REGIONAL DIMENSION OF INVESTMENT ON RESEARCH
THE CASE OF THE SOUTHERN TRANSDANUBIAN KNOWLEDGE BASE

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KNOWLEDGE CREATION: A NEW TOOL FOR REGIONAL COMPETITIVENESS

A general consensus exists on innovation-oriented regional development in the literature in which the utilisation of regional knowledge base, innovation potential and co-operation between businesses and research institutions continues to play an increasing role not only in regard to business success but also in the competitive economic performance of a certain region (Cooke, 1995).

Although several factors are influencing regional competitiveness, its driving forces still can be identified. The European Union's regional reports consider innovation, research and technology development to have the major potential in gaining competitive advantages. The competitiveness of regions can be increased by successful R&D activities within the region and by the creation and spreading of innovation in a wider sphere. Regional level innovation, and especially the practical implementation of R&D results may directly be manifested by the competitive advantages of the region's business enterprises (Lengyel, 2000).

The development of science and technology and their accumulated knowledge basis have become one of the key factors in the development of regional economy. Universities and research institutes as knowledge centres extending and disseminating comprehensive scientific information are playing an increasing role in regional development. A wide range of literature has studied the regional effects of the universities' research-development potential (Ács and Varga 2002; Varga, 2004). Not only has the direct support of universities increased significantly, but for regional governmental budgets the subsidisation of projects involving universities in various forms with the support of university-industry links are the biggest items of expenditure (Varga, 2004).

This paper provides an overview on the ERAWATCH regional benchmarking surveys—in which the Southern Transdanubian region participated—on innovation potential and investment into research surveys concentrating on the role of innovation networks, within them highlighting the special role of regional universities in collaborative research networks. The introduction will be followed by a demonstration highlighting the role of universities in national and regional knowledge transfer, emphasising the fact that the spatial (regional) structure of innovation is very much determined by the transformation of university potential and their widening innovative functions during the economic transition in Hungary. The next section will introduce the findings of the ERAWATCH survey (2006) on the role of universities in regional network building and university—industry links and will discuss those factors that are necessary for the establishment of a research university model.

THE ROLE OF UNIVERSITIES IN REGIONAL INNOVATION

Higher education has a potential influence on regional development, not only because of its place in the R&D sector, but also because of its dominant position in the training of experts responsible for producing technologically-developed products and competitive services. From this point of view, the rapid development of tertiary education, especially outside Budapest, plays a balancing role. The number of students has been growing rapidly since 1990, especially in the newly-established provincial tertiary education centres (Table 1).

Table 1. Share of Higher education in the Hungarian RTD indicators, 2003.

INPUT	OUTPUT
RTD units: 70%	Published books: 77%
RTD expenditure: 25%	Published studies: 70%
RTD personnel: 57%	Patents: 32%
RTD personnel (FTE): 38%	Patents at EPO & USPTO: 16%
Share of doctorates: 72%	
RTD investment: 12%	

Source: CSO publications, 2003.

Universities can have an impact on the economic development of their own region in two ways (Forax, 1992): on the one hand through the multiplier effect of the purchasing of students (a so-called expenditure effect) and on the other hand through the knowledge transfer (scientific, technical, technological and economic) from the university into

the business sector (knowledge effect) (Varga, 2004). A very important side-effect of technology transformation is that industries and companies manufacturing competitive products are selecting their sites on the basis of qualitative criteria.

Higher education is an extremely significant factor the attractive force for capital of which is secured not only by creating competitive advantages in the local labour market but also by its absorbing innovative capacities. It can be seen all over Europe that while the development of large technology systems concentrated in metropolitan agglomerations was mostly determined by the research-development units of large firms, the technology innovation of SMEs, the organisation of local and regional technology clusters in the majority of cases was initiated by institutes of higher education. The engine force of regional higher education can touch upon the development of the Western European core regions (Bennett and Krebs, 1991). In several Hungarian regions (for example in Southern Transdanubia) the higher education sector is the largest knowledge potential and value generator, yet at the same time it has fewer links with the industrial sector than would be necessary. The potential links between the two sectors should be identified and the institutional background of these links should be created. Successful cooperation between the business and university sectors may secure a favourable environment for innovation.

