

RESTRUCTURING OF R&D INSTITUTES IN POST-SOCIALIST ECONOMIES: EMERGING PATTERNS AND ISSUES

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INTRODUCTION

The growth prospects of individual post-socialist economies are to a great extent constrained by their ability to transform inherited technological capacities from the period of closed economy into assets in the market economy context. In terms of analysis this transformation cannot be reduced on marketisation of old capabilities. Capabilities exist in an institutional context which have to be restructured and in this process market failures become pervasive. The main locus of R&D capabilities in the socialist systems was not in industry but in the 'science and scientific services' sector or R&D institutes. The R&D system itself was over extended because of its closed character and its isolation from industry. Under the new market conditions a deep restructuring is therefore inevitable. How successfully R&D organisations restructure will have an impact on the growth prospects of many sectors and on the economy as a whole.

Elsewhere (see Radosevic, 1994, 1996) we analysed the broader facets of this process within a national systems of innovation perspective which are appearing between, on the one hand, the inevitable dismantling and restructuring of parts of the R&D, and on the other hand, the erosion of R&D capacities which would otherwise be viable in a market economy context. Here the focus is on the R&D system and especially on its main micro subject - industrial R&D institutes.

From this, still very rudimentary, analysis we try to provide answers to the following: What are the basic restructuring processes taking place in R&D institutes in economies in transition? Based on these micro processes, is it possible to envisage some nationally specific patterns of R&D restructuring? Do these restructuring processes indicate convergence with or divergence from the basic organisational features of R&D in market economies? What are the likely patterns of restructuring of academy-industry links in post-socialist economies¹?

The answers to these questions are not yet definite but we hope that at least we may have generated useful hypotheses. We argue that the transition has not brought about the integration of previously separated R&D institutes into industry, which would have been the best option from an economic point of view. Instead several other processes seem to dominate of which conversion of R&D institutes into production or service enterprises is

¹Here we use the term 'academy - industry' links which does not refer to Academy of Sciences but denotes all non 'in-house' R&D organisations.

very common. The processes involved in the transformation of R&D have generated several quite peculiar phenomena (diversification of R&D institutes, spontaneous privatisation, quasi-spin-offs) which we consider to be temporary before the systems settle within the basic features of R&D similar to those in market economies. While from the institutional side the ultimate states may appear similar, the actual transformation processes are very much nationally specific and their outcomes will have qualitatively different effects on the role of R&D in the growth of individual economies.

In the first section of the paper we set the stage for the analysis by outlining the main institutional features of the old system and, by interpreting them from an economics of R&D viewpoint. Based on several recent contributions from other colleagues, and my own research and consultancy work in eastern Europe, the different patterns in R&D restructuring and their link to micro responses are analysed. Micro adjustment processes are analysed in the third section. In the section four we evaluate the current academy-industry relations in eastern Europe as well as their likely future developments.

1. ECONOMICS OF R&D AND SOCIALIST HERITAGE IN RETROSPECT

The restructuring of R&D systems in post-socialist economies is handicapped by its past role which must be taken into account if we are to understand its current crisis. We briefly outline some of the characteristics of the Soviet R&D model which dominated, albeit to different degrees, in all countries of central and eastern Europe and the former Soviet Union. The orthodox Soviet model was transformed in the 1970s and especially in the 1980s². However, its basic features have been present throughout the socialist period.

First, the ex-socialist economy must be considered as one large complex enterprise where individual enterprises did not exist as business units but only as production units. The marketing function was dislocated to the Ministry for planning, the export function to the foreign trade organisation, the finance function to the Ministry of finance, and R&D function to R&D institutes which most often were not integrated into enterprises. Enterprises were production units with not only dislocated R&D but also engineering, design and technical problem solving activities. These, together with production of specialised parts and components, were dislocated to industrial institutes which were

²By re-organising the economy into combines (associations of vertically integrated enterprises which also include R&D institutes) an attempt was made to link R&D with the production units. Moreover, with the worsening of the economic situation R&D organisations were given independence in making contracts with other enterprises although funding was for some time still coming from the responsible ministry or from obligatory R&D expenditures imposed on enterprises. This created a technology 'quasi market' where technology assumed the role of the commodity to be exchanged on it. However, treating technology as a commodity did not solve any of the underlying structural problems of the Soviet model. In fact, the treatment of technology as a commodity which can be easily transferred into production is quite compatible with the Soviet R&D model (see Hanson and Pavitt, 1987). Combined with the lack of incentive to appropriate the results of R&D this led to technological lagging and often deterioration.

conglomerations of all these different activities. Although R&D systems in socialist economies were very much oriented towards the needs of industry they were not organisations *in* industry but *for* industry³ (see Radosevic, 1994). R&D was externalised and treated as a separate activity with enterprises seen as passive recipients of 'R&D achievements ready for implementation' previously developed by the R&D institutes⁴. The neglect of the role of enterprises as a source of technology and emphasis on extramural R&D were at the root of the problems of R&D in the socialist system.

Second, as the socialist economies were closed economies their R&D systems had to compensate for this through extensive imitative and 're-invention of the wheel' type technological effort. In addition, R&D systems were strongly oriented towards military objectives which further reduced their contribution to the economy and R&D was oversized in relation to comparative market economies. Elsewhere (Radosevic, 1995b) we show the degree to which the R&D systems in these countries were oversized in relation to comparable groups of countries. The specific economic system also influenced the type of R&D and technological effort. Product development dominated over R&D and over technological effort which focused on process technologies, cost reductions and organisational efficiency.

