139	2 120	1 251	2 157	2 600
15	Number of PhD/DLA academic degree/title holders between 2009 and 2011, annual average	**1**	725	57	46	153	32	160	122
16	Number of industrial parks specialising in RDI, 2012	**2**	10	8	5	4	7	6	8
17	Number of Accredited Innovation Clusters, 2012	**2**	4	4	0	2	1	3	7
18	Membership of Accredited Innovation Clusters, 2012	**2**	166	141	0	50	45	103	282
20	Regional Innovation Scoreboard 2012: regional benchmarked index derived from the percentage rate of technologically innovative companies	**2**	0.24	0.14	0.07	0.1	0.1	0.1	0.08
21	Number of patents registered with the Hungarian Patent Office, annual averages for 2011-2012 (pro-rated to 1 million people)	-	125.1	41.9	40	34.0	47.7	44.8	45.5
22	Number of patents registered with the European Patent Office, annual averages for 2007-2009 (pro-rated to 1 million people)	-	34.87	7.15	11.46	7.50	8	6.39	11.79
23	The number of landline internet subscription pro-rated to 1,000 people, 2010	**2**	405	378	358	312	312	300	289

2. Development in the headcount of researchers employed by individual sectors presented in a geographic breakdown

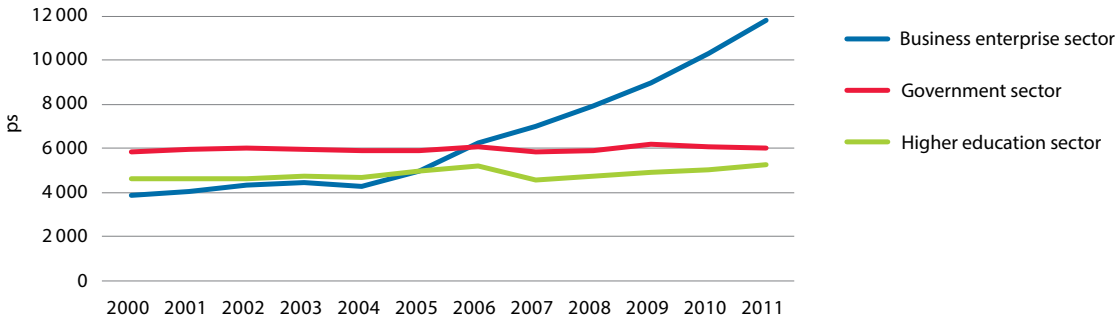

Figure 1: Development of the FTE headcount of various sectors in Hungary between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

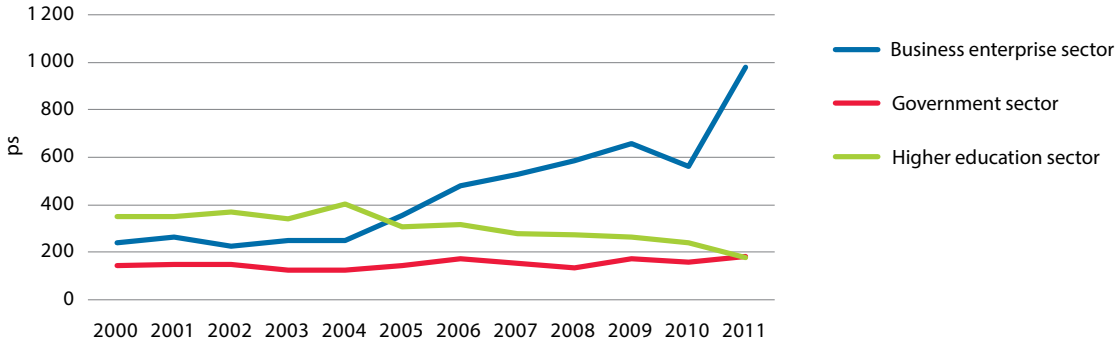

Figure 2: Development of the FTE headcount of various sectors in Central Transdanubia between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