Enablement of the higher education system to exercise its innovative functions and to be capable of performing its *integrative functions* as an element of the innovation system (Horváth, 2003) emphasizes the necessity of at least preconditions:

1) Research should be regarded as a primary function of higher education. This should be reflected in its financing and the development of the knowledge potentials of university research bases should also have a key role.

2) The structure of higher education should be adapted to the requirements of a post-fordist economy and should be capable of generating technology and economic innovations.

3) National innovation policy and regional policymakers should support the institutionalised co-operation of higher education and business organisations.

4) Higher education should territorially be decentralised, institutional developments and university integrations should be in conformity with the aspects of the economy of scale. An optimal efficiency of scale with the institutions of the core region can create equal chances, both for accessing research funds and for joining the international division of labour in research and development.

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Higher education, which is placed among the R&D performing sectors is very much in the national interest as it plays a significant role in innovation processes. The economic attractiveness of the regions and spread of knowledge depend largely on a spatially-balanced network of university-based research facilities, with special regard to their relation to companies (Gál, 2002). The Act on higher education defined the tasks underpinning a dual transformation of the universities so that research might be returned to them and traditional universities transformed into research ones.

Higher education has developed into Hungary's biggest R&D generating sector and while its share of Hungarian higher education from governmental R&D spending is similar to Western European ratios, lagging behind may be observed regarding two indices. One is the very low ratio of business sector funded research departments and the other is the very weak links between university research and the business sector. While in OECD countries the average rate of corporate funded R&D is 70%, in Hungary this figure was only 38% in 2002. The ratio of R&D expenditures to Hungarian GDP is also low (0.3%), especially when comparing it with the 0.87% of Slovenia or with the 1.2% EU-15 ratio.

However, most of the university-based research units are too small to be effective both in terms of the share of researchers and overall R&D expenditure. Despite the co-operation between universities and the private sector, and participation in multilateral scientific programmes, the R&D budgets of universities are largely dependent on governmental subsidies.

DESCRIPTION OF THE REGIONAL KNOWLEDGE BASE IN SOUTHERN TRANSDANUBIA

The knowledge (RTDI) infrastructure, which includes universities and research centres, plays a significant role in the knowledge creation capacity of the regions. This infrastructure, which is easily accessible to firms, may constitute the foundations of innovative systems (using proximity arguments), but not automatically. There are many cases reported where HEIs or research laboratories operate in relative isolation from the regional productive processes, in particular when they concentrate on formal educational duties rather than covering the wider range of functions of a modern university, when they are active in sectors that lead them to have better connections with firms outside the region or when they focus exclusively on basic research.

Knowledge transmission mechanisms and knowledge enhancing linkages, including university-industry and intra-industry links such as technology intermediaries, spin-offs and inter-firm research collaborations, as well as the development of science parks and technopoles are important factors in strengthening the knowledge diffusion capacity of the regions. The knowledge enhancing linkages, ideally based on a dense interaction of interdependencies between research establishments and firms and/or among firms themselves, evolve into trust relationships that characterise, for example, economies of scope.

Southern Transdanubia is not among the wealthiest regions in Hungary. Until the mid-1990s Southern Transdanubia had the poorest R&D capacities in Hungary (in 1995 only 3.5% of all R&D employees worked in the region and not more than 1.5% of the total expenditure was realised here). This setback in R&D activities was an outcome of the disintegration of those large enterprises and research institutes engaged in R&D. The Southern Transdanubian Region has the largest provincial university centre in Hungary (Pécs) in terms of the number of students (34,000), and the two universities (Pécs, Kaposvár) in the region have significant research capacities in certain fields. The HEI sector plays a dominant role in R&D performance as it accounts for 78% of total RTD expenditures. Despite these endowments RTD creation of the business sector in Southern Transdanubia is limited (3.4 M € BERD in 2003). Outputs of R&D and the uneven disciplinary structure of higher education are not very advantageous from all points of view of innovation. Southern Transdanubia's regional GERD was 22 M Euro in 2004, which is only 3.2% of Hungary's total.