Third, the productivity of the R&D system, especially in civilian sectors, was very low due to weak incentives in the system and administrative co-ordination mechanisms. This was not so much the case in the military sector where technical performance was all-important and the Ministry of Defence was in control of the whole chain. However, in the civil sector the system was unable to cope with rapid changes in technology which became very obvious with the advent of microelectronics. Although R&D systems in terms of manpower and funding were in the main oriented towards industry the organisational set up and weak incentives in the system led to mainly intermediate type of R&D outputs, like technical documentation, prototypes and research. Implementation of innovations was slow and inefficient and user specifications and requirements did not play an important role. Problems in implementation were ignored and preference was given to new product developments to the stage where they were still far from being implementable.

³This distinction is important also for a further understanding of this chapter. Therefore, in the text we use the term 'industrial institutes' which is different from 'business R&D'. In this latter case these are R&D departments of industrial enterprises. Industrial institutes are independent organisations that worked for several enterprises and some of them (central industrial institutes) served whole branches.

⁴The degree of externalisation of R&D has varied widely within socialist economies. For example, the degree of externalisation of R&D in the Czech Republic was not so anomalous when this country is grouped with countries of a similar level of development. The share of R&D manpower in industry (enterprises) of 38.7% is at the bottom end when compared with the OECD countries. However, it is still above countries such as Turkey (36.2/1986), Portugal (16.6/1989), Ireland (19.5/1990), Greece (19.8/1989). The only country in the group of less developed EC countries whose share of industrial R&D personnel in total is higher than in Czech Republic is Spain (43.9/1990). The EC average is 58.0% (1989). (Source for the Czech figure is Muller, 1995; for OECD 'Main S&T Indicators 1995')

These typical features of the socialist system are currently changing as post-socialist economies progress in the development of their own specific type of market economy. Some of the basic technological features of the market economy will then apply to them as well. The most important change is the recognition that technology is a firm-specific capability embodied in organisational routines and firm competencies. Elements of technology, like patents and information, can be traded but by themselves do not ensure technological capability. Technology is irreducible to a commodity and hence there are high limits to its transferability. Historical analysis shows that R&D and technology capability grew most rapidly within the firm and to a much lesser extent in extramural institutions (independent R&D centres, universities) (Mowery, 1983). The more firms compete on the basis of their ability to innovate the more they tend to internalise R&D in order to capture the gains that accrue from innovation. The main driving forces of new eastern European capitalism, as of any other market economy, are enterprises which are the only agents able to transform technology into products (Tunzelmann, 1995). There was much technology outputs in socialist economies, especially within industrial R&D institutes, which were not transformed into products but remained in its intermediate form of design, prototypes and technical documentation. However prolific these outputs by themselves do not create technological capability which can be developed only within the enterprises. The market for many types of R&D services is relatively small and the cost of contracting in such activities rather than doing them 'in-house' are huge. This reduces the R&D services market to only those areas where R&D can be separated from production and technology. For enterprises and for the R&D sector this means a change in perspective and radical restructuring in terms of mode of operation.

On this basis we would expect that the transformation of R&D systems in post-socialist economies would develop in three directions.

First, there would be a strengthening of the 'in-house' R&D capabilities of business enterprises relative to the extramural R&D sector.

Second, we would expect a restructuring of R&D systems in terms of downsizing, and organisational restructuring and reorientation from product development toward process improvements and user requirements.

Thirdly, the opening up of the economy would lead to much R&D being displaced by foreign products and technologies. Also, this opening would reorient demand in R&D system and would bring new ways of integrating domestic R&D with foreign S&T.

2. MACRO POLICIES AND MICRO RESPONSES: SHOCK VS GRADUALISM IN R&D RESTRUCTURING IN POST-SOCIALIST ECONOMIES

In this section we analyse the interaction of micro-macro responses and how jointly they create specific national patterns of restructuring. The analysis is simplified by using a matrix involving two basic criteria: first, the features of the dual regime of operation of R&D institutes, and, second the (non)existence of active restructuring policy focused towards micro level (R&D institute) (see matrix below).

The dual regime of operation of R&D institutes in the 'gradualist' and 'shock' policy versions

R&D institutes in post-socialist economies operate under two different regimes: the market regime of direct contracts for R&D and the non-market regime of public funding for R&D. While their responses are also shaped by their internally developed strategies it is these two exogenous groups of factors that influence very much the way they adjust. (For example, Wolf (1995) in his analysis of responses of ex-institutes of eastern German Academy argues that the exogenous factors have been by far the most dominant in the restructuring outcomes of institutes.) Elements of the dual regime under which they operate are summarised in the table below.

Table 1
Elements of the dual regime of operation of RD institutes in post-socialist economies

Market for R&D contracts, services and products	Public funding of R&D
Degree of competition (monopoly vs. new domestic private and foreign competitors)	Funding criteria (project vs. institutional financing)
Structure of demand (big vs. small firms)	Evaluation procedures (peer review vs. negotiations)
Quality of demand (export vs. domestic orientation)	Budgetary conditions

Restructuring responses of R&D institutes are influenced by the tightness and stringency of these two regimes.

