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Science and Technology Policy in Eastern Europe — a Demand-Oriented Approach

By Jürgen Bitzer and Christian von Hirschhausen¹

Summary

This paper analyses the changes of Eastern European science & technology (S&T) systems caused by the transformation from socialist to capitalist market economies. Our hypothesis is that the largest part of Eastern European S&T capacities has been devalued by this change, leaving behind a highly fragmented system. Domestic enterprises, the ultimate beneficiaries of a national S&T system, have quickly integrated into international production and sales networks, leaving domestic S&T capacities largely without a market. Under these specific post-socialist conditions, the S&T-policy approach has to change: instead of continuing to supply capacities, we propose a demand-oriented S&T policy, consisting of i) the identification of newly emerging enterprise networks and the reduction of S&T policy to clearly identified bottlenecks, and ii) the rapid restructuring, buy-outs or closure of those S&T institutes without a market. We apply this approach to three different industries, each with of different technological nature: software, shipbuilding, and computers. We conclude that in the post-socialist transformation process, there is very limited scope for a demand-oriented S&T policy. The radical nature of the break between socialist and post-socialist S&T requirements becomes only evident at enterprise level; policy conclusions based on fragile aggregate S&T statistics may be misleading. The analysis of Eastern Europe may also teach us something on the demand-oriented restructuring of Western S&T systems.

1. Introduction

Science and technology systems (S&T), innovation systems and human capital are at the centre of scientific discussion. It is not only an important topic in Western Europe but also in Eastern Europe, where the restructuring and creation of new S&T systems is required. In both cases, the discussion is centred around the same main two questions: firstly, what should an efficient S&T system look like, and secondly, how should it be implemented? The S&T policies in Eastern Europe cannot be based on Western models because neither comparable institutional nor financial conditions exist. Therefore, Eastern European S&T policies have to take the special *post-socialist conditions* into account.

This paper reviews the structural changes of Eastern European science & technology systems on their transformation from socialist systems to capitalist market economies. Our hypothesis is that this change has diminished the value of the largest part of the socialist S&T-capacities. In the post-socialist context, a new division of labour is established that implies new enterprise structures and new networks. We argue that the radical nature of this change can only be detected at enterprise level; analyses of aggregate statistics on S&T are only of limited meaningfulness and may lead to false policy conclusions.

The paper is structured in the following way: after a brief review of the socialist S&T systems (section 2), we analyse the restructuring of these systems in the post-socialist context (section 3). With the monetisation of the economy, the socialist production network collapsed, leaving behind a fragmented S&T system. Human and physical capital was devalued, entire production networks torn apart, and international competition introduced. A gradual change of the S&T system is impossible, thus S&T policies aimed at a gradual adaptation are inadequate. We propose an alternative policy option: a *demand-oriented* S&T policy (section 4). We apply the concept to analyse enterprise restructuring in three different sectors: software, shipbuilding, and computers (section 5). It turns out that the S&T policy conclusions are specific to each sector; no generalisation of a

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“best” S&T policy is possible. We conclude that what appears to be a disadvantage of post-socialist countries, i.e. the disappearance of socialist structures, does not necessarily have to be perceived as a disadvantage. On the contrary, Eastern European countries and enterprises may seize this opportunity to create new S&T structures which could function as models for the West.

2. A stylised picture of the socialist science and technology system

Under socialism, decisions concerning production and distribution of goods were made by the Party-State, without any reference to monetary criteria. The upstream socialist S&T system had three pillars: i) the universities and the institutions of higher education, ii) the academies of sciences and iii) the branch research institutes (cf. figure 1). The main task of the universities and the institutions of higher education was education. Only a small part was concerned with basic research. Research in its whole breadth and depth was carried out in the academies of sciences. The concrete development of new products and technologies was the task of the branch research institutes. This includes the development of products and technologies to the state of prototypes, pilot systems and experimental models.²

Inside the S&T system, steep hierarchies existed which were controlled by branch or science ministries. S&T institutions did not have any autonomy, severely limiting the freedom of research.