Based upon the key indicators (measured as a percentage of the national average) the following picture of the regional knowledge base of Southern Transdanubia can be drawn. *The region has large public RTD infrastructure mainly based on the two universities absorbing more than two thirds of regional GERD.* Among them, the University of Pécs has a dominant position. It hosts 87% of the enrolled students and 84% of the research staff of the HEIs. Unlike the public RTD sector, the visibility and the performance of the business sector is very low, even in comparison with the national average. Universities are the major employers of RTD personnel. They account for three quarters of the total RTD personnel of the region. The remainder is divided almost equally between the corporate and public RTDI sectors. As a percentage of total employment with the national average (=100%), Southern Transdanubia's share of RTD personnel is 73%. However, there are huge differences

in expenditures between the different sectors. HEIs exceeded the national average (107%), while RTD personnel make up very small shares of the total in business and the government sector, accounting respectively for only 28% and 25% of the national average, (Graph 1).

The orientation of the knowledge creation activity of the region is based to a great extent on the scientific profile of its universities. Of all the knowledge creation sectors, HEIs[1] have the strongest potential in life science (biotech and animal cytology) research and they also have a good reputation with measurable RTD outputs in laser physics, environmental and agrarian research. At the same time, engineering and some fields of science (informatics, electronics and chemistry) are proving to be the weakest elements of the regional RTD base.

The strength of *the life science (biotech) research base* is demonstrated by its large share of total input-output indicators and also by the increase of RTD spending in this field (€4.8m in 2004). In addition, the 11 university spin-offs in the biotech sector are tightly connected to the Medical School (MS) which has 48 employees (40 of them with an HEI degree) and produces a turnover of €3 million (2004).

In contrast to this positive trend, the share of engineering in total RTD personnel especially in the fields necessary for technology change (micro-electronics, informatics, automation), dropped from 8.9% to 6.9% during the short period from 2002-2004. Due to the uneven disciplinary structure of HEIs the outputs of the RTD sector in the region are not very advantageous and from the point of view of innovation are clearly characterised by lower patenting activity in the region. There was a similar decline in the proportion of researchers in natural sciences and also in agrarian science (which declined from 6.6% to 5.4%, and from 8% to 7.3% respectively). The traditional overrepresentation of researchers in social sciences and humanities is changing only slowly, and even though their share has declined from 42% to 29.5%, it is still high (Graph 1).

The lagging position of the region is best expressed by the RTD expenditure indicators measured as a percentage of GDP. Comparing the performance of the region in relation to the country as a whole, the GERD only improved slightly during the last decade, reaching only 43% of Hungary's average. The largest increase in R&D expenditure in the case of Southern Transdanubia can be observed in the HEI sector, illustrated by its high HERD figure of 108% (above the national average). Unlike the

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[1] University of Pécs and University of Kaposvár.

HEI sector, the limited RTD activity of the business sector is the main characteristic of regional RTD performance, accounting for only 17% of Hungary's average as a percentage of GDP. *This figure is lower than the RTD expenditure of the government RTDI sector* (23%).

Figure 1. Key indicators on Southern Transdanubia's knowledge base development in comparison to the national average
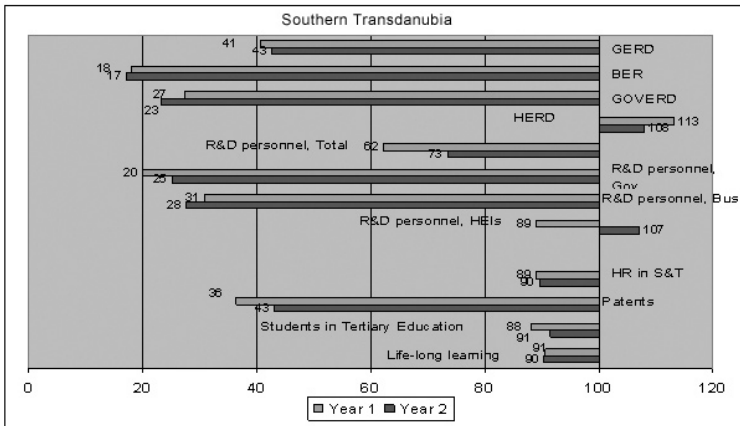
Source: calculated by the Author based on EUROSTAT data

Note: The following years were used for BERD, GERD, HERD GOVERD 1999, 2003; R&D personnel 1999, 2004; HR 1997,2005; Patents 1995, 2003 and Lifelong learning 1999, 2004.

UNIVERSITY INDUSTRY LINKS: CULTURAL BARRIERS?

