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Academic Entrepreneurs and their Role in 'Knowledge' Transfer

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Summary

We examine the historical background to the emergence of academic entrepreneurship in the transition countries, taking Hungary as an example, in terms of the peculiar weaknesses and requirements of the old, planned system, and the specific way in which transition has affected research institutes. We proceed to essay a taxonomy of academic spin-offs - by origin, by pattern of relationship to the 'mother' institute, by nature of activity and by approach to that activity, and then go on to try to assess what are the key factors of success in the academic spin-off business. This leads on to a discussion of the kinds of knowledge and skill that academic spin-offs actually transfer. In concluding, we underline the key importance of academic spin-offs, as 'knowledge merchants' in the special transition environment - especially for SMEs, which are too small to have their own R&D departments, even in developed market economies, but also for bigger firms, because under socialism even the biggest firms did not have the full range of R&D services in-house. In that context, academic entrepreneurship could have a critical bearing on the economic future of the Central and East European economies.

1 Introduction

Academic entrepreneurship in Central and Eastern Europe can be interpreted as a straightforward result of the transition from a centrally planned to a market economy. Although the rate of formation of firms in and around academia has been increasing during the transition period, entrepreneurial behaviour is in fact not an entirely new phenomenon among researchers and university teachers. Both immediate research conditions (the funding situation) and the wider economic environment (the market) have been challenging academics to modify their patterns of research activity for a long time. Thus academic entrepreneurship in transition countries has its roots in the experiences and capabilities accumulated in the pre-transition period. During the transition period, however, the R&D sector has been under increasing pressure on account of shrinking budgets and the disruption of links with former 'customers'. The R&D sector in most of the countries concerned has been generally viewed as overdeveloped in relation to the economic potential of the country. In considering the issue of academic restructuring or reorganisation, we can accordingly interpret the creation of firms and the spinning off of small firms from academia as a 'spontaneous' (bottom up) response to this problem of over-capacity. This process can be seen as one possible way of shrinking the research sector, serving both to conserve human resources and link the expertise residing in those resources to industry.

Although academic entrepreneurs are bound to be rather different in Central and Eastern Europe from their counterparts in the developed countries, there are several similarities between them. Except in the leading high-tech sectors, financial pressure as well as professional interest plays an important role in the process of firm formation. University firms and university spin-offs vary greatly from sector to sector, in terms of the maturity of the technology involved and the length of the product development cycle. They also vary by size, location, type of linkage with the public sector and with other firms, and by their mode of operation. They can be based on research results, on technology, or on technical knowledge.

Academic entrepreneurs who set up their small firms seek to use their accumulated capabilities, skills and 'insider' information as well as their purely scientific knowledge. Through their activity they are in a position to transfer knowledge, information, skills and expertise from academia to industry, or from abroad to the local market. Knowledge transfer holds a particular importance for new lines of production in Central and Eastern Europe. The transition period itself can be understood as a learning process, involving learning by firms, learning by individuals and learning by organisations. There is a special value in analysing the role of the public research sector, and of academic entrepreneurs, in this learning process.

In this paper I develop a framework and taxonomy for further research on academic entrepreneurs in Central and Eastern Europe,[1] on the basis of my recent research on 'Innovation Potential Embodied in Changing Academy-Industry Relations'.[2] This was a comparative study of seven Central and East European countries which focused on different forms and mechanisms emerging on the interfaces between university, research institutes and industry. We studied science parks, technology centres and small spin-offs from academia. Our central interest was in mall firms and academic entrepreneurs, whether still located in public research institutes or having left them for science parks, technology centres or for an independent existence. The understanding of the processes and interests involved in the formation of firms that emerged from this project helped us to gain a sharper appreciation of the capabilities embodied in academia and the economic potential of these firms.

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[1] Being carried on under the rubric of 'Academic Entrepreneurship: A Study of the Development of Technology-Based Firms from the Public Sector in Central and Eastern Europe'. This is a PHARE/ACE project, involving a comparative study of Bulgaria, Hungary and Poland, co-ordinated by Fred Steward at Aston Business School

[2] Within the framework of a research project supported by the Central European University, Research Support Scheme (1001/93) and carried out by a network of researchers; Z Andrasi and K Balazs (Hungary), A Jasinski (Poland), M Lenardic and S Radosevic (Croatia), W Meske (Germany), K Muller (Czech Republic), S Sandu and C Vlaicu (Romania), and K Simeonova (Bulgaria). See articles by Balazs *et al*, Balazs, Muller and Simeonova in Special Issue of *Social Studies of Science*, Vol 25 No 4, November 1995.

2 Academic Entrepreneurs

Let us begin with some terminological clarifications. The term 'academic' can be misleading in the East European context. Historically, its use is associated with the Academy of Sciences. In this paper I refer to 'academic' in the Western sense, which includes university teachers/researchers and public-sector laboratory researchers too. The more restricted earlier usage in Central and Eastern Europe was important in that it embodied the strict division of labour between university (teaching) and research institutes. However universities are now developing research to some extent, while at the same time researchers are gradually getting involved in education, at least on a personal basis. Thus the study of entrepreneurship is relevant in both contexts.

I understand academic entrepreneurship primarily as *behaviour*, which modifies patterns of research. It is an 'income-oriented' (profit-maximising) activity which can be seen as 'risk-taking', technology- and knowledge-based, 'small business', having a stabilising role for the academic institutions in which it is located (Tyson *et al*, 1994). In line with this approach, some forms of public sector contract and research or development for commercial partners, can be understood as 'business-oriented quasi-entrepreneurship' (Balázs, 1993). But the clearest examples of income generating behaviour have come in the form of 'in-house' business activity at universities and research institutes, involving for example manufacturing and distribution of products, contracting-out of equipment and provision of services, trading or other form of market activity. We can think of all these as forms of entrepreneurial behaviour, developed with in the organisation and the management structure of academia.