In an economy where foreign investments are still relatively small, like in Russia, we may expect that the degree of competition will be different from the economy which is small and very open in terms of trade and investment. Progress in privatisation changes the structure of enterprises towards smaller private enterprises which in turn alters the demand for R&D and technical services when compared with the old type of enterprises. Export sectors are often the only remaining pockets of effective demand for R&D in post-socialist economies. The structure of demand for R&D is different depending on whether exporting sectors are commodity producers or capital goods and machinery producers.

Criteria for public funding, evaluation procedures and the general budgetary conditions, strongly influence the degree to which R&D institutes are moving towards the market. In the majority of post-socialist economies, competitive bidding procedures are introduced to some degree. However, the differences between countries in this respect are noticeable. For example, in Russia, the Ukraine and Romania competitive bidding is still marginal⁵. Even though the nominal criteria may support competitive bidding there are big differences in the evaluation procedure. In some countries the system is based on peer-review with independent evaluators while in others it is still more a system of negotiation with authorities and per capita finance. Also, the budgetary positions of public R&D differ significantly depending whether there is a strong lobby for science or its power is weak and in addition the general budgetary situation (budget deficit or surplus) plays a role.

On this basis it is possible to distinguish between countries that have pursued sudden and very sharp change in the rules of public funding and those where the rules of public funding are the same as in socialist times⁶. This is especially noticeable in relation to industrial institutes where their predominantly public funding in new market conditions is considered as incompatible with market economy principles. The argument is that industrial R&D should be the responsibility of industry and should be left to the market. In economies where demand for R&D collapsed almost overnight any drastic reduction in funding for industrial R&D means, as Ivanova (1995) put it, 'shock without therapy'. Opposite to this is the gradualist policy of slow changing of public funding criteria.

Micro restructuring policies

Another important factor which determines the micro response is the existence or otherwise micro restructuring policies in the R&D system, in other words whether the responsible ministries have undertaken explicit activities on evaluation of R&D institutes and their restructuring in terms of privatisation, splitting, liquidation, or conversion. This *active* or *direct* restructuring may also involve a transformation into cost/profit centres, strategic business units or investments. In this case the restructuring organisations is explicitly addressed as a policy issue. Since almost all R&D institutes are initially under state ownership active restructuring by their nominal owner usually the State Ownership Fund, Privatisation Fund or industrial ministry or Ministry of S&T is required. Active restructuring also provides a necessary element of therapy in the new situation in which R&D institutes in these economies suddenly find themselves. If such explicit micro policy is absent institutes respond by passive adjustments some of which are discussed later on in the paper.

Passive or *indirect* restructuring is the creation of an environment in which institutes restructure themselves by submitting to hard budget constraints, and/or exposing

⁵In Russia the Foundation for Basic Research has been set up which is based on competitive bidding procedures. However, it disburses only 3% of government R&D funding. (see Ivanova, 1996.)

⁶Characteristics of different national markets for R&D should be also taken into account. However, we lack any systematic information on this.

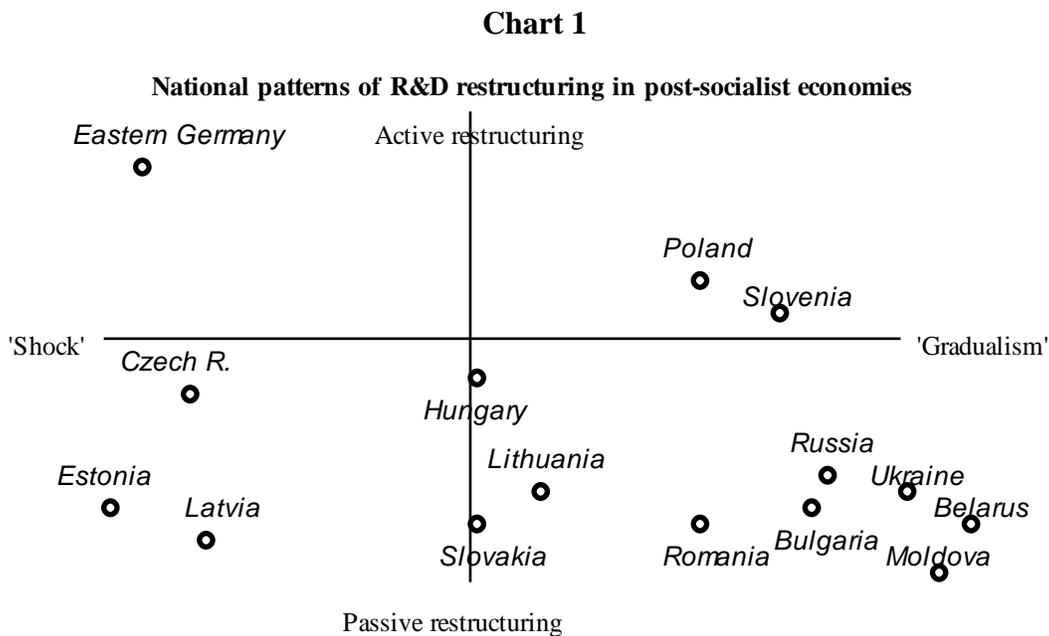
themselves to competition and to the threat of bankruptcy. In the case of R&D institutes there is ample room for this type of restructuring through making priorities in funding policy or by cutting funding for their activities.