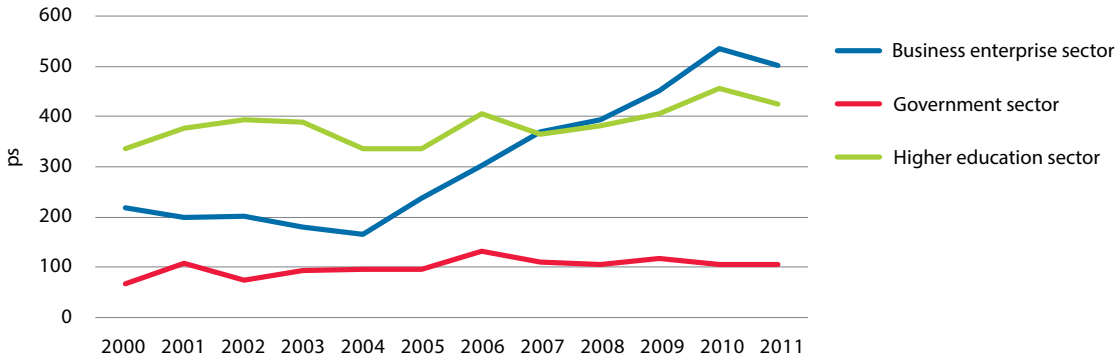

Figure 3: Development of the FTE headcount of various sectors in Western Transdanubia between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

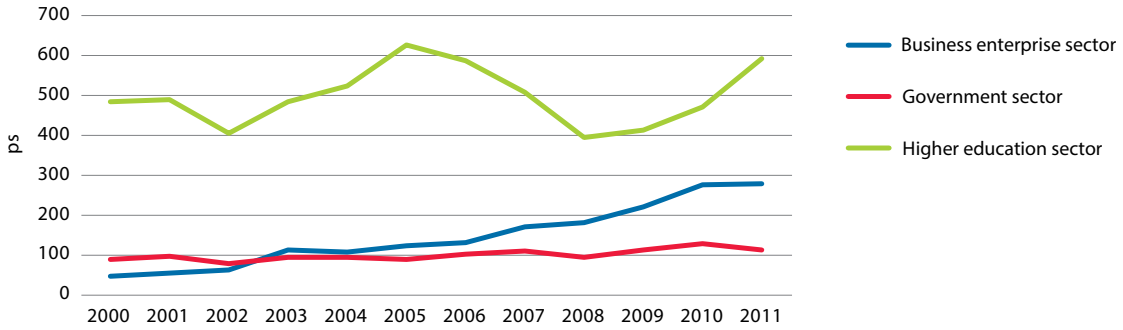

Figure 4: Development of the FTE headcount of various sectors in Southern Transdanubia between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

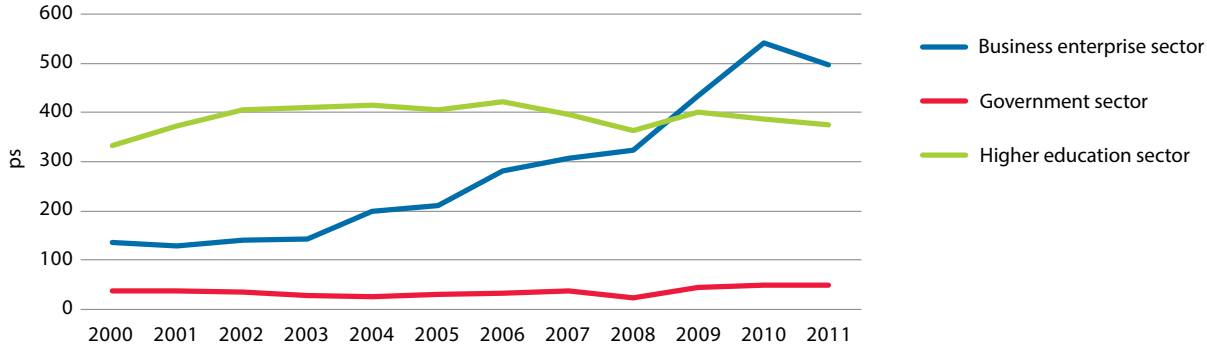

Figure 5: Development of the FTE headcount of various sectors in Northern Hungary between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