Secondly, I see academic entrepreneurship in terms of a *class of small firm.* Small firms of this type have been set up by academics and former academics, and are based on their knowledge and expertise. These firms vary widely, by type of activity and by location.

In the next section of this paper I describe the emergence of academic entrepreneurship in Hungary. Following that, I describe typical entrepreneurial patterns, especially the spinning off of firms, including empirical 'stories' I drew from several interviews. I use the case material which I collected for the project cited under footnote 2, which took the form of a pilot study in Hungary on 'academic entrepreneurship', involving visits and interviews at more than thirty small firms at research institutes of the Academy of Sciences and the Technical University of Budapest. In this part I also develop a framework for the shaping of future research. The evaluation I provide at this stage is, of course, provisional, based, as it is, on a mere pilot study.

3 The Origins of Academic Entrepreneurship

Academic entrepreneurship in the developed industrial countries has strong links with scientific progress, economic success and competitive markets. The origin of academic entrepreneurship in Hungary is rather different. It emerged under the pressure of falling budgets, in response to the problems of an industry with a low technical level, struggling in a shortage economy, and facing weak incentives for innovation.

Academic research was institutionally isolated from industry and fairly generously funded from the central budget till the late 1960s. But even under these relatively good funding conditions, many people in the applied sciences developed a professional interest in implementing research results in, or working with, industry. The policy orientation and funding conditions then changed, as Hungary introduced the New Economic Mechanism (NEM) in 1968, with a view to linking the research sector to industry through contract research. The impact of this on the academic side was much more noticeable than on the industrial. The research organisation became much more dependent on the industrial partner, because it was more dependent on income gained from working with that partner. In the context of what remained a socialist system and a shortage economy (Balázs, 1993), however, industry still felt only weak incentives to invest in innovation. The gap between academia and

industry tended to widen, which forced the research sector to look for new ways of developing its business. Let us pause to tease out this story in some detail.

There was no high tech industry as such in Hungary, so typical industrial partners came from traditional sectors working with mature technologies - manufacturing units which saw no real need for R&D. However these units were aware that they needed help to open up bottlenecks in manufacturing, and with technical breakdowns and quality problems in raw materials or components from suppliers. Technical difficulties such as these could outgrow the problem-solving ability of local engineers. So although the research sector was designed to supply advanced scientific results, what industrial enterprises typically looked to that sector to provide was something of a very different nature indeed.

In market economies, management is responsible for market strategy and incremental innovation. However, under central planning (and even under the NEM), technical development was managed through large, discrete lumps of investment. Moreover, in the Hungarian economic literature investment by itself tended to be seen as the main factor of economic growth, while technical development was neglected, being viewed as the business of engineers and of technical staffs. The firm as an executive body is in these circumstances best understood as a manufacturing unit without a management function. Thus in between the discrete investments the firm simply kept the new technology running and sought solutions to any emerging technical problems. But there was no incentive, and equally no capability, to upgrade technology incrementally. Thus not only was the in-house R&D capacity missing, as many studies on Eastern Europe have pointed out (Pavitt, 1987, 1995), but there was no management function either. What this meant in terms of relationships with the research sector was that the content of the 'research contract' could not grow out of any 'innovation strategy' but only out of everyday technical problems as described above. The restricted, 'executive' character of the firm explains why it was so difficult to bring in any new technology except as embodied in the big investments, why the firm was such a poor learning organisation and teaching object.

These potential industrial partners defined the character of academy-industry relations. Elsewhere I have analysed the relationship thus forged, and its impact on the business activity of the research institutes and universities (Balázs, 1993), describing typical 'quasi-entrepreneurial' activities like industrial contracts (of the particular nature described above), in-house production and provision of services. Here I would like to focus on the *content* of these activities, to see if we can learn about the capabilities accumulated through them.

Industrial contracts or contract research represent a broad category, which can cover several different sort of activities with differing content. However, there *are* common elements, in terms of managing the contract, building the relationship with the firms concerned, using formal and informal channels to achieve given goals. Now in the past the management function was as much a black hole in academia as it was in industry. So moving into the contract business involved a learning process on contract conditions, the legal framework, financial management, cost accounting, and profit maximisation. It also involved searching for industrial partners, recognising 'market' opportunities based partly on informal contacts (like common university background, etc) or on official channels. It required a lot of effort in terms of learning about the relevant industrial sector, about its technical level, manufacturing structure, about the firms operating in it, and about who, within a given firm, you had to negotiate with. Even just the *preparation* of a contract led to the accumulation of a particular kind of local knowledge.

The content of contracts aimed at providing limited technical help to firms could be of two types. One type was connected to the investment process, and took the form of technical advice on selection of equipment, purchase and start-up of the new production process. This kind of advice frequently extended to overcoming bottlenecks and making quality improvements before the new equipment was even on stream.[3] The second type of contract related to problem-solving as such, coping with technical difficulties, managing bottlenecks

[3]Typically the firm did not purchase every element of the given technology, or else they forgot about some 'unimportant' details (to save money!) which caused serious difficulties at the implementation stage .

and transforming inappropriate components or raw materials into something that would fit the production process. This kind of problem-solving required technical knowledge and sometimes applied research. Further, the academic partner always had to be well informed about the organisation of manufacturing and the technical details of the whole production process in the given case. The industrial experience thus gained predicated the accumulation of large amounts of tacit knowledge on technical and managerial details.

This pattern of development also created opportunities for the academic entrepreneur to *sell the same thing twice.* Under cover of contract research to solve the specific problems of a new industrial customer they could apply a particular technology - for example a piece of process control equipment - to a different industry. In this way the university or institute turned into small-scale agents of technical diffusion. Such *specialised supplier* applications, together with the development of research equipment in a closed economy with limited import possibilities, spawned opportunities to start small series *production* in the university or institute laboratory.[4] Manufacturing activity sometimes grew beyond laboratory scale, and there have been several examples of production units in universities' or research institutes' sites.