Different national patterns of restructuring

Using these two criteria - the degree of shock or gradualism in public funding and the (non) existence of active micro restructuring policy - we can distinguish several different national situations. These are, inevitably, very rough simplifications as our objective is not to describe fully the specific national context but to illustrate the diversity of national responses and the underlying factors behind them.

(Insert matrix about here)

Contrasting national patterns of restructuring



'Shock without therapy'

The Czech government rejected any structural policy toward the microeconomic level within the R&D system (See Schneider, 1996). It abruptly withdrew financial support to the majority of industrial institutes. Since 1991, industrial companies in the Czech Republic have had to finance their R&D activities themselves. Industrial institutes suddenly lost a relatively secure income and had to find means for survival. Also, under

the process of privatisation R&D institutes were treated as 'normal' production enterprises. This 'shock therapy' led a to massive conversion of their activities to services and production.

'Shock with therapy'

Germany may seem from one perspective to be an exemplar of shock therapy in R&D taking into account the speed and scale of reduction of its eastern German R&D system. However, the analysis shows that government gave generous subsidies followed by evaluation of individual institutions on which basis they were then restructured. (see Schneider, 1995 for detailed account). Over a very short period, restructuring of all R&D institutes in eastern Germany was enabled by the available administrative capabilities and finance.

'Gradualism with some therapy'

The Polish government also pursued (or at least attempted to pursue) a policy of restructuring but in a gradual manner. It changed the principles of public funding of R&D by ranking R&D institutes based on their direct, however imperfect, individual assessment (Jasinski, 1994). However, a number of R&D institutions as well as large number of industrial institutes are still on, perhaps low, but statutory subsidies which indicate this gradualist policy (see Jablecka, 1995).

'Gradualism without therapy'

Russia and Romania are good examples of gradualism in R&D. Institutional financing in these countries is still dominant and there is no systematic policy or attempt to restructure the R&D system. In both countries the slogan of 'salvation of national science' was taken as cover for saving jobs in R&D sector⁷.

In Romania the Ministry of S&T still negotiates research 'themes' with the R&D institutes. It also has set up funding to 'transfer' the technology once it has been developed by R&D institutes. This shows that in Romania the Soviet R&D model is still present in some elements. Although in Russia the Ministry of Science and Technological Policy officially has abandoned the policy of 'science salvation' and initiated prioritisation in funding and differentiation among institutes by granting to 60 of them the status of State Scientific Centre this is still a gradual change which only prevented full erosion of these institutions (see Gaponenko, 1995).

'Shock and gradualism without therapy'

The case of Hungary does not fall clearly within our matrix as the government's inconsistent policies actually resulted in a combination of shock therapy and gradualism. By the end of the eighties institutes were operating under tight funding conditions where funding was available only through loans for innovation development and not for project funding. By 1992 Hungary began an evaluation of industrial institutes which was not followed a policy of restructuring in any systematic direction (see Mosoni-Fried, 1995;

⁷In Romania current policy of gradualism was strongly shaped by the trade union pressure and street demonstration of workers in R&D sector.

Balazs, 1994). The outcome has been deterioration and collapse of the network of industrial institutes because of prolonged and unsystematic attempts to restructure them.

Assessing national patterns

How can we evaluate these different national patterns? Are some of better than others? Which factors should be taken into account when assessing them? There are two issues which should be used as criteria in assessing these patterns.

First, countries differ significantly in their administrative capacities to implement change and especially active restructuring. Policy disasters do not come from decisions about whether to become actively involved or not but from state activities incommensurate with its implementation capacity. The problem is one of how to formulate policy commensurate with the administrative capability to implement it. For example, individual privatisation of R&D institutes means that boundaries must be drawn over which activities should be private and which public or semi-public in each particular case (Webster, 1989). This requires administrative skills beyond those available in post-socialist economies. Only the eastern German rapid restructuring of R&D was commensurate with the available administrative capacities for such change. Also, the radical reduction in financing industrial R&D in Czech Republic was commensurate with that country's low capability to implement state led restructuring policy. The gradualism of Russia and Romania requires better restructuring policy and administrative capacity to implement it than is available. In the absence of such capacity there is erosion within R&D institutes which only nominally remain institutions they used to be but in reality are often deserted. Restructuring is especially complex in the case of inter-organisational restructuring as this requires the wider consensus of several actors which is very difficult to achieve in the fluid institutional system of today in post-socialist economies. Typical are non-profit making R&D centres or research associations, which are still very rare in eastern Europe as they require the establishment of a new organisation based on consensus, and interest from several enterprises and public bodies. Only in eastern Germany was this a real option (see table 4) pursued through the Treuhandanstalt model of privatisation of R&D institutes (see Schneider, 1995). The setting up a network of R&D centres based on the Fraunhofer society model in Hungary (Zoltan Bay institutes) shows all difficulties of such institutional transformation.