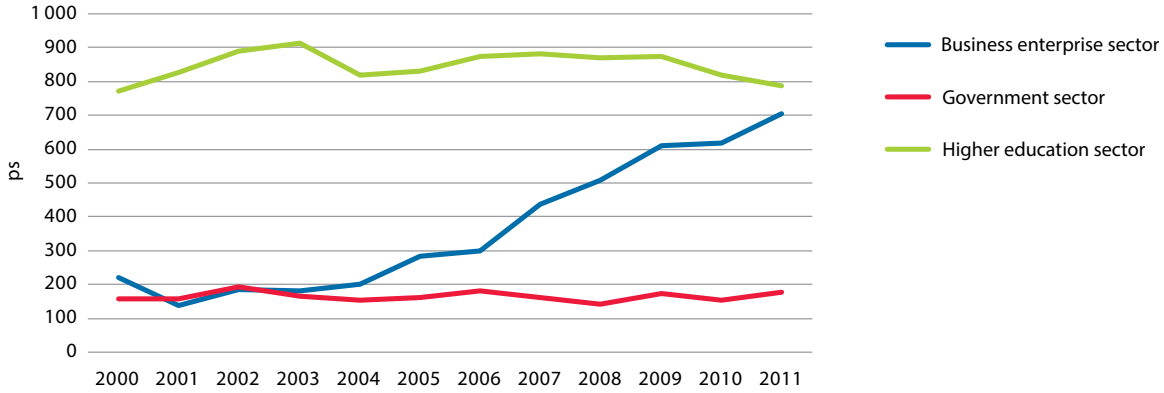

Figure 6: Development of the FTE headcount of various sectors in the Northern Great Plain between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

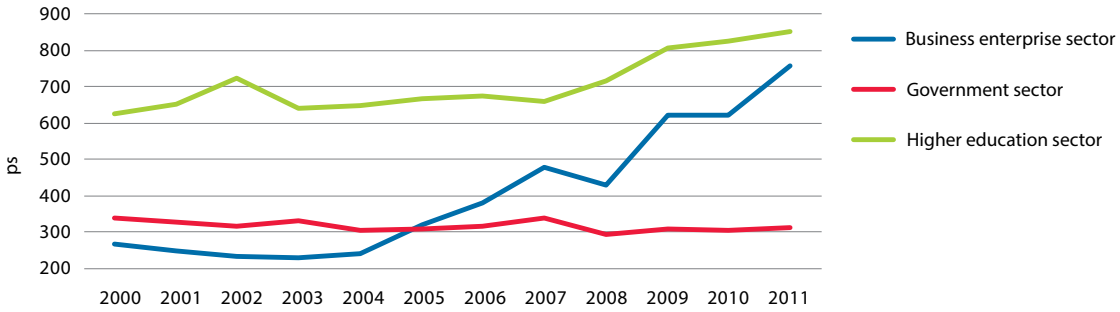

Figure 7: Development of the FTE headcount of various sectors in the Southern Great Plain between 2000 and 2011.
Source: National Innovation Office RDI Observatory's own calculations based on Eurostat data.