Two type of production outcome can be distinguished here. One is *commercialisation* of research or development. After unsuccessful attempts to find an industrial partner for manufacturing, the laboratory itself starts the process. That in turn involves adding the further functions of marketing and distribution. The other main form of in-house manufacturing was based on *imitation* of Western technology. The most characteristic example was computer production for the CMEA market. Imitation of various devices and pieces of equipment typically started off with an attempt simply to understand the device - taking it apart and learning about its operation so as to design and adapt technology for production. Imitation requires an analytic approach on the cognitive level and a high level of imagination in design.

[4]I did a case study in the early 1980s on industrial contracts at the Isotope Research Institute. They developed and produced equipment for process control which was applicable alike in sugar plants, milk processing plants and steel mills.

And while production based on imitation always lags behind the technical level of the world market, the CMEA had a large, closed, and undemanding market which was happy to absorb good imitations. This kind of manufacturing and distribution required a certain knowledge of Western technology, the ability to understand, translate and transfer. It was a form of technology transfer from Western to Eastern Europe. From these two forms of experience and capability development the research institute gained knowledge in manufacturing, in work organisation, in co-operation between R&D unit and production, and in market operations. It also built distribution networks, and learned to work with trading companies and to deal with exporting.

A trade in *services* evolved from the possession of special research equipment, particularly where it was expensive or unique. Much of this special equipment could be used in testing or measuring for industrial purposes, or leased out to other research institutes, etc. The utilisation of equipment in this way developed under financial pressure to make income. But provision of services in this way also generated channels for research expertise, which allowed consultancy and technical assistance to develop. Management of services, like other forms of quasi-entrepreneurial activity, built up management skills, knowledge of work organisation, marketing, contracting, pricing and so on. Through servicing there developed an information exchange between academia and industry on data availability, personal contacts, and potential knowledge requirements.

I see all these pre-transition, non-research, income-making activities at universities and research institutes as factors enabling research groups and research managers to move into knowledge-based business, once it was allowed to emerge as a fully-fledged, 'normal' activity.

4 Formation of Small Firms In and Around Academia

Financial pressures grew enormously in the early 1990s. Research funding from the state budget fall dramatically and industrial expenditure on R&D dropped to zero. At the same it became legally easy and cheap to set up new firms. There was no required minimum capital for start-ups. The firm as an organisational form offered advantages in terms of taxation and social insurance costs. It was a natural and evolutionary response to financial pressure for researchers and research groups who already had some kind of business experience. Second or third jobs became general in the public sector. They supplemented incomes which were falling in real terms owing to a combination of loss of markets, falling levels of funding and inflation. In this section I describe some patterns of firm formation and of firm activity,[5] with a view to providing some empirical evidence to serve as a basis for developing the research framework further and establishing a taxonomy of evaluation.

There have been two main routes of firm formation - as proposed by institute management (top-down), or as initiated by individuals or small groups (bottom-up).

Examples of top-down initiative: Formation of firms out of research institutes could be part of an organisational reform initiated by top management. The manufacturing and production capacities which had been built up under the old system lost their domestic and CMEA markets in the changing environment. Manufacturing capacities and related capabilities *had* to be re-evaluated and restructured since they threatened to become a source of net cost rather than net profit for the research organisation. One possible way forward was 'privatisation' - to shift these activities into small firms. In the Central Institute of Physics, for example, business-oriented units were offered the option of setting up small firms as limited liability companies. The new firm manager (the former research unit leader) typically invested 2 per cent of the starting capital. Buildings and machinery were not transferred to the firms, but

[5]The following is an extract from the paper "Small firms in and around Academia".

they could rent them. In this way, a dozen or so firms were founded within the framework of the 'Innovation Holding Company', which remained the property of the research institute.

SMEs created on this pattern vary widely in terms of their origin, strategy, potential market and future. The ones with the most difficult beginnings and most uncertain futures originated either from the former equipment manufacture and service sector, or were set up for a particular project, viz.-

Groups of *skilled workers with tacit knowledge on specialised equipment use*, who were forced to operate as a firm if they wanted to keep their jobs. They had always worked for research institutes, and their hope for the future was linked to new international projects and investments, such as might increase the demand for improved equipment, nested in these institutes. Their business prospects were closely tied in with those of the research sector.

Then there were *'single project firms'*, using the special expertise gained on a particular co-operation deal with the Soviet Union to take over an old contract. With income uncertain and the knowledge involved narrowly specialised, the dependence of single project firms on the research institute also remained high.

Some new firms took over a former *research assessment* function (like laboratory service and development) and acquired the legal right to work for outside orders. This is just a new organisational form, since the main partner is still the institute to which they are attached. The dependence of these firms on their institute does, in fact, then to increase as the local market shrinks, and research assessment firms are unlikely to be able to buy out the equipment they need to become independent.

Firms spun off from the Computer Research Institute face a more promising future, but they also vary widely in profile. There are firms specialising in *technology assessment*, in *software and system development application*, and in hardware *distribution and trading*. The activities

of these firms are mainly connected with advanced computer technology, adaptation and services. Their main markets are in the public services, and they combine trade and distribution with adaptation, upgrading and development. Computer spin-offs have real growth potential in relation to niche markets.

The most promising firms are driven by *new products* which have emerged from research programmes initiated under the old system. The two outstanding examples are in computer hardware development, and these may bring world market success in the long run. They combine features of spin-off with features of business incubation.