Through their integration into national and international knowledge bases and networks, universities and research institutes are functioning as potential knowledge bases for companies in their environment even if universities are generally less embedded into their regional context and prefer national and international co-operation (Koschatzky and Sternberg, 2000). The importance of universities compared with customers and suppliers is by far less for the business sector than as information and knowledge bases. It is obvious that small companies are co-operating with universities to a lesser extent and local SMEs particularly rarely communicate with universities for technology information, but in the case of co-operation geographical proximity certainly plays a key role in connection

building. It seems obvious that the co-operative affinity of SMEs is the smallest, yet it is they are who are most in need of co-operation. In the case of co-operation, SMEs naturally prefer establishing relations with local knowledge bases (Koschatzky and Sternberg, 2000).

In regional innovation surveys special attention is paid to universities as major sources of regional innovation. One thing that our survey assesses is the importance of universities in comparison to other actors of innovation systems with the channels of knowledge transfer and also the geographical features of knowledge flow between universities and industrial companies. In some less developed regions the university sector has no links with the economic sector.

It is clear that most Hungarian businesses do not want to collaborate with any non-business organisations. The most popular non-business organisations for past and future co-operation in the Southern Transdanubian Region are the Chambers (47%), the University of Pécs (40%), and the regional innovation centre (DDRFÜ) (37%).

The spatial extent of knowledge flows emanating from university research laboratories has attracted considerable attention in the international literature. There are theoretical arguments for localised knowledge transfers (the importance of tacit knowledge, the role spatial proximity plays in easing maintaining interactions etc) which are to a large extent supported by empirical evidence; however, substantial variation can be observed according to firm size, industrial sector or the stage of innovation (Varga, 2002).

It is clear that university research units more frequently collaborate with local (within the region) firms and the intensity of co-operation vanishes with distance. There are also notable differences across research fields. Whereas for some scientific fields we can observe that active local collaboration is followed by active domestic and international interactivity with firms (physics and surgery) for some other fields (such as informatics and construction) localised connections are more important than collaborations with distantly located companies.

Several hindering factors may be owed to universities in building regional level relations. Universities are operating by their own rules and principles, which are hard to make compatible with the objectives of the business sector. Both universities and companies are organised by their own differing logical, cultural and organisational limits, which raises difficulties in co-operation between the two parties. The majority of university research departments carry out basic or applied research, but very few

university research organisations are joining experimental development projects. The interest of universities in co-operating with business sector is much more oriented towards short-term fund-raising than towards a strategic development of the innovation chain. Universities with industrial links are rather more interested in projects involving large-scale funding than in the support of SMEs. In several cases the purchase of technology licenses from outside the region is much more profitable for companies than intraregional innovation co-operation.

Thus, the potential areas of co-operation should be identified between the two sectors and an institutional background should be created for these links (Table 1). A successfully co-operating business and university sector may secure an innovation-friendly environment. The majority of researchers is doing basic research and despite the difficulties in the financing of higher education are uninterested in direct co-operation with the business sector as yet. Research tasks are fragmented, the concentration and their corporate relation system are weak, and market-oriented research development is still a rare phenomenon. To provide an example from the University of Pécs, being one of the largest provincial universities in terms of student numbers, recently a five-year contribution by the business sector project to the university's total income was about the third of the one year total budget. Spin-off ventures originating from universities have important functions, although they are rare cases in the LDRs (Gál, 2003).

Generally, the co-operation of universities and research institutions with businesses and especially pre-competitive research have positive impacts on the business success of companies and the region's economic performance, yet large and medium-size companies have more extensive relations with universities though these links are crossing the border of their region and this seems to support the theory of the low impact of universities on their region. For all that, the building of information and technology transfer links between SMEs and university R&D bases and the co-ordination of university re-training and information courses are very important for both sectors.