3. Geographic distribution of unemployment according to qualifications

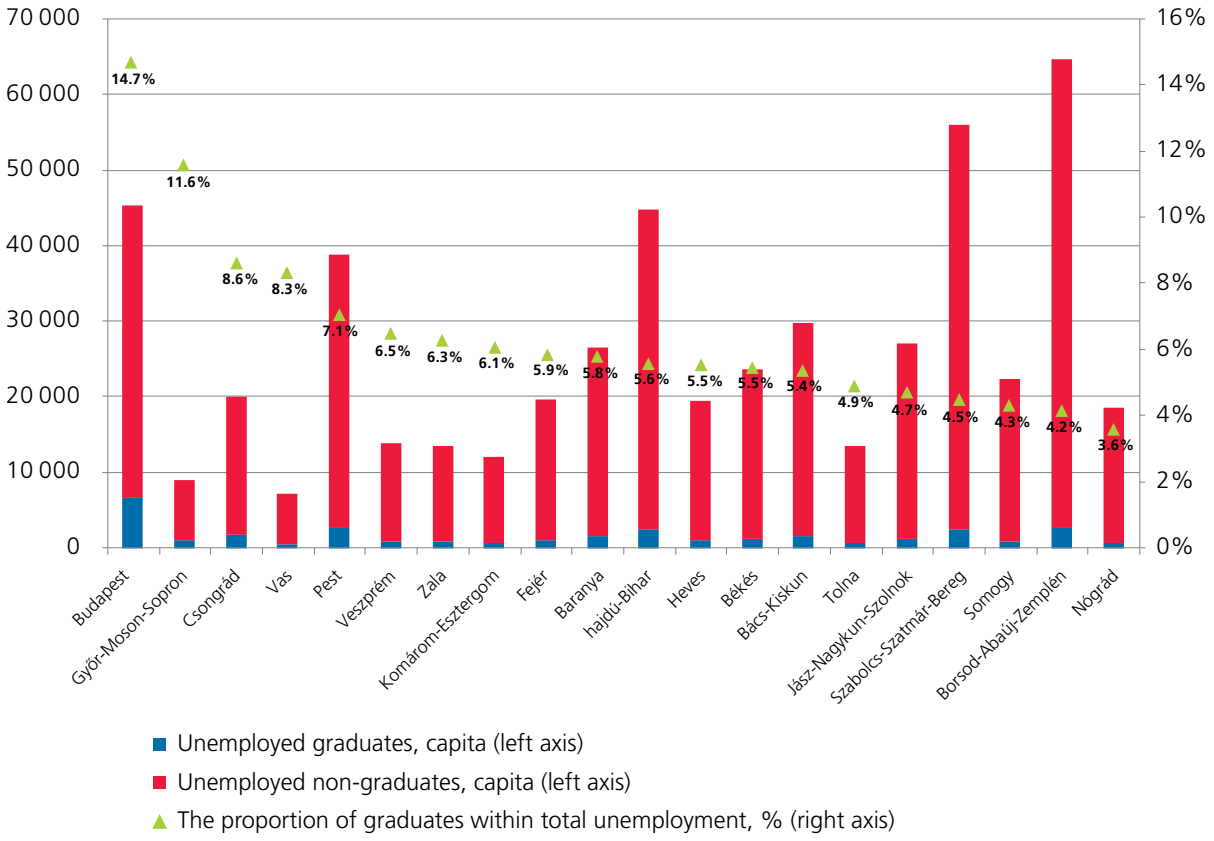

Figure 8: Number of the registered unemployed by county, separately stating those with higher education qualifications both in numeric and percentage terms, Q3 2012. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