Second, S&T policy practitioners often point out that the advantage of gradualism is that it enables R&D professionals to remain specialised in areas where they have developed their competencies, i.e. they do not move to non-R&D activities. Others maintain that it acts as a good subsidy until institutes can develop their own products which can be marketed and until they transform themselves into more competitive organisations. These arguments do not recognise the problem of cost-effectiveness, duration and the objectives of 'subsidy dressed' as institutional finance for R&D. The system of financing should differentiate between subsidising commercialisation of R&D results and financing R&D

projects where scientific and technological relevance should be the dominant criteria. This form of hidden subsidy for product development is not the most effective way to convert R&D institutes into production or service companies. The effect of subsidies distributed as *en bloc* institutional finance may be to destroy good research without making industrial producers or service providers competitive. Finally, the conversion into marketable products or services can be done in-house within R&D institute only in certain sectors. The most common cases in post-socialist economies are institutes in information technology which are trying to turn their R&D results in saleable customised software. However, in many other sectors R&D results cannot be converted to products within R&D institutes (as they quite simply require additional facilities and equipment) or marketable applications are not feasible due to the character of the research.

To sum up, whether policy should be in the direction of active or passive restructuring, gradual or radical reduction in public funding, should be assessed in the context of policy capability or lack of restructuring capacity. In cases where policy capability is lacking the costs of gradualism could be very high in terms of erosion of R&D and prevention of the restructuring which would otherwise have occurred. In such cases the option is rapid privatisation of industrial R&D activities. Effective policy is that which aims at supporting activities (projects) and not institutions *per se*. Too often in post-socialist economies policy makers try to pursue too many objectives with too little management capacity and finance. For example, governments like Hungarian want to only partially privatise R&D institutes in order to ensure that they retain control over their activities, but are not able to ensure that institutions retain their core activities (see Mosoni-Fried, 1995).

3. MICRO ADJUSTMENT PROCESSES

This section outlines several characteristic adjustment processes at the level of R&D institutes common to post-socialist economies. These should be seen in the context of macro policies discussed in the previous section and taking into account how these R&D institutes were organised in the socialist period.

3.1. *The emerging adjustment outcomes*

R&D institutes in the socialist period were conglomerate type of organisations which combined R&D with other activities like micro-production, services and engineering. Even if we use an example of one of the least-Soviet like R&D systems - that of ex-Yugoslavia - we still find a significant combination of R&D, production and services. For example, in Croatian R&D system in 1989 52% of total revenue was came from research, 37% from production and 11% from services (Radosevic, 1992). In other countries, where the definition of R&D was even broader, this mix was more pronounced. Such institutes which were conglomerations of different activities were a

form of organisation in the context of the socialist economy (see section 1). Their emphasis was on product development and servicing enterprises within a branch and micro-production and they compensate for the lack of specialised suppliers in the economy.

In the post-socialist period we might expect that these conglomerates will be transformed into four different types of organisation within which activities are more coherent (see table 2). This need for unbundling of R&D institutes is confirmed in the case of the institutes of the former eastern Germany Academy of which 47% had to disintegrate into separate activities (see table 3).

Table 2:
Transformation of conglomerate based industrial institutes into market-based organisational forms

Socialist R&D institutes: activities	Post-socialist transitory phenomena	Market-economy organisational forms
1. Research 2. Designs and proto-types 3. Engineering and technical services 4. S&T information 5. Micro production	- Temporary diversification - Spontaneous privatisation - Quasi-spin-offs	1. Dominantly public research institutes 2. Profit based production or service enterprise 3. R&D company 4. Non-profit R&D centre (research association) 5. Liquidation

Table 3:
Evaluation outcomes for the institutes of the ex-eastern German Academy

Outcome	Percentage
Disintegration	47%
Conversion	35%
Liquidation	10%
Integration	9%

Source: Wolf (1995)

The available, sparse evidence indicates that the most common transformation path might be the transformation of R&D institutes into manufacturing or service enterprises. Instead of relocating R&D groups to industrial enterprises, R&D institutes are turning themselves into commercially oriented enterprises not necessarily based on the old core activities.

Schneider (1994) gives figures on restructuring outcomes of industrial institutes in eastern Germany which confirm this (Table 4).

Table 3

Restructuring of 103 eastern German 'Research Plc'

	Number
Transformation into production or service enterprises through privatisation	52
R&D institute remain integrated with its now privatised mother company	1
Transformation of R&D institutes into research associations through 'Treuhandanstalt' model of privatisation (20), or into regional institutes (5)	25*
Liquidation	25

* In almost every case a commercial part had been spun off before transformation

Source: Schneider, 1995, p. 11

A very rare outcome is the integration of R&D institutes into industrial enterprises - the option which would be most favourable for technological development. Why should transformation into industrial or service enterprise be prevalent and why is integration into industrial enterprises so rare? In section 1 we pointed out that technology is a firm-specific which means that the people involved in technology oriented R&D are usually familiar with the technology and thus in the best position to develop R&D into commercial products or services. On the other hand, the problem involved in integrating externalised R&D groups that were working for industrial enterprises are a result not only of the poor financial situations of these enterprises but also of the significant change in the demand for R&D and technology which cannot be met by domestic R&D institutes. In other words, the mismatch between old supply and new demand makes massive integration of R&D groups into manufacturing enterprises unlikely. This has important implications for the nature of Academy - industry relations which we discuss in section 4.

3.2. Post-socialist transitory R&D micro phenomena

We have noted several transitory phenomena in R&D institutes which are a part and a reflection of patterns of adjustment described in the second section. These are: diversification of the activities of R&D institutes; spontaneous privatisation and, related to this the phenomenon of quasi-spin offs. This phenomenon, an adjustment response at the level of R&D institutes, should be interpreted as a manifestation of the transition crisis rather than a sustainable restructuring path.