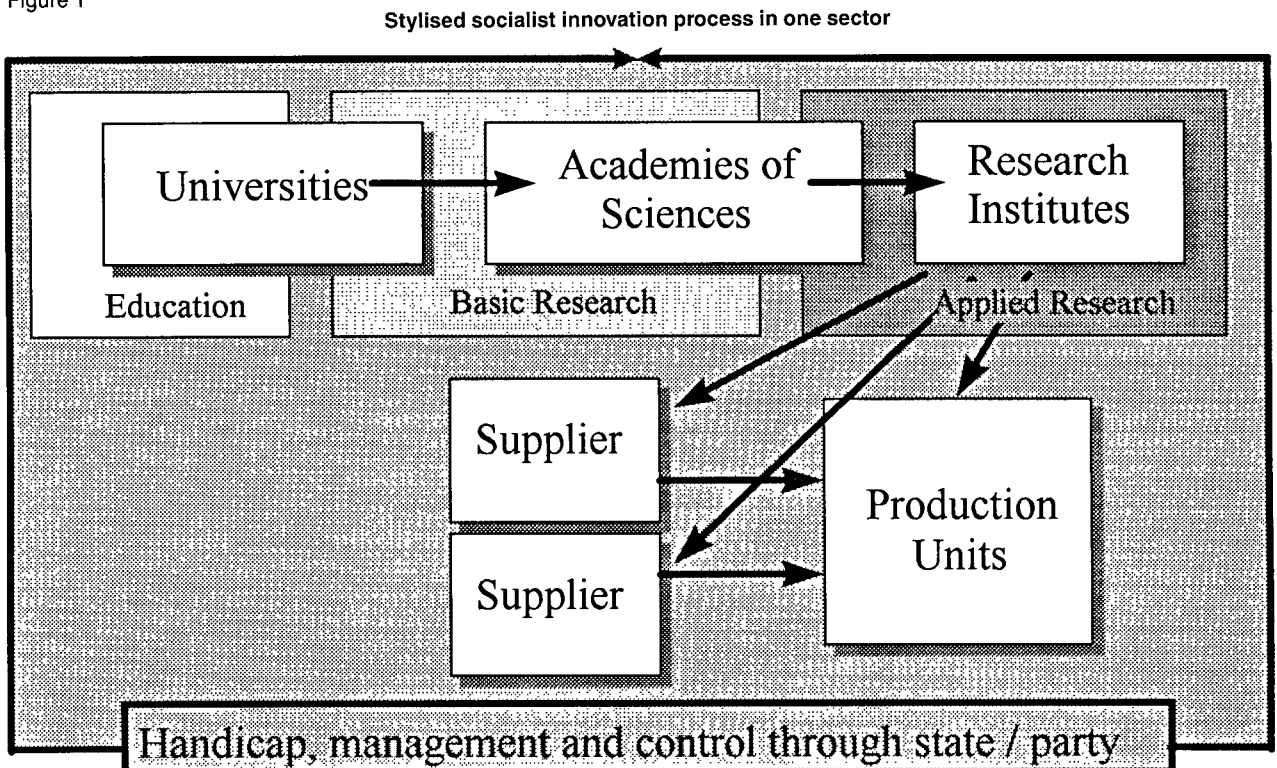
The focus of the S&T was directed mainly towards science and less towards applied research and development. Therefore, absorption capacities remain small. This was one of the reasons why despite relatively high investments in S&T, the technological pace could not keep up with capitalist countries. Furthermore the steep hierarchies hampered interactions and with it spill-over-effects between the institutions of the S&T.

In contrast to western practice, applied research was mainly carried out in external institutions, like the branch research institutes. The research capacities inside the production units were small because their task was seen purely in terms of production.³ Monetary constraints on research activities did not exist. For example an institute would never have been closed or have fired staff because it did not achieve the planned targets.

² Cf. Meske (1997).

³ Cf. Radosevic (1996).