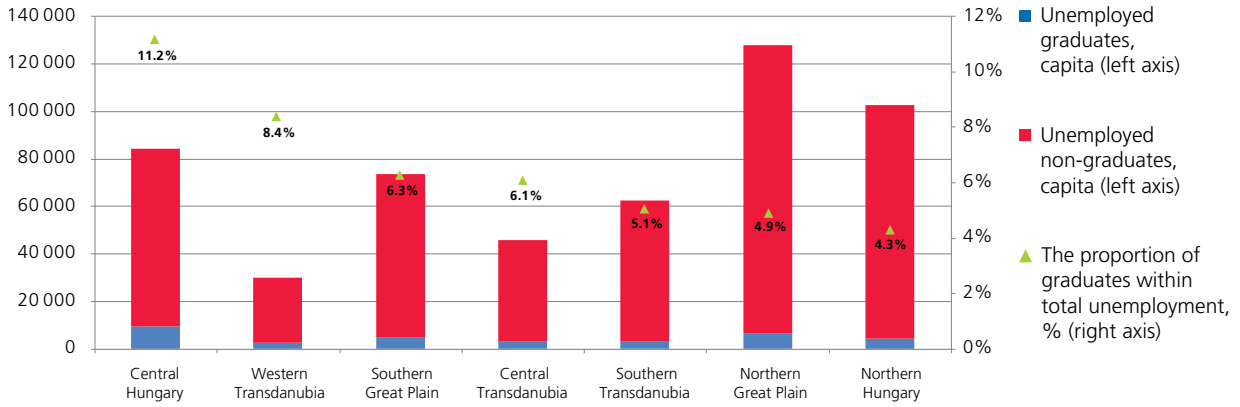

Figure 9: Number of the registered unemployed by region, separately stating those with higher education qualifications both in numeric and percentage terms, Q3 2012. *Source: The National Innovation Office RDI Observatory's own calculations based on HCSO data.*

4. Regional correlation matrix of innovative sectors/industries

	CF	CI	CL	CJ	D	E	M	J	K
CF	1	0,34	0,19	0,05	0,36	0,25	0,49	0,42	0,56
CI	0,34	1	0,84	0,64	0,79	0,78	0,85	0,89	0,79
CL	0,19	0,84	1	0,7	0,63	0,58	0,68	0,73	0,63
CJ	0,05	0,64	0,7	1	0,47	0,63	0,45	0,57	0,39
D	0,36	0,79	0,63	0,47	1	0,62	0,81	0,76	0,79
E	0,25	0,78	0,58	0,63	0,62	1	0,84	0,81	0,82
M	0,49	0,85	0,68	0,45	0,81	0,84	1	0,94	0,93
J	0,42	0,89	0,73	0,57	0,76	0,81	0,94	1	0,87
K	0,56	0,79	0,63	0,39	0,79	0,82	0,93	0,87	1

Table 1: Rank correlation matrix; correlating the ranking of counties in order of importance according to the number of companies operating in the nine innovative industries/sectors. *(Data source: HCSO) We highlighted strong correlations (above 0.7) in green. (CF Manufacture of pharmaceuticals; CI Manufacture of computer, electronic and optical products; CL Manufacture of transport equipment; CJ Manufacture of electrical equipment; D Electrical energy, gas and steam supply, air conditioning; E Water supply; M Professional, scientific and technical activity; J Information communication; K Financial, insurance activity).*

	CF	CI	CL	CJ	D	E	M	J	K
CF	1	-0,73	-0,73	-0,41	-0,49	-0,49	-0,85	-0,92	-0,61
CI	-0,73	1	0,77	0,63	0,6	0,66	0,77	0,89	0,77
CL	-0,73	0,77	1	0,34	0,83	0,09	0,54	0,71	0,43
CJ	-0,41	0,63	0,34	1	-0,11	0,69	0,57	0,69	0,4
D	-0,49	0,6	0,83	-0,11	1	-0,09	0,37	0,43	0,49
E	-0,49	0,66	0,09	0,69	-0,09	1	0,77	0,71	0,77
M	-0,85	0,77	0,54	0,57	0,37	0,77	1	0,94	0,89
J	-0,92	0,89	0,71	0,69	0,43	0,71	0,94	1	0,77
K	-0,61	0,77	0,43	0,4	0,49	0,77	0,89	0,77	1

Table 2: Rank correlation matrix; correlating the ranking of counties in order of importance according to the number of companies operating in the nine innovative industries/sectors. *(Data source: HCSO) We highlighted strong positive correlations (above 0.7) in green, and negative correlations in red. (CF Manufacture of pharmaceuticals; CI Manufacture of computer, electronic and optical products; CL Manufacture of transport equipment; CJ Manufacture of electrical equipment; D Electrical energy, gas and steam supply, air conditioning; E Water supply; M Professional, scientific and technical activity; J Information communication; K Financial, insurance activity)*