3.2.1. Temporary diversification

The conglomerate type of R&D organisation has not totally disappeared in post-socialist economies. Further diversification of an institute's activities is a temporary strategy to overcome the enormous uncertainties and financial difficulties which it faces. This diversification, which was normal in the socialist context, today creates serious problems in managing very disparate sets of activities, with very different objectives and underlying ideologies. Institutes have become even more hybridised than during socialist times which creates huge problems in terms of their organisational coherence and especially in terms of defining organisational values, objectives, competencies and financial management. (see Radosevic, 1994).

However, the difference between the present diversification and the former socialist diversification is that today this diversification is primarily in terms of products, services and markets. In terms of technologies and competencies institutes have had to focus much more since a wide range of inherited competencies is not competitive or technologically up to date in the newly open and cost sensitive business environment. Pressure to specialise faces strategic uncertainties regarding the pace and area of specialisation. Also, today's diversification is managed quite differently. Instead of integrated and bureaucratic organisations present-day institutes are usually organised through profit/cost centres or strategic business units⁸. The scale of this reorganisation can be illustrated by the transformation of large Russian research institutes into smaller research centres leading to an increase of 36% in the number of scientific organisations within the Russian Academy of Sciences in the three years 1990-1992 (Gaponenko, 1995, p. 170).

These smaller, coherent R&D groups must take responsibility for their own survival and prosperity resulting in stream-lining of overheads, reduction in auxiliary personnel and full responsibility for technical and financial elements of contracts. The consequence is a very disparate financial situation across different groups and the appearance of a new problem: the inability of boards to strategically manage business portfolios since the possibilities for cross-subsidisation and synergies are restricted or impossible. While in the medium term cost efficiency and flexibility have improved, in the long-term the possibilities for developing a knowledge base and expanding into new areas, are limited.

With the stabilisation of their environment, diversification of R&D institutes, encompassing any production and service activity which may bring income, become an unsustainable organisational form. Newly restructured R&D organisations will be more focused or coherently diversified⁹. Their profiles should fit with one of the organisational forms in table 2.

⁸A good example of this shift is the institute in Romania visited by the author which has 400 employees and is organised into 77 profit centres which are entirely responsible for their income. This was pointed out by the director in the following way: 'I can move people among these groups but there is no way that I can move money among them'.

⁹For the notion and analysis of corporate coherence see Teece et al (1994).

3.2.2. Spontaneous privatisation by individuals

The need for researchers and engineers to survive in new conditions, combined with the poor property rights, led to different forms of spontaneous privatisation or massive implementation of individual strategies of survival which can be interpreted as spontaneous privatisation. The more uncertainty there is regarding the future status of organisations and the greater the lack of clearly defined property rights, the more widespread is spontaneous privatisation. In an analysis of spontaneous privatisation in the Russian R&D system Tambovstev (1995) shows that spontaneous privatisation is less pervasive in organisational forms with better defined property rights (joint-stock company; lease-hold) than in those in which they are poorly defined (state-owned specialised institutes and academic institutes).

In spontaneous privatisation, control rights and cash flow rights get entirely separated. Control rights are all rights about how to take decisions about using the assets. Cash flow rights are the rights to earn benefits and pay costs that result from a particular use of the asset. The ownership structure becomes inefficient when control rights are dissociated from cash flow rights. (For a discussion on this in the case of Russia see Boycko, M., A. Schleifer and R. Vishny, 1995.)

The nominal owners of R&D institutes - usually State Ownership Fund and/or Privatisation Fund(s) - decide on their control rights while the Ministry of S&T, as the major client of R&D institutes, is the main controller of their cash flow¹⁰. Control of cash flow rights is divided between the Ministry of S&T and employees where management has rights to make direct contracts on domestic market. The control rights remain with State Ownership Fund and Privatisation Fund. The longer this continues the more negative are its consequences for R&D institutes through uncertainties as to the direction of restructuring, outflow of people, etc. In the case of fast privatisation, changes in control rights would prevent the appropriation of cash flow rights.

Table 5

Percentage of workers generating extra income in the workplace without official registration but with implicit approval of management

Organisation status	The rate of phenomenon occurrence, %		
	low (0-15)	middle (16-50)	high (more than 50)
<i>State-owned</i>			
specialised	39	33	22
academic	29	45	28
lease-hold	75	25	-

¹⁰Here we have to abstract different privatisation types in post-socialist economies. Full analysis would require a separate paper.

<i>Joint-stock company of the open type</i>	50	46	4
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Source: Tambovtsev V.L. (1995)

Laure-Couderc (1995), based on cases of several Russian institutes, indicates the existence of a practice where employees use the intellectual stock of institute and commercialise it on an individual basis¹¹. Such practice is impossible without some sort of agreement between management and researchers. Tambovtsev (1995) argues that the basis of this is an informal contract between the institute's administration and the researchers: in order to retain them administration allows researchers to carry out spontaneous privatisation of equipment and intellectual property in exchange for obtaining a guarantee that management 'can retain their positions and can participate in gaining incomes from the spontaneous privatisation of the immovable property of the institute' (p. 328).