Figure 1



The isolation of the socialist countries through the COCOM restriction lead to a twofold innovation strategy. On the one hand an "independent-problem-solution-strategy" was carried out which tried to develop required products and technology without input from western countries. Often, this lead to the "reinvention of the wheel" and to a waste of resources. On the other hand pure imitation was carried out to satisfy missing inputs of western countries. This combination of "independent-problem-solution-strategy" and pure imitation lead more and more to a technological backlog in most areas of the S&TS.

Another reason for this technological backlog was the dominance of military research. Immense resources were invested in military research, but the research results of the military industrial complex were secret and therefore spill-over-effects into the civil part of the S&TS were prevented. In western countries it is assumed that the civil sector benefits from research results found in the military sector. The allocation of immense research resources, like financial means and research personnel, as well as the lack of diffusion of the research results prevented the socialist countries from keeping pace with the western countries.

3. Restructuring Science and Technology Systems in Eastern Europe

3.1 Basic Conditions for Restructuring in Eastern Europe

With the collapse of socialism, the socialist production networks and the established links between production and the socialist S&TS also collapsed. This resulted in a fragmented S&TS without any connection to the economy. With the "monetisation" of the economy and the creation of capitalist market economies the S&TS was also monetised. Secure governmental funding was replaced by the introduction of monetary constraints. Today, governments are no longer willing or able to finance a S&TS which has no function in the production process. The countries of Eastern Europe face the question of how to create a new S&TS, which helps to improve the competitiveness of domestic enterprises under the predominant post-socialist conditions.

Western models cannot be applied in these particular post-socialist circumstances, because neither the required financial nor the institutional conditions exist. Therefore new models must be developed which take existing restrictions and conditions into account.

The post-socialist conditions in which the S&T policy has to be carried out are characterised by a shortage of financial means and high opportunity costs. The policy makers have to decide if they should invest scarce money in the creation of a new S&TS (and if so, more precisely into which activities) or in the improvement of the infrastructure, the creation of institutions, etc.. Therefore expenditures in the S&TS have to be carefully justified. It has to be ensured that

they do not hamper the necessary ongoing adaptation process of the changed requirements on the S&TS in the post-socialist time. Consequently, the triggered structural changes have to be taken into account because they make it clear that the restructuring of S&TS in Eastern Europe is more than a question of money.