5. Number of companies engaged in innovative sectors and industries

	CF	CI	CL	CJ	D	E	M	J	K
Budapest	42	713	160	304	201	327	42144	16183	6150
Baranya	2	32	22	27	17	95	3938	976	1204
Bács-Kiskun	1	45	45	40	20	114	3923	918	1326
Békés	1	19	10	20	5	65	2260	514	839
Borsod-Abaúj-Zemplén	2	42	24	30	34	108	4152	1007	1630
Csongrád	1	58	22	24	24	80	4174	1090	1193
Fejér	1	65	56	40	18	95	3772	1038	1137
Győr-Moson-Sopron	2	44	45	31	37	65	4540	1082	1338
Hajdú-Bihar	4	37	12	23	28	108	4333	1029	1351
Heves	6	25	11	32	11	54	2062	515	846
Komárom-Esztergom	1	53	38	35	26	65	2735	639	874
Nógrád	1	19	5	8	2	42	1114	268	437
Pest	17	307	124	136	45	333	13909	5276	3198
Somogy	5	22	20	18	10	51	2166	514	916
Szabolcs-Szatmár-Bereg	1	30	19	12	15	70	2884	648	1230
Jász-Nagykun- Szolnok	0	29	22	36	8	73	2356	537	862
Tolna	0	16	5	26	10	54	1959	446	582
Vas	0	20	20	20	19	49	1962	497	742
Veszprém	2	30	38	23	11	61	2972	707	950
Zala	2	26	14	15	15	58	2526	487	868
Total	**91**	**1632**	**712**	**900**	**556**	**1967**	**109881**	**34371**	**27673**

Table 3: The number of business enterprises operating in various counties and forming part of innovation-oriented industries/sectors (pcs). *Source: HCSO (CF Manufacture of pharmaceuticals; CI Manufacture of computer, electronic and optical products; CL Manufacture of transport equipment; CJ Manufacture of electrical equipment; D Electrical energy, gas and steam supply, air conditioning; E Water supply; M Professional, scientific and technical activity; J Information communication; K Financial, insurance activity; end of 2010)*

The report and any data and indicators published therein, can be downloaded from the Kaleidoszkóp website: http://www.kaleidoszkop.nih.gov.hu/

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National Innovation Office

Government Decree 303/2010 (XII. 23.) established the National Innovation Office (NIH) as the governmental body responsible for research, development and technological innovation. The Office operates under the direction of the Minister for National Economy.

Main activities of the National Innovation Office:

- RDI strategic analysis and planning
- provides innovation management services
- operates the Kaleidoszkóp system, a comprehensive register of domestic RDI actors
- is involved in the development and application of RDI policy
- coordinates and facilitates international RDI cooperation

International activity:

- attracts foreign investments to Hungary
- harmonises international and EU RDI policies
- coordinates bilateral scientific and technological cooperation

SME-support activities:

- provides easier access to domestic RDI results for market players
- supports research-related cooperation and promotes networking between RDI players
- boosts the innovation activity of SMEs

To promote these objectives, NIH works in close cooperation with other government agencies, ministries, bureaus, the Hungarian Academy of Sciences, higher education institutions and research institutes, national and regional organisations and RDI market players.

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Central fax number: +36 1 318 7998
E-mail: info@nih.gov.hu
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Kaleidoszkóp

Kaleidoszkóp (the name refers to the multifaceted nature of RDI) is the name of the information system used by the National Innovation Office. Kaleidoszkóp's objective is to create an integrated RDI database of the relevant institutions and companies of the sector, as well as data and analyses supporting RDI policy related decision-making. With the help of this database, RDI stakeholders can be involved in diagnosing problems as may exist within the sector and work out possible solutions. All Kaleidoszkóp system data and service functionalities are meant to assist public sector institutions and other organisations in their networking, strategy development and market analysis efforts.

Kaleidoszkóp's main objectives:

- promote networking within the RDI sector
- assist facts-based decision-making
- assist national and international statistical activity
- provide solid foundations for RDI strategy-making

Kaleidoszkóp's services:

- generic and specific sectoral RDI analyses and statistics
- quality data sources informing analysis
- information on public funded RDI projects
- register of Hungarian research infrastructure facilities
- map-based search engine of RDI organisations and businesses
- finding project partners and mapping project opportunities

Kaleidoszkóp is operated by the National Innovation Office RDI Observatory Department.

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