Table 2. Motivations behind university-industry co-operation

UNIVERSITY	INDUSTRY
Decreasing state support: gain additional financial resources	Knowledge has become the main factor of business competitiveness
Increasing cost of R&D: force to co-operate	Access to knowledge base/R&D infrastructures
Developing the service & knowledge transfer function of the university	Outsourcing: involving academic expertise
Increasing researchers' practice in outer contracts	Strengthening external relations of companies
New challenges of experimental research & development	Increasing pre-competitive R&D
Direct link to the labour market; an increasing labour mobility	Acquaintance with students as potential future employees
Practice-oriented training	Influence on improving the training structure and curriculum
Strengthening Spin-off entreprises	Favourable start-up conditions
Stimulating Regional development	Stimulating economic development

Source: edited by the Author

ASSESSMENT OF THE REGIONAL INNOVATION SYSTEM IN SOUTHERN TRANSDANUBIA

Here we try to assess the efficiency and coherence of the RIS with regard to the needs and capacities of the regional economies and the extent of matching or mismatching between knowledge and economic specialization (Table 2). Southern Transdanubia is considered to be a backward region in terms of RTD and the knowledge absorption capacity in its economy, and the basic conditions for change in the technology sphere were rather unfavourable in the region during the transition period.[2]

Public sector RTD infrastructure investment, which is dominated by the local universities, is much larger than the investments and the RTD capacity of the business sector in Southern Transdanubia. The orientation of the knowledge creation activity of the region is to a large extent based on the research profile of the two universities. As regards the relationship between RTD and economic specialisation, we found a *stronger correlation* in certain traditional fields with a considerable research background (agrarian research). Universities have also built up strengths

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[2] Some restructuring can be seen within the industrial sector, moving towards mechanical engineering and the emergence of high-tech electronics through foreign direct investment; however, the share of labour-intensive, lower-tech sectors, such as the food, textile and leatherwear industries, is still above the national average.

in *biotechnology, laser physics and in environmental science, demonstrating the most promising and deeply rooted avenues of research for the future development of the region*. The new clusters of the biotech, health and environmental industries have been built on the expanding knowledge creation capacities of the affiliated faculties and the enterprise networks. *Nevertheless, the industrial background of the region in these fields is still weak*. Therefore, *the research outputs from biotech (produced by the university spin-offs) are still mainly utilised outside the region*.

When comparing the matching of the *economic structure in the region with its knowledge specialisation*, some discrepancies can be observed. In contrast to the positive trends in RTD, some fields of natural science are rather under-represented in terms of the research capacity in engineering, while social sciences and humanities with less direct economic benefits are over-represented. The absence of a strong research capacity in S&E during the 1990s became one of the serious obstacles to the modernisation of industry, as it was unable to meet the demand coming from the high-tech companies located in the region. The shortage of highly skilled engineering graduates at the University of Pécs and the lower standard of RTD at the Faculty of Engineering in the fields of informatics, IT and electronics contributed in large measure to the relocation of the NOKIA plant from Pécs in 1999. In the case of engineering, both the weaker research capacities and the low demand from the underdeveloped branches of local industry compound their respective handicaps.

The private sector in the region is dominated by SMEs operating in low/medium-tech sectors (LMT) characterised by a lower level of innovation. The smaller number of indigenous large companies mainly specialise in traditional LMT industries (food, textile, leather). A few large enterprises in high tech electronics (mainly multinationals or locally based joint-stock companies) have been engaged in high-tech activities, but their influence on the local RTD sector is considered to be marginal, as they usually rely on the in-house RTD activities of their parent companies importing the technology from outside the region. Nevertheless, a few dozen innovative SMEs with significant RTD performances are to be found in the biotech, IT, plastic and the mechanical engineering sectors. *In general it can be said that the RTD capacity and visibility of the business sector is still low and the region is heavily dependent on public funding*.

However, the main reasons for the poorer performance in RTD activities are the following: on the one hand, the mismatch between the economic and research specialisations, combined with the low share of the business sector in RTD

investment, the high share of the traditional lower tech sectors, the small size of local SMEs and the consequent lack of resources to invest into RTD and absorb its results and, on the other hand, the lack of demand for research results from larger (mainly foreign) companies and, to some extent, the lack of the necessary knowledge supply in the region in certain fields. These factors, together with other mismatches in economic and RTD specialisation, explain why demand for research results in the region remains low.

From a study of the relationships between the regional economic structure and knowledge creation it can be concluded that establishment of the local knowledge base in some cases (e.g. laser research) did not take the existing sectoral specialisation of industry into consideration. In other cases, the extensive agrarian research base, strongly linked to the agro-food sector, is slightly loosening their sectoral background due to the structural decline of agriculture during the transition. The biotech sector, based on the Medical School research teams and university spin-offs, relies to a much lesser extent on local RTD co-operation. As a result, the players have integrated into the interregional RTD networks, establishing co-operation with companies outside the region.