3.2 Structural changes of the S&TS

3.2.1 Partial devaluation of human capital

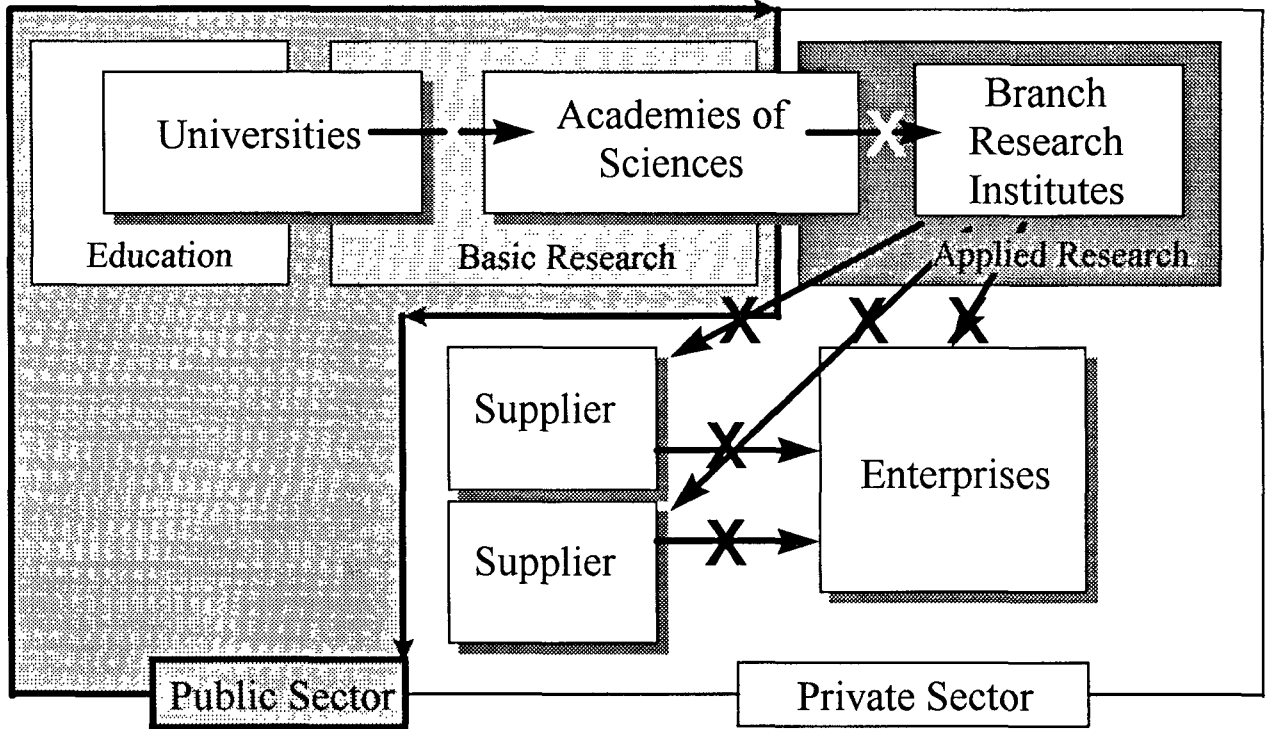
Through previously high investments in the creation of human capital, the Eastern European countries possess a high level of education. Particularly in natural sciences, experts consider Eastern European researchers to be among the top group in the world. But this should not conceal the fact that large parts of the human capital have been severely devaluated through the transformation. With the opening of the Eastern European markets to western products and technologies and their quick diffusion, parts of the human capital were devaluated. Particularly in the field of applied research and production a strong devaluation occurred because the changes which took place in this fields were far-reaching. Examples for such changes are the introduction of new machines, new forms of organisation, new forms of logistics, new input factors which require a different use etc.. In the field of basic research, a partial devaluation of human capital occurred as well because the Eastern European researchers had to adapt their work procedures to international standards (e.g. pay attention to copyrights, fulfilment of standards in the case of participation in international research projects and programmes, etc.). Especially problematic is the devaluation of human capital in the case of the teaching staff, because often obsolete knowledge is still being taught.

3.2.2 Changes in the division of tasks in the innovation process: from State to enterprises

Besides this devaluation of human capital, the division of tasks in the innovation process has also changed dramatically. This lead to the loss of functions in different institutions of the S&TS. Under socialism, the party-state as organiser of the innovation process took over all functions. The orientation of the research, the implementation of knowledge into new products and their production was organised by the party-state. Distribution of the products was guaranteed, competition and financial restrictions did not exist. With the introduction of capitalism as an economic principle, the implementation of the new knowledge into new products shifted from the state to the emerging capitalist enterprises. The use of new knowledge in the field of applied research for the development of products and their production is seen as core task of *enterprises* in capitalist economies. This includes the development, production and commercial exploitation of products under competition and financial restrictions.

Figure 2

Changed tasks in the innovation process



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These changes bring with them the fact that new emerging enterprises chose their sources of innovation themselves. Often, the domestic institutes were not able to supply the required input. Therefore the enterprises chose foreign sources of innovation and the obsolete domestic sources were not used any more. Figure 2 shows the changes in a stylised form:

Both commercial exploitation under competition and financial restrictions play a particularly important role in the successful use of technological potential. Frequently, the technological capabilities are not the limiting factor for the competitiveness of Eastern European enterprises. The competitiveness depends on a number of additional factors like existing market structures, used competition axis, existing market barriers or network effects, etc.. Competition disadvantages of Eastern European enterprises can often be found in these "new" areas of business. Examples are a lack of quality, bad or non-existent marketing activities, low reliability, a lack of customer orientation, lack of financing possibilities, etc.. In the international competition, these disadvantages are often a knockout criteria.