There are also examples of a more *flexible top-down approach*. The management of one research institute introduced new management practices in the form of strict internal accounting and costing. They also developed special arrangements for the different parts of the institute, according to the type of activity - academic research, applied/contract research or information services. Researchers were invited to join the different divisions by application. They were also given the opportunity to set up firms with the institute's support. Within this context, I identified three main types of firm:

The first type is spun off on the basis of accumulated expertise and potential market. These spin-offs set up their offices in the next street to the institute and maintain their professional links with it. They work for a foreign partner on development projects which increasingly involve *local distribution* of the partner's products in computer technology. They tend to evolve into joint ventures, exploiting local industrial contacts, expertise and capacity to *adapt.*

The second type is in software development, based on old research projects which have been developed into *contracts*. These spin-offs maintain close contact with the research departments they have spun off from, with some of the employees even keeping their jobs in research. However there is a clear dividing line between research and business. Within this framework, the institute has even hired research staff to solve particular problems. A new and

growing element within the activity of this kind of firm is trading in hardware and teaching people how to use software.

The third type is also legally a spin-off. In practice it is a quasi-firm. The business here is also contract research, problem solving and software development. Here there is only a manager and one partner/employee, who bring in the projects and hire staff from the institute to carry them out as and when required. Sometimes the project goes to the institute, sometimes to the firm. Thus the two live in a flexible, symbiotic relationship.

Example of the bottom-up approach: Researchers and university lecturers have taken advantage of the new opportunities to set up firms in great numbers. The shrinking of the old market for contract research meant no more big projects, but plenty of small projects, often of a new type. The main motivation to start up a small firm is the low level of university salaries and general financial pressures. Running a little firm promised more flexibility and a better standard of living. Most of these firms at first just continued with the old style of R&D activity, either diverting contracts from the department into the private sector or sharing the project out between the university and the new firm. The creation of firms has been semi-surreptitious at the universities. However many of them have risen impressively to the new challenges. Let us look more closely at three types of university entrepreneurship.

Contract research can still provide a basis for business. The business is now, however, not with Hungarian organisations, but rather with *foreign partners* - for western universities or industrial research units. Having advanced laboratories and high quality staff, Hungarian university personnel are in a position to offer low-cost subcontracting. They pick up this kind of international co-operation work on the basis of their university background (up-to-date knowledge) and their industrial experience (their experience in imitation-based innovation honed their ability to understand the technology and develop it).

Previous industrial contact forms the basis for creating firms in the realm of *consultancy and technical advice*. University departments have particular local sectoral knowledge flowing from the expertise they accumulated through supporting investment and providing technical assistance in the past. The process of industrial restructuring obviously raises new technical and business development questions. At the same time foreign direct investors need local advisers, and people of university background and experience may be ideally suited to the job. Many consultancy and technology assessment firms operate in symbiosis with a university department. Tasks and income are shared out on the basis of what is best from a business point of view.

Professional knowledge qualifies group of researchers to *work for foreign firms or multinationals as local distributors.* The examples I gathered came from manufacturing industry and computer technology. In both cases the creation of firms gave them a flexibility and independence in doing business, while the university background was important in terms of providing credentials to the foreign partner. In both sectors the business is managed through the firm, but the new technology is used in education too.

These examples show that academic entrepreneurship and the creation of academic-based firms:

- evolved under financial pressures and in response to changing market opportunities
- evolved from previous practice and accumulated expertise
- was based on academic knowledge and ties to the 'knowledge base'
- was also based on local knowledge (both professional and informal links)
- plays a knowledge and expertise transfer role, from universities and from abroad to industry.

5 Framework and Taxonomy Building

The above case-studies demonstrate the rich texture of academic entrepreneurship in Hungary, and may reflect a pattern more widely distributed in Central and Eastern Europe. If we are to identify their exact nature and function, we must develop a framework within which we can classify firm types and set up criteria and a taxonomy which will enable us to evaluate the impact of those firm types.

5.1 Conditions of firm formation[6]

Economic climate: The economic climate has changed in this period of transition to one pregnant with uncertainty and economic crisis, and characterised by falling levels of GDP and shrinking markets. Public expenditure has been cut back, and this has greatly increased financial pressure on research organisations. At the same time the economy has opened up, and imported goods have generated much stronger competition in technology and in science-based commodities. The emerging market economy has provided new opportunities and challenges. Foreign investors and business partners have entered the Hungarian market. It has become easier to found firms.

Demand and market conditions: Demand for old products and for the old kind of contract research has contracted or disappeared. The large but undemanding market of the CMEA days has been replaced by a much more competitive one. On the other hand customers are typically still not very sophisticated or demanding. New small and medium-sized firms are looking for a way to enter the market and stabilise their position. The pattern of demand for

[6]I apply here a framework, developed in the literature, which has grown out of the evaluation of the 'key stories' of the creation of spin-off firms, viz.- the classical examples from the 1970s of microelectronics spin-offs in Silicon Valley, California and on Route 128, Boston. (Debackere *et al* (1991), Jawitt (1991), Joseph (1994), Stankiewicz (1994b) Massey, Quintas and Wield, (1992)). This pattern of exceptional regional economic success is used here for as a basis for evaluating set-up conditions for firms. The framework enables us to make comparisons of economic and social background, though it is not complete enough to make a definitive evaluation of the economic and social impact of academic entrepreneurship in Hungary, or indeed in Central-East Europe as a whole.

research or academic expertise is changing. New streams of investment and foreign partners impose new requirements.

Existence of a knowledge base: Hungarian research organisations have inherited some faculties, departments and disciplines which could be seen as constituting an 'outstanding research base'. However, these have no direct contact with industry, and have played no significant role in the creation of firms. Firm formation is *not* at the high-tech end of the innovation chain. Nevertheless the knowledge base, emanating from the research institute and university background, has been extremely important in the pattern of founding and operating firms. It has been a source of experience in the past. It is a source of knowledge and of information in the present. It provides the basis of professional credentials, and also of professional contacts.