3.2.3. Quasi-spin-offs

The spin-off is usually defined as a new organisation set up by the parent organisation in order to resolve its organisational incoherence by developing and commercialising activities which are not parts of its current core but which may become so in the future or may remain as independent activities. In the context of post-socialist R&D institutes spin-offs provide a way to achieve a more focused organisation by spinning-off purely commercial activities and preserving the R&D profile of the institute. Indeed, the number of small firms attached to R&D institutes in post-socialist countries is relatively high. For example, in 1993 there were 12,000 small enterprises in the Russian R&D sector of which 513 were within the Russian Academy (see Gaponenko, 1995, p. 17). In the case of the Ukraine, in 1993 there were 400 small firms around the Academy of Sciences (Issakova and Klochko, 1994). Balazs (1994) is an interesting account of the phenomenon of small firms around the Technical University of Budapest.

However, deeper insights into the nature of these spin-offs provide a more complex picture in terms of their relationships the with parent company as well as in terms of the factors which shape this relationship.

As pointed out by Balazs (1996) the majority of these firms are in the area of services like consultancy, technical assistance, trade and distribution. Very few are commercialising accumulated R&D results through new products, although in the past product development and design was their main activity. In economies where services in general were extremely undeveloped these firms could be considered to be the potential future nodes of technical and related services which are lacking. In accordance with this Balazs (1996) argues that these forms play a useful role as a part of the domestic 'knowledge industry'. In cases where they are spin-offs of parent companies, and where they complement the activities of R&D institutes, they may be new actors in the R&D

¹¹This is particularly widespread in institutes in 'soft' areas like information sciences, and software where the distinction between assets and merchandise is not clear (see Laure-Couderc, 1995).

system and in industry. However, privatisation, crisis conditions and slow, mainly spontaneous restructuring of R&D institutes, create very specific, post-socialist forms of spin-offs which are better described as quasi spin-offs.

A new, quasi spin-off firm, is usually a joint-stock company which has, in different degrees, developed links with its parent institution but never fully spun-off¹². Often (co)ownership of the new company is coupled with arrangements where core employees of parent company work on a part-time basis for the new company. In the conditions where privatisation is in turmoil and the legal framework is changing this link enables the transfer of resources, knowledge and people from a public organisation to a semi-public or private organisation. Whether in a quasi spin-off relationship, the knowledge assets of both organisations increase, are stripped-off or merely transferred from parent to spin-off company, are issues which need more systematic research. A rare piece of evidence on this is Tambovtsev (1995) who, based on a sample of 130 institutes, found that about 48% of them had small firms specialised in the institutes' line of research. About 39% of them had small enterprises not specialised in their line of activity and these were in general purely commercial enterprises¹³. The presence of these enterprises is not systematically linked with the characteristics of the R&D institute. A similar number of small firms in institutes with different levels of demand for their activities indicates that attached small firms are primarily a reflection of crisis and the search for new growth opportunities, and not of the growth itself. They allow personnel to compensate for the decrease in their living standards but not in a decisive way (Tambovtsev, 1995, p. 326). The fact that they remain in a sort of symbiotic relationships show that these are quasi spin-off firms.

4. RESTRUCTURING OF ACADEMY-INDUSTRY LINKS IN POST-SOCIALIST ECONOMIES¹⁴

Academy-industry links have been seen in the immediate period after 1989 as a magic formula for commercialising accumulated R&D capabilities and the whole oversized R&D sector. This shift was a continuation of the initiatives undertaken in several socialist countries during the 1980s when R&D systems were forced to become more commercially viable (For Bulgaria see Simeonova, 1995; for Hungary see Balazs, 1994; for Russia see Orel et al, 1995, p. 310-311.) However, after 1989 the market and the whole economic environment radically changed which makes the response through strengthening academy - industry links inadequate. Its limitations are:

¹²An extreme version of 'quasi spin offs' is a firm which is only formally, but not in any other sense spun off. R&D institute and firm are in symbiotic relationship where the firm serves to increase the personal income of researchers and keep the public image of institute 'clean'. (see Balazs, 1994, p.17).

¹³Laure-Couderc (1995) reports on the case of the Russian design institute which founded a bank as its spin-off activity.

¹⁴See footnote 1.

First, academy-industry links cannot be a solution for all R&D areas. In some areas 'technological distance' between R&D area and local industry is great and bridging mechanisms are undeveloped. In table 6 we show how the intensity of interaction varies with the profile the of R&D institutes.

Table 6
Frequency and intensity of Academy - industry links on the sample of 10 Croatian R&D institutions

Type of institutions	Independent institutes in basic science	Applied science faculties	Industrial R&D institutes
Average frequency of links	2.5	9.3	8.4

Forms of interaction	Short-term projects	Long-term projects	Consulting	Informal knowledge transfers	Education transfers	Ministry projects
Intensity of links	21	4	12	17	9	13

Source: Radosevic, S. (1992) Based on interviews by the author, March 1992.

Note: Scaling is based on three level assessment of links (3=strong presence; 2=noticeable presence; 1=present on a modest scale)

Second, types of interaction from the former system show the character of technology transfer market. These are mainly short-term projects and consultancy activities (see table 6). Non-market links (informal knowledge transfers; education transfers) play an equally important role and, by definition, these cannot be pushed on to the market. The only systematic links are those through joint R&D projects between academic and industrial organisations, which were rare in most of socialist economies as business R&D was very limited. In summary, the market for bridging activities seems to be much smaller than the initial expectations of countries that pushed R&D institutes to the market.