3.2.3. Researcher and S&T systems in the international competition

With the opening of the East European markets, these countries' enterprises have entered international competition; competition between national S&T systems is carried out indirectly on the product markets. Enterprises and customers are now free to decide which of the available international products they want to buy. The quick availability, the high quality and high technology level of western products lead to their quick diffusion into the East European markets. However, with the purchase of western products, the services of western S&T systems were also bought. Through the creation of international supplier networks, East European enterprises get access to modern technology which they strongly need in facing international competition. The domestic S&T system was by and large not able to provide the required technologies or knowledge as inputs for the newly emerging production. In many areas of research, this comparison between Eastern and Western S&T systems did not correspond with the high expectations of certain parts of the East European S&T systems. Thus institutions of

East European S&TS have comparative advantages which attract direct foreign investments from all over the world, only in very few areas.⁴

3.3. Disintegration of the former division of labour in Eastern Europe

The collapse of socialism did not only bring about the collapse of the national production and innovation structures but it also affected the established CAEM production and innovation structures. The division of labour between the East European countries, which was the result of political decisions and not competition, completely collapsed with the restoration of independence of the East European countries. This further increased the problems of a restructuring of national S&TS. Structures which were designed to serve the innovation and production system of the entire Eastern Block have now to be adapted to the new requirements at enterprise level. As a result, the size of the S&TS in most countries was significantly reduced. Furthermore, required parts of the S&TS, which in socialist times were established in other socialist countries, had to be created because they were no longer accessible.

The Baltic countries Lithuania, Latvia and Estonia can be seen as an extreme example. As a former part of the Soviet Union, R&D for electrical engineering for civil as well as military use was concentrated in these three countries. The capacities created were designed according to the needs of the Soviet innovation system which served a population of 271 million. In comparison to the number of inhabitants of Lithuania (3.8 million), Latvia (2.6 million) and Estonia (1.6 million) the capacities created were far too large.⁵ A further result of this division of labour was that the production of goods developed in the Baltics was mostly carried out in locations other than the Baltics themselves. To illustrate this, one need only refer to the production of computers, which were mainly produced in Belarus whereas the R&D was carried out in the Baltic countries.⁶ The former socialist demand for the Baltic S&T services from within the Soviet innovation system collapsed overnight after the restoration of independence. The missing production units which are now in foreign countries no longer demand S&T services from the Baltic countries. As a result of this developments the size of the S&TS has to be reduced dramatically.⁷

3.4. The limited meaningfulness of S&T indicators in Eastern Europe

As in western countries, S&T indicator analysis is also used to assess the situation and the developments of East European S&TS. It is further common practice to derive out of this policy implications for those countries. But while these implications are already heavily debated in Western countries, the S&T indicator analysis in Eastern Europe contains further problems, questioning the meaning-

fulness of any S&T indicator in these countries. There are three reasons for this:

1) The most trivial, yet least respected reason is that socialist countries had other indicators which are incompatible with those in a capitalist market economy: for example, the notion of GDP as an indicator for (capitalist) value added did not exist.⁸ So in socialist countries, the ratio R&D/GDP did not exist. This ratio has been reaffected, ex-post, by S&T statisticians ignorant of socialist reality, in an attempt to fill their standardised S&T tables. This, however, is an illegal falsification of history; the use of the R&D/GDP indicator is only possible where GDP really exists, i.e. in the post-socialist period (i.e. for example in Poland 1990 onwards, Czech and Slovak Republics 1991 onwards, CIS-countries and Baltics 1992 onwards).

2) The second argument against S&T indicators is the *fragile statistical base* upon which they are based. This data is characterised by incomplete series, frequent changes of methodology, and unreliable data collection.⁹ Whereas a comparison of East European countries in socialist times is possible, this is not the case for the post-socialist period. At the beginning of post-socialism each country started to use a different delimitation for their S&T statistics and furthermore the availability of data differed strongly between individual countries. Today only some countries have introduced the OECD procedure for collecting S&T data but this did not guarantee the quality and completeness of the data either.

3) The third problem of the S&T indicator analysis in Eastern Europe are the radical *structural changes* mentioned above. These immense and manifold structural changes are only incompletely reproduced by the S&T indicators. In western countries the interpretation of S&T indicators is made possible by the gradual structural changes in the S&TS. In contrast, in Eastern Europe it is exactly these structural changes which are the driving force of the developments. They tell the real story and therefore it is crucial to take them into account when interpreting the figures, to arrive at an accurate picture of the situation in the East European S&TS.

We conclude that nothing relevant can be derived from a comparison of aggregate S&T statistics. For historic reasons, we have nonetheless reproduced the table below on R&D-expenditures. All countries decrease the expen-

⁴ Cf. Dyker (1996) for successful examples in information technology.

⁵ Berg (1998), p. 515.

⁶ For a detailed description of the created institutions in the single countries cf. case studies on computer and software sectors in Lithuania, Latvia and Estonia in Bitzer/Hirschhausen (1998), p. 509-721.

⁷ Cf. Bitzer/Hirschhausen (1998), p. 510-515.

⁸ Cf. von Hirschhausen (1996).

⁹ Cf. Radosevic (1996).

Table 1

Gross Domestic Expenditure on R&D as a percentage of GDP*

	1990	1991	1992	1993	1994
Czech Republic ²⁾	2,19**	2,12	1,83	1,35	1,25
Hungary ³⁾	1,60	1,08	1,07	0,99	0,89
Poland ⁴⁾		1,05	0,83	0,83	0,84
Slovak Republic ⁵⁾	1,99**	2,57	2,03	1,66	1,12
Russian Federation	2,03**	1,54**	0,78	0,81	0,82

* Defence R&D not included. — ** The figures must have been recalculated by OECD. The black line represents the structural break between socialism and post-socialism. — ¹⁾ Total expenditure of the R&D base, depreciation costs not excluded. — ²⁾ Until 1993, including purchase of licences, know-how etc.; break in series in 1991 due to changing methodology for calculating GDP. — ³⁾ Until 1993: capital expenditure in enterprises and the higher education sector not included, depreciation costs not excluded. — ⁴⁾ Until 1993, total expenditure of the R&D base; depreciation costs not excluded.
Source: OECD (1996).

ditures on R&D, but to conclude that this decrease is “bad” per se would be ignoring the underlying structural changes. These developments could be the result of the above mentioned adaptation of the S&TS to national requirements, an increase in productivity, a change in the economic structure as well as the shift of large parts of R&D to the private sector and would not automatically be seen as negative.

The observed decrease is the result of two opposite effects. On the one hand there is the necessary reduction of the publicly financed R&D, which is still at a high level, and is the result of the shift of tasks in the innovation process. On the other hand, there is the take-over of these tasks by the private sector. But the international availability of products often makes independent domestic development unfeasible, in particular for enterprises which are not situated at the cutting edge of technology. Microprocessors are a case in point. Furthermore following common known patterns, the overwhelming majority of small enterprises, which are usually only active in their domestic market, carry out only a little part of R&D by themselves.¹⁰

This interpretation shows that the reduction of expenditure on R&D is less dramatic than often perceived and is more a move towards the development of “normal” conditions of R&D. The often heard demand for higher expenditures on R&D must be carefully justified and cannot be derived from comparisons with expenditures of western countries.

4. Elements of A demand-oriented science and technology policy

The preceding explanations have illustrated the difficulties of a science and technology policy in the Eastern European countries. A policy must address the needs of newly established enterprise networks. The possible policy options are subject to severe restrictions: limited financial

resources and high opportunity costs. Particularly the scarce financial resources mean that western models which as a rule are based on a supply-oriented strategy and require considerable financial expenditure cannot be applied in Eastern Europe. The high opportunity costs, which for example appear in the form of investment in infrastructure or the health service, should in any case prevent available funds being invested in projects whose returns are extremely uncertain and lie far in the future.