Availability of qualified labour: Academic spin-off firms are set up by former or still active academics - but they also employ staff of research institutes and universities. Against a background of economic decline and financial pressure, spin-offs have helped to reabsorb qualified labour that was idle (like the skilled workers at the Institute of Physics) or in receipt of only a very low income. Thus firms have been set up to utilise available human capacity. They provide jobs or second jobs - for survival or to improve living standards. However, small firms can also tap the more general human resources of academia, and hire staff (including those already fully employed and/or adequately remunerated) for particular tasks. Academia provides a big pool of labour that can be recruited for either permanent or short-term jobs.

Communications and transportation: Information technology has, of course, changed the picture here quite dramatically since the 1970s. Academic organisations have a latecomer advantage in Hungary as far as communications networks are concerned. The computer base that has been installed is young and technically advanced, thanks to the enlightened information policy of the Academy of Sciences. The academic network links organisations to

each other and to the international networks. Computer literacy is high (not only within the research sector). Information technology and its application has become an important source of knowledge acquisition. Academia is better off in computers and information technology than industry, and this is also an important factor of business opportunity.[7] Transportation is neither a real problem nor a real advantage. Academic locations are in the capital or in local centres.

Business culture: There is a particular cultural factor of entrepreneurship in Hungary.[8] The market mechanism and the idea of profit maximising behaviour is not alien to Hungarians. Under the old system, there were opportunities for people to gain experiences of self-management. Small working units within state owned companies, and also in the public sector, operated after working hours on a semi-private basis (*gmk*). However the combination of 'socialist ethics' and private interest had a somewhat perverse impact. It encouraged rent-seeking behaviour, and the avoidance of co-operation and responsibility. This approach looks for easy success in the short term, and ignores opportunities which could develop on the basis of trust and loyalty. As well as being rent-seeking, this primitive entrepreneurial mind-set tends to try to milk the public sector, and to avoid paying tax and social insurance contributions. One of the factors behind the fact of rapid growth in the creation of new firms is this social 'fashion' for cheating the state. Sometimes the founding of a firm is motivated primarily by the quest for a 'legitimate' cover to avoid income tax and social insurance. An important research question for the future is: to what extent do spin-off firms represent real academic entrepreneurship, to what extent simply a stratagem for tax avoidance?

Business environment: The business environment has been changing, and the pattern of change has itself become a factor of uncertainty. The business environment is immature, with

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[7]The telecommunications situation is much less satisfactory. The big jump in development only began in 1995.

[8]Although Hungary has had more experience of market behaviour then other post-socialist countries I believe there are common themes in a common past. In the centrally planed system, informal relations and personal 'trickiness' had a significant role in managing everyday life. The question is: are these 'skills' transformable into trustworthy business management routines, or do they simply lead to black market behaviour?

an underdeveloped and unreliable banking system. The interest rate is so high that most small firms cannot afford loans. Avoiding loans is not risk-averse behaviour, but rather just a way of staying out of trouble. Rates of profit are lower than interest rates. Banks in any case do not know how to evaluate business profitability properly. Banking is weak on the money transfer function, which creates masses of problems for small businesses. Development of Information technology on the one hand, and economic stabilisation on the other, are, however, gradually improving the business environment. The Hungarian forint has been fully convertible since January 1996. Finally, small businesses can apply to a number of support schemes.

We can sum up the conditions for forming new firms in tabular form thus:

economic climate	decline, crisis, falling public expenditure
demand and market conditions:	contracting, changing pattern of demand
existence of knowledge base	yes
availability of qualified labour:	yes
communications and transportation:	good
business culture	(*sui generis*) improving
business environment	in early stages of development and improving

5.2 Reasons for creating firms

There are reasons for firm formation which are common to academic entrepreneurs and other small firms. There are the *push factors* (Gibb, 1993): growth of unemployment (Meager, 1992), uncertainties in the labour market, including lowering the opportunity cost of self - employment (Grabowski and Kulawczuk, 1992), and the inadequate salaries of many (Galasi and Sziraczki, 1992). On the *pull side* there is: growing imbalance between the demand and supply side of the economy (Scheinberg and Alange, 1991) - which has been affecting research organisations for a long time; low rates of value added, but at the same time plenty of

opportunities (Charap, 1992); and the privatisation process (Piasecki, 1991), in particular small business privatisation, which has been the most successful kind of privatisation. In parallel with privatisation has also gone restructuring and reorganisation on the one hand, and successful restitution of private property on the other. In this way family companies could start or restart, or could make their property available for leasing by other small firms.

Formation of firms in and around academia is also related to specific factors like: organisational restructuring, defending professional status and links with the parent research organisation, and exploiting accumulated expertise. Since there is no market for contract research, the academy-industry link is weak. So the 'research units' set up their own industry, and link themselves in with it. There are various motivations for academic firm formation: forced (restructuring of the research organisation forces units to leave), management-initiated (firm formation is offered and supported), spontaneous (taking advantage of opportunities). These motivations can be shared between entrepreneurs and the given research organisation (when it is part of a co-ordinated action), individual (independent from the academic organisation), or surreptitious (semi- legal).