Other research bases in S & E were established in order to extend the disciplinary profile of the HEIs during the 1980-90s, and their development was based on their internal dynamics rather than on local economic development. RTD processes have been speeded up recently, mainly through accelerated public investment. In the future, RTD investment ought to rely much more on the business sector contribution in order to ensure the direct economic benefit of RTD activities which can foster industrial modernisation and economic restructuring of the regional economy.

The conclusion can be drawn from the findings of the survey that RDTI intensity is not necessarily a decisive element of regional growth. It should be emphasised that the region needs to build on existing capacities rather than attempting to build their strategies by reference to as yet undeveloped or non-existent technologies, industries or fields of research. Nevertheless, an international reputation in university-based RTD activities (e.g. biotech), even without an extensive local industrial background, would make the regional knowledge centres more attractive for business sector investment, which may lead to the location of new plants in the region. Also, when making RTD investment decisions, the importance of the regional context and the established policies have to be taken into account.

Table 3. Strengths and weaknesses of the Regional innovation system

	Strengths	Weaknesses
Knowledge creation capacity	- Strong university base with wide disciplinary profile - The largest provincial university centre in Hungary in terms of the number of students (UP) - Strong RTD base at HEIs in agro and life sciences	- Weak and biased RTI base, -Uneven disciplinary structure in HEIs' RTD (over-representation of social sciences, weaker S&E base) -Limited RTD activity of business sector -Lower share of national GERD indicates the lower fund absorption capacity in the region -LMT sectoral dominance in the case of SMEs -Low level of patenting activity
Knowledge diffusion capacity	-The region has developed technology and business park infrastructure -High-tech oriented university spin-offs with good performance in Biotech	-Technology transfer/liaison infrastructure still in its initial phase and lacks resources to supply all needs of SMEs
Knowledge absorption capacity	- General HR endowment of the region is close to the national average	-Participation rate in Lifelong Learning is half of the EU-15 average - Share of HR in S&T is below the national average -Students in tertiary education is lower than the national average
Interactions of main actors	- Huge variety of collaborative programmes from informal networks, clusters to the Regional University Knowledge Centres – introduced - Active participation by a few innovative firms in a variety of collaborative ventures	- Difficult to orientate and choose among the forms that best fit the participants' needs - Overall low intensity of participation and low level of utilisation of results - Weak communication among the different sectors / potential partners
RTDI governance capacity	- Reorganised RTDI governance structur following EU recommendations, growing regional awareness	- Centralised policy-making but rather weak coordination among the different national bodies - Lack of legislative and decision-making right and financial resources of the regions

Source: edited by the Author

SUMMARY

The role of universities and research institutes as knowledge centres improving and disseminating comprehensive knowledge have an increasing importance in regional development. Today the facilitation of the spatial diffusion of knowledge, the spatial mechanisms of knowledge transfer and the access of business sector to knowledge bases are priorities in support and development policies (Landabaso, 1997). A general consensus exists on innovation-oriented regional development in which, through the co-operation between businesses and universities, it continues to play an increasing role not only in regard to business success but also in the economic catching up of a certain region.

Spatial differences in economic development have serious impacts on the network relationship of universities and business organisations. The differences between the advanced core regions of metropolitan agglomerations and the most backward regions are manifested in the relationship between universities and their environment. In his research, Attila Varga points out that agglomerations are not negligible factors of the efficiency of regional development policy. With the same amount of university expenditure the impact of university knowledge transfer is significantly higher in areas of high industrial density than in smaller towns (Varga, 2000). This statement is highly important from the aspect of economic policy suggesting that the support of university researches for stimulating local economic development may be an outstanding instrument in case of advanced regions but not necessarily for the backward areas.

Most of the sample businesses still view the university as a traditional educational centre. The most significant impediment of a stronger co-operation between university units and businesses is the limited information about each other. Most firms have no information about what the university is doing besides education, while university researchers and staff have only rather dim ideas about business needs and the potential business application of their research. It is very positive that recently most university researchers now at least recognize the requirements of the practical applicability of their research, but acceptation and appreciation of business requests are still under way.

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