Which strategy should a post-socialist S&T policy follow in order to construct a new innovation system and to smooth out possible short-term bottlenecks, which limit the competitiveness of domestic firms? We propose several *demand-oriented* policy measures, implying that monetary demand should be the dominant criteria for S&T policy decisions:

- Firstly, it has to be estimated whether the scientific system represents a bottleneck for the Eastern European countries. As described in the preceding section, it is often not the technical capacities but the competitive drawbacks in the marketing of their potential which are the limiting factors. The existing potential is often constrained by the sales or market side. Market barriers, market conditions, but also the inability to meet the requirements of customers as well as competitors can lead to the shutting down of single companies and sometimes of entire industries. Often, these conditions cannot be influenced by policies. In the case where technological capabilities are not the limiting factor, a construction of corresponding parts of a S&TS would not have the desired effect. It is often argued that

¹⁰ It should be mentioned that the reproduction of privately financed R&D through corresponding S&T indicators is still lacking, because of incomplete data capture. So the decrease of R&D expenditures will in most cases be overestimated.

demand-oriented S&T policies will lead to a loss of technological potential, in the form of human capital, which might be required in the future. However the often quoted scientific potential of the Eastern European countries must be precisely analysed in the new environment of global competition to see if it is still a potential.

- Secondly, the remaining required competitive institutions and consequently those institutions that are eligible for public financing must be “filtered out”. This applies in particular to the research institutions which conduct applied research (academies of science and branch research institutes) because these are classed with the corporate sector anyway. By analysing the newly arising production network, the innovation sources, the connections to the science and innovation system, the potential demand can be identified. Research institutions can be examined in terms of whether they are successful in finding demand for their output. If the reorientation of the institutes is misplaced they should be put up for buy-out, or closed. Holding on to obsolete institutions under the existing budget restrictions results in a lack of funds for innovative and newly established institutions. A demand-oriented policy approach on top of systematically discovered competitive advantages in particular areas of research could enable targeted support. Furthermore, it is assumed that the firms are in a better position to assess the existing scientific potential than the state. This type of action opens up the opportunity for enlisting firms to finance parts of the innovation system which they profit from.

5. Demand for S&T services of different industries

In this section, we apply a methodology for evaluating sectoral S&T systems. Our point of analysis is always the enterprise(s) which is supposed to be the ultimate beneficiary of the S&T. By taking into account the specifics of an industry, we can derive concrete S&T policy conclusions for a set of enterprises. We determine the existing demand for domestic S&T services for the software, shipbuilding and computer industries. These three sectors represent three different types of production networks leading to different kinds of technology transfer, and with it, sources of innovation.¹¹

5.1 Software

In socialist times software development was mainly localised in industry and ministries.¹² Individual application software was developed for the needs of the military industrial complex, for the institutions engaged in central planning, and scientific and technical computing. Computer technology had scarcely permeated industry and the focus of software development lay on mathematical

applications. The restrictions in terms of hardware and the lack of exchange of knowledge in modern computer technology led to software products which were far below the Western standard. Software products were not traded and therefore software enterprises did not exist. With the collapse of socialism the situation changed completely. Existing software products from the West as well as new developments from the East were available for purchase. This was the birth of software markets in Eastern Europe. Programmers left their former positions and founded new software enterprises. The collapse of several socialist producers as well as the rapid saturation with Western standard software led to the shutdown of the former centres of software development, the internal software development departments. This led to a further release of programmers into the newly emerging software sector.¹³

Today the software market is divided amongst numerous international and domestic enterprises. The segment for standard software with a high degree of standardisation is dominated by international software enterprises, which have a competition advantage in terms of quality, reputation, price, created network effects and the existing base of installations. In contrast to this, domestic enterprises dominate the segments for software with a low degree of standardisation and the segment for individual software, where their greater flexibility and low personnel costs work as competition advantages. A specific Eastern European problem in the software market is the high rate of software piracy (an estimated 90 % is thought to be illegally copied). This particularly affects the newly emerging domestic software enterprises which are not paid for their work.