The table below summarises these factors and motivations:

	Small firms (general)	*Academic spin-offs (specific)*
Push factors	unemployment uncertainties in the labour market inadequate salaries	falling public expenditure loss of former partners organisational restructuring no demand for research
Pull factors	imbalances of demand and supply market opportunities privatisation	opportunity to defend human capacity new foreign and domestic partners exploitation of accumulated expertise demand for advice and consultancy
Motivations		forced / initiated / spontaneous common / individual / surreptitious

5.3 Factors of 'success'

Continuing the comparison of Hungarian academic entrepreneurs with the 'key stories' of spin-off firms, we have to understand that success is defined differently in Central and Eastern Europe from elsewhere. Success is stability and continuity but not, as yet, growth. Hungarian firms are mainly not high-technology firms. But they *are* based on academic knowledge. My pilot study suggests that they are not going to grow, but rather try to maintain their position in the market, while remaining close to the research sector. In the 'key stories', and in the wider science park literature, the main criterion of evaluation comes down to two knowledge transfer mechanisms: from academia to industry through creation of new firms on the one hand, and through the R&D links between academia and the new-born firms on the other. It is clear that academics leaving their former organisations take their knowledge with them into the industry where they are going to operate. Thus the effectiveness of the first of these knowledge transfer mechanisms above has been generally confirmed by my research. The second, however, has been thrown into doubt, by my research and also more widely in the science park literature. Maintaining R&D links after separation has definitely been problematic.[9]

The role of the small Hungarian firms studied in 'knowledge' transfer is nonetheless significant, and particularly important in relation to potential economic impact. I place 'knowledge' in quotation marks, because I believe that what they transfer is not pure scientific or technical knowledge. *The knowledge they trade in is gathered from their scientific background, their technical expertise and their experience, and we have to explore all the aspects of this knowledge if we are to understand the full market potential of these businesses.* In the rest of this paper, I try to go beyond 'knowledge', and to analyse the content of the notion of knowledge in relation to the role spin-off firms have played in linking academia and industry.

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[9]I consider here only spin-off firms. I am aware that many of the firms established in science parks are not really academic spin-offs. The argument about the weakness of firm-university links obviously applies *a fortiori* to them.

In the regional context, the economic impact of the founding of firms is the creation of markets. New firms generate demand for components, and for labour, by creating new jobs. Demand for components is important for manufacturing firms. Job creation has had a rather specific meaning in the Hungarian context. The creation of firms has defended jobs as much as it has created entirely new ones. Researchers and university lecturers set up firms to keep themselves close to the research sector. *Managing part of their professional activity through firms enables them to maintain their university base as well*.

We cam summarise factors of success thus:

technology	not high-tech.
growth	no (just existence)
knowledge transfer through creation of firms	yes
through R&D links	yes: 'knowledge'
demand creation	limited
employment creation	defensive, oriented to income creation

5.4 Types of academic spin-off firm

We are now in a position to take a more analytical view of the taxonomy of academic spin-offs, viz:

Mode of operation: As we saw on the basis of the pilot study, entrepreneurial opportunity for these firms is based on previous experience in research, on industrial contracts and on available complementary assets. The case studies showed, in turn, two main pathways of development: one group of firms growing out of activities pursued under the old system (like production or contract research); and the other group taking advantage of new opportunities (eg, multinationals, new markets). We now review, in tabular form, the activity matrix that emerges from these elements:

type of activity:	*based on:*
• production	skilled workers inherited manufacturing capacity development
• technology assessment	contracts under the old system previous experience of advisory work
• trading	local knowledge up-to-date information image, university background
• software development	experience, development, professional relations under the old system
• services	equipment, expertise
• expert assessment	local knowledge knowledge of knowledge
• contract research (for foreign clients)	professional contacts, credentials (from research and imitation)
• private teaching	university background

Firms may, of course, pursue more than one kind of activity. We have had examples of combined development and teaching, trade and services. In effect, as argued by Stankiewicz (1986;1994; forthcoming), firms operate in one of the following modes - or in two or three simultaneously.

- Consultancy and R&D contracting mode (CC)

  Consultancies which sell problem-solving capabilities; service companies which perform specific technical functions based on their special skills and/or access to unique equipment; customising vendors who develop new, client-specific applications of existing equipment; R&D contractors

CC mode is widespread at Western universities, and many of the Hungarian firms studied also operate in this mode. They take a common approach in exploiting competence and highly specific expertise.

- Product-oriented mode (PO)

These firms are organised around a new product, and the manufacturing and marketing thereof. This type is the most widely studied and analysed in the West, because it plays a dominating role in some high-tech industries. As of the late 1980s, however, only a few academic spin-offs were highly successful with hard products (Olofson and Wahlbin, 1993). Where Western university firms have been successful is in production of laboratory instruments, other specialist equipment, sophisticated components and computer software. The Hungarian experience is very similar, though here the 'new' product may still reflect the 'old' innovation model (owing to a failure to upgrade.)

- Technology assessment mode (TA)

These firms deal with technologies which are already commercialised (through spin-off companies, licensing, joint ventures or other type of alliance). Activities include establishment of intellectual property rights, identification or even creation of markets for technological assets, and in some cases development of the technology to the point where the market value is optimal. It is difficult to identify the TA mode among Hungarian firms; however, identification or even creation of market is becoming increasingly relevant. Firms distributing foreign technology (software or CNC machinery) identify and create the market, and may also offer particular services in relation to the adaptation and development of technology.

There are other differences between firms which reflect the dynamics of the technology they operate. Disciplinary or sectoral differences can also flow from the vintage of the given technology, its appropriability, the length of the development cycle and the position of the firm within that cycle. Disciplinary and sectoral differences are important factors in the taxonomy which we need to develop. At this stage, I see the firms I studied all playing rather similar roles in knowledge transfer - because they are not at the high-tech end of the product

cycle (even in computing sciences), and despite their sectoral specialisations (there is, of course, an obvious difference between, for example, chemistry and computer sciences).

Relationship to the research organisation - location: We can identify three main types of relationship between firms and their 'parent' research organisation. There are firms which have spun off and left, establishing an independent business and moving on to a new market. These may still settle in a nearby location - although of course in Hungary everything is nearby by wider European standards. Firms created under a compulsory research institute initiative were initially set up in the same location; but the more successful ones left later. There are also symbiotic firms which are legally independent but stay physically on the premises of the research organisation. This strategy gives them an advantage in cooperation, in hiring staff and in tapping into new knowledge. The third form of academic firm is covert. It is essentially complementary to university or research institute activity in terms of providing substitute income on the one hand, and supporting education by bringing in up-to-date technology on the other. The covert firm may be located inside or outside the parent institution.