Third, the new demand is not for packages derived from R&D, which, in Bulgarian statistics are termed as 'R&D results ready for implementation'. Simeonova (1994) shows that in the period 1990/93 there was a 46% decrease in this type of output. Putting this type of output in the market will only show up how inadequate is the old type of supply in the new conditions, especially since the value of the R&D contracts market is being sharply reduced.

These factors explain why bridging mechanisms which are common, at least to a certain extent, in all Western countries are rather limited in post-socialist economies. (See examples of this mechanisms in different post-socialist economies in Jasinski (1995) for Poland, Lenardic (1995) for Croatia, Simeonova (1995) for Bulgaria, Muller (1995) for Czech Republic, and, Sandu (1995) for Romania.) Agencies and associations for technology transfer are more institutions for lobbying and protecting group interests than actual mechanisms for supporting transfer. Technology parks are more 'renting agencies' than places for nurturing the growth of small firms. They cannot provide venture capital and are unable to provide or assist in acquiring loans from banks. In summary, the transfer of organisational models into a different institutional context has inevitably been transformed into something different from the original idea.

So what do the future academy-industry links in post-socialist economies look like? In their convergence towards a market economy some basic features of the economics of academy-industry relations will probably shape the future intensity of these links. Some of these features (based on Mowery, 1983; 1990, Bell, 1996) are as follows:

The *supply* of R&D services is determined by:

1. Economies of scale and specialisation in providing R&D services. Independent R&D institutes should have advantages in routinized services, like testing, which cannot be fully exploited by 'in-house' R&D units. The knowledge provided is, in principle, of generic character, with little firm specificity, which reduces the problems of its transferability. These isolated (separable) aspects of firms operations are improvements rather than 'in-house' type of developments.
2. The quality and complexity of R&D services are determined by the degree of interdependency between R&D and production. The greater the interdependence the lower the R&D unit costs due to cumulated experience in implementing new technologies. That is why firms are in fact the best source of technology and R&D services. This especially applies in the case of knowledge which is highly specialised and idiosyncratic.

The level and the degree of *demand* by industry for R&D services is influenced by:

1. The absorption capability of users. The more sophisticated his 'in-house' R&D activities the more the user is able to exploit R&D services provided. The better expertise he has to pose a feasible research problem (evaluate results) the more he is able to utilise the results of externally performed R&D.
2. Contractual difficulties (transaction costs) in the case of complex and uncertain research projects. Large scale, more specific and the more complex R&D is more likely to be 'in-house' organised.

Taking into account these factors that determine supply and demand the range of market based services supplied by research organisations is limited, encompassing those

at the low risk end of the R&D spectrum. Where more complex R&D activities are supplied these function for enterprises (users) as *complements*, rather than as *substitutes* for their 'in house' research. The complementarity of contractual and 'in house' R&D is higher for the more complex (non-analysis) projects. In the case of simple R&D, like testing, the substitutability of these two categories is much higher. Mowery (1983) shows that independent R&D organisations primarily serve firms that have 'in house' research facilities. The low risk projects, for which learning complementarities are less important are more prone to be contracted as substitutes.

From this it follows that academy-industry links in post-socialist economies are strongly determined by the pace of building R&D within manufacturing and service firms (banks etc.). This also implies that academy-industry links will probably be focused more on the direction of strengthening 'in-house' R&D capabilities than on the transfer of R&D results from independent R&D institutes to manufacturing firms.

In the post-socialist context it follows that the limited transfer of the technology available from the R&D institutes in post-socialist economies is the outcome of the following:

- a) Poor quality R&D which is to a great extent obsolete and needs restructuring;
- b) Low effective demand from industry which is strapped for cash, and still hindered by the market, privatisation and other legal uncertainties;
- c) Inherent difficulties in transferring technologies across inter-organisational boundaries limiting the role of academy-industry technology transfers. As argued in the first section, due to the firm-specific character of technology, it is more likely that R&D institutes will be transformed into industrial enterprises or service enterprises than they will remain as a source of R&D which will then be marketed to industrial enterprises with relatively weak in-house R&D capabilities.

The available empirical evidence confirms the limited role of the existing bridging institutions (associations, agencies, S&T parks). Similar to the whole R&D system the bridging functions are undergoing a restructuring. They are distributed across institutions a different way to that of the socialist system. Under the socialist system bridging functions were the responsibility of several government authorities who actually managed technology transfer. In the market context, these functions become institutionalised within and among those organisations that produce technical knowledge (enterprises, universities, academies).

Even more than in the case of the flourishing academy-industry links we should expect that the whole R&D system will structurally change. In such a context intra-organisational restructuring will dominate over the possibly stronger impact of technology transfer and bridging institutions¹⁵. The bridging functions will most likely become a part of the newly restructured enterprises, universities, R&D service companies, industrial associations or R&D centres rather than being provided only by

¹⁵For the discussion on this in the context of developing countries and its implications for transition economies see excellent contribution by Bell, 1996.

institutions specialised in transfer services. In other words, we should expect the bridging function to develop much less often as a stand-alone function (Bell, 1996). Often it will be a complementary function of R&D institutions or enterprises. Bridging functions will be supported as a way to better understand clients/customers needs and requirements. If independent they would be mainly operating in the transfer of simple information like marketing information and/or would act as intermediating agencies by bringing organisational know-how through consultants which they can better do due to economies of scale in collecting information and networking.

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