In the East as in the West, software development is mainly dependent upon *internal sources of innovation*. The development of new programmes is carried out internally and suppliers do not play a significant role in this process. In some rare cases there are links between enterprises and universities in the development of software products. This is the result of the nature of software production. The real production of software is the development process, where there is a complete product at the end. A production process in the ordinary sense, with physical inputs which are transformed into the end product, does not exist. The only input into software production is *human capital*, and to a certain degree, hardware conditions, which are no longer a bottleneck today. So the link between software enterprises and the S&T is an indirect one concerning the creation of human capital for software technology.

One possible scope for an S&T policy would be to facilitate the creation of *human capital* for software technology. A more precise orientation of university education, as well as the modernisation of the knowledge of

¹¹ This section largely draws upon Bitzer (1998).

¹² See Bitzer (1997b) for a detailed discussion and analysis of the software sector.

¹³ Katkalo/Mowery (1996).

university staff seems to be a necessary and promising strategy. Another promising starting point is the *improvement of the patent protection laws and their enforcement*, which will put the development of domestic enterprises on equal terms with foreign companies.

5.2 Shipbuilding¹⁴

Under socialism, shipbuilding was first and foremost a military, strategic activity. Civil shipbuilding was considered to be of secondary importance. A socialist shipyard was characterised by enormous production depth, i.e. the in-house fabrication of ship outfits and machinery equipment including winches, steering gear, accommodation, electrical equipment, switchboards, etc.. The restructuring of the shipbuilding industry consisted mainly of a reorientation of the product range, which implied a reorientation of the production process, outsourcing, purchase of foreign equipment, etc. Particular emphasis was put on developing in-house design capacities, which turned out to be a necessary condition for product range differentiation. Two important determinants of the success of restructuring are purely *non-technical*: access to cash-flow, and integration into upstream and downstream production networks.

International competition forced Eastern European shipyards to specialise and to lower production costs. Alongside the technical changes in the production process, such as computerisation of project planning, construction, and design, the main change was the reduction of production depth. The production of several components was outsourced; the external value added increased (up to 16 % in Polish yards, in comparison: the external value added in Western countries is currently between 60-70 %). Alongside domestic suppliers, foreign suppliers were also integrated into the new production networks. The Eastern European shipyards are often dependent on external foreign sources of innovation, particularly in ship design, because of their continually limited design capacities. Where Eastern and Western enterprises co-operate, the design is often carried out by Western enterprises, whereas the production is carried out in Eastern European shipyards. The same is true for specialised high technology equipment, like radar systems, computer equipment etc. Domestic maritime research institutes continue to carry out some basic research, but concentrate on the adaptation of imported technology to domestic needs.

The links between shipbuilding enterprises and the S&TS are manifold. Sources of innovation are domestic as well as foreign suppliers, and domestic and foreign research institutes. The suppliers play a key role as sources of innovation in this industry. International production networks work well and *technical bottlenecks do not seem to be an important hampering factor for the Eastern European shipbuilding industry*. The largest problems which the Eastern European shipyards face are their large debts from socialist times and problems in financing projects. Accord-

ingly, demand for domestic research institutes exists mainly in the producing enterprises. However, there is no need for these institutes to be state-owned: as all the results produced by these institutes can be internalised in the enterprises, the latter should also be enlisted to finance them.

5.3 Computer industry

Under socialism, computer production was mainly for the military industrial complex, the institutions engaged in central planning and scientific and technical computing.¹⁵ The destination of the production was fixed. The sources of innovation were to a large extent the imitation of Western products and only partly internal R&D. The result was obsolete computer technology when compared to Western products. The opening of the formerly closed markets in Central and Eastern Europe opened the gates for international computer manufacturers. The highly competitive, well organised and well financed computer vendors forced the obsolete regional computer industry into strong competition. As a result the local computer manufacturing organisations either collapsed or switched their activity to assembling low cost PCs; some enterprisation also took place through diversification, e.g. into electronic appliances. The collapse of obsolete capacities released personnel to the newly emerging private computer industry.¹⁶ Entrepreneurs took over facilities which had been shut down and started to assemble PCs, while the required components were imported from the Far East.

Today the computer markets in Eastern Europe