Independent spin-offs are generally run by former academics, while many of the entrepreneurs at the symbiotic type keep a job in academia too. The firms I identify as covert are run by active academics.

Location of spin-offs by type of firm and type of entrepreneur

type of spin-off firm ⇒	independent	symbiotic	covert
type of entrepreneur ⇓			
former academic	out /close	in house	
active academic		in house	out / in house

Linking function: Academic entrepreneurs by definition link the 'knowledge base' and industry. However it is the efficiency and content of the knowledge flow that determine the potential economic impact. The knowledge transfer function is mainly understood in terms of linking university to industry so as to transfer R&D. Our Hungarian pilot study suggests that we should take a wider approach. Our academic firms have contacts with: other domestic firms (customers), academia (their 'mother' organisations), foreign firms (business partners, suppliers) and foreign universities (research contracts).

Academic entrepreneurs are in a special position because of their university or research institute background. As lecturers or researchers they should possess up-to-date, state-of-the-art knowledge of science and technology. (While the standards of universities and research institutes vary, both the university mission and scientific competition push them in this direction.) They have access to a pool of accumulated knowledge, and the knowledge of how to fish in this pool, and how to hook out information (ie, they have 'knowledge of knowledge', as defined in Gibbons & Johnston 1974, Faulkner 1995). Their academic background also confers professional status and legitimacy, which in turn provides them with credentials as academic entrepreneurs too (a palpable competitive advantage in being selected for collaboration by potential foreign partners).

Just as entrepreneurship grows out of previous industrial contacts and experience, so academic small firms (especially those operating in CC mode) acquire special local knowledge in the course of doing business. Working with industry on technical problems relating either to investment or to technical breakdown, they get to know the sector, its companies, their management and organisation, production processes, technology, machinery and so on. Thus they know the people and the technical/technological 'map' of the country. This is a sort of local network with industry which provides an invaluable set of conduits for the circulation of knowledge.

It is academic credentials and local knowledge that attracts local and foreign partners to do business with academic spin-offs. Domestic firms trust their ability to assess knowledge from the academic pool or find new sources. They can rely implicitly on the information they provide, and on their expert advice. The academic background and industrial experience of the spin-offs also enables them to find new business partners for their customers.

Professional credentials apart, it is the local industrial links that are particularly valuable for foreign partners. This is what they are looking for - reliable professionals who know how to operate on the local market. There are several examples of high-tech product distributors among the academic spin-offs (software, hardware, CNC machinery), and also a number of advisers to foreign direct investment. In both cases they require this 'double' orientation.

Academic firms link foreign partners to academia and to local industry. They also link local firms to the pool of academic knowledge and to the world market. Directly or indirectly, their business activity plays a significant role in distributing information through formal and informal linkages. As under socialism, academic entrepreneurs play an important role in technology transfer, from academia to industry and from the world market to the local market. In this exchange, academic firms also gain by accessing up-to-date technical knowledge and equipment which can then be used in educational activities. The table below summarises this pattern of linkage.

LINKS forged by academic SMEs:

local firm	⇒	knowledge pool		
local firm	⇒	foreign technology		
		local knowledge pool	⇐	foreign firm
		local firm	⇐	foreign firm
local market		**⇐ SME ⇒**		**world market**

5.5 Knowledge flows

There is a growing concern in the science and technology literature with the understanding of knowledge flows between firms, and between academia and industry. 'Knowledge' has been understood as R&D or scientific knowledge and 'flow' as from academia to industry. However R&D knowledge is itself complex. Faulkner and Senker (1995) have explored the content of knowledge flow between private sector and public research organisations. They have developed a sophisticated taxonomy of types of knowledge used in innovation and transferred between firms and public research organisations. Faulkner (1995) provides a literature review of previous research on the categorisation of knowledge used in innovation. Like Gibbons and Johnston (1974), Faulkner and Senker start with an attempt to characterise all the *scientific and technological* inputs into innovation.

The categorisation of knowledge and analysis of the different types that emerge helps us to understand both the 'knowledge flow' between firms and public research organisations and the interest both partners have in co-operating. This approach is equally germane to the understanding of the links between academic entrepreneurs and their customers. Knowledge is the 'product' they sell directly, or in the form of value added to the product they distribute. Our empirical study of Hungarian research organisation and academic spin-offs provides a basis for categorising the 'knowledge' these particular firms dispose of, and which enables the academics concerned to become entrepreneurs. This knowledge is *not only scientific or technological knowledge but also managerial and business knowledge*. I go on now to explore the knowledge categories which emerge from my empirical study, in the light of the other research results cited above.

Knowledge related to scientific research and teaching:

- scientific knowledge of the research field,
- information on scientific sources (literature)

- knowledge of other researchers working in the field (knowledge of people)
- knowledge of existing research equipment, laboratories (knowledge of capacities)

Skills related to research:

Managing knowledge flows:

- organising knowledge
- accessing and acquiring knowledge
- searching for information
- transferring knowledge from other sources
- interpreting knowledge from the literature
- identifying and understanding problems

Managing research:

- managing co-operation, linking up people
- organising research
- raising funds through competitive application (focusing on problems)
- taking part in scientific competition (competitive approach in relation to scientific activity itself)

Doing research:

- operating research equipment
- designing and building research equipment
- testing and experimenting on research products

Knowledge related to research contracts and the business environment:

- knowledge of the local market
- knowledge of firms (partners)

    - as organisations (management)
    - as production processes, involving technical details
- knowledge of people (managers, technical professionals)
- knowledge of other contact persons (civil servants)
- knowledge of the legislative and regulatory framework
- knowledge of world market (foreign firms)

Skills relating to research contracts and doing business:

- identifying potential partners
- managing the building of contacts
- developing contracts and frameworks for co-operation
- cost accounting, labour management
- division of labour within the group (or firm)
- management of job specifications

This categorisation illustrates:

- how knowledge and skills, accumulated through research and teaching, have become important in business. (Examples of comparative advantage over non-academic SMEs include: experience of competitive application for funding; and knowledge of knowledge (skills in searching, identification, transferring knowledge and translating it from one context to another).)[10]

- how scientific, technological and business knowledge is interwoven. This interweaving has two aspects: through research management, academics acquire capabilities which are

[10] The academic and the entrepreneurial cultures are, of course, quite different. The literature on spin-off firms and science parks highlights the clash between academic and entrepreneurial cultures as one of the main barriers to spinning off. In the Central and East European context, I would argue that the case is quite different. Here, academic entrepreneurs really do possess accumulated entrepreneurial skills, in function of their different economic and social experience in past and present.

also useful in business; and they learn more about business management and the technological end of the scientific spectrum as they move into the market. (Note again the strong comparative advantage vis-à-vis non-academic SMEs.)

- how academics and small firms accumulate knowledge as *individuals* and as *organisations*. Most elements of scientific and technical knowledge can be considered to be essentially individual, while business-related knowledge is more organisational.

- how a great part of the knowledge academic entrepreneurship is based on is tacit knowledge. Scientific and technological knowledge itself is, of course, both codified and tacit - as analysed in the literature (Faulkner, Senker). In our research, the distinction between codified and tacit knowledge is important, because codified scientific and technological knowledge is what academic firms help to transfer from outside sources. However a large part of the capabilities of these firms, in terms of both the research-oriented and business-oriented knowledge they have accumulated through experience, is tacit, on both individual and organisational levels, ie, it consists of:

- knowledge of knowledge
- knowledge of people (informal contacts)
- organisational knowledge
- market, partners, firms (who's who)
- technical knowledge (history of particular pieces of equipment)

The table below summarises the categories and forms of knowledge to be transferred:

formal & informal	
codified & tacit	scientific & technical
complex & simple	business & managerial
general & specific	

6 Conclusions and Signposts for Further Research

My research has focused strongly on academic-entrepreneurial capabilities, with a view to understanding their potential economic impact. Academic-entrepreneurial capabilities have been built up from previous experience in the public sector, in terms of what I call 'quasi-entrepreneurship'. The study of this background provides insights into the process whereby small firms spin off from academia as a response to economic crisis and financial pressures. The academic entrepreneur I described is the modal type. However I believe we may find other types as well. There may be small firms which spin off in a more progressive way, and capture a market niche within which they can grow, responding to opportunities rather than constraints. Although I do not think there are many such firms, we have to identify them. As a rule, academic spin-offs grow out of crisis and pressure; but they represent more than just a defensive strategy - they can play a new role in technology and knowledge transfer. Let me suggest some alternative analytic approaches which can help us to detect these nuances.

We have to consider *sectoral differences.* There might be sectors in particular countries which are more advanced, and which generate growth-oriented academic SMEs. However identifying such firms may not be easy, in that the sectors concerned may not be leading-edge in international terms (eg, microelectronics, biotechnology, advanced materials), but may still have a competitive advantage on the local market. In all this we do, of course, have to study not only sectoral patterns *per se*, but also the firm structure within the given sector (eg, the extent of privatisation, firm size, local networks).

Firm size does clearly matter in relation to dissemination of technology and provision of technology-oriented services. Small firms depend on external 'knowledge' sources more than large ones.(Rothwell, 1990) In addition, large firms have more contacts with public sector research. For them, in-house laboratory and contract research are complementary. Co-operative research cannot substitute for the lack of in-house R&D typical of small firms (Mowery, 1983). SMEs have no staff to identify technical problems, so they need advice in

problem-solving as well. Thus they may have to use technical consultants to find information in the scientific literature or find personal contacts, as well as using collaborative or government-supported schemes (Senker, 1994). Services for small firms address industry-wide, process-related problems - developing standards, testing, validation and technical problem-solving, as well as dissemination of new technology. The development of the small firm sector clearly means the development of a potential market for academic firms.

However I do not believe that we should focus exclusively on SMEs in the Central and East Europe context. In post-socialist conditions, *large firms and small firms may suffer from very similar problems*. On the one hand, new small and medium-sized firms born out of privatisation, restructured large firms and wholly new firms, all face the challenge of improving their position on the local - and potentially the world - market. Firms which have 'grown up' under a regime of central planning have not only to develop technical skills, but also to learn the management skills that will enable them to expand on the market. Post-central-planning firms lack in-house expertise as well as a range of management functions. As a result they may depend on external expertise much more than firms of a similar size in the developed countries. It is true that, in traditional sectors, large firms may act as brokers between the science base and their small firm suppliers (Senker, 1994). Within the region, this is a feasible pattern for both local and international companies. However, many post-socialist companies still need to learn how to operate on the market, how to search and select technology, and how to introduce it. Learning about technology and learning about the market could, indeed, be parallel processes (Hobday, 1995). Thus improvements in technological learning capacity can increase the capacity to respond to the market.

'Learning firm' and 'learning organisation' issues may open up a new research field in Central and Eastern Europe. What is clear at this stage is that there is a direct link between these issues and the question of the development of academic entrepreneurship. Since academic SMEs commercialise, transfer and sell knowledge and expertise, there is an obvious research question about their potential contribution to the learning process at firm level. Academic

spin-offs may contribute in terms not only of technical knowledge, but also of learning to manage and market as well. Matching the taxonomy of types of knowledge and skills which academic firms can provide with that of the types of knowledge and skills industrial firms need to acquire, could provide a framework for evaluation of the role of academic spin-offs, and indeed for policy articulation on a potentially crucial interface in the transition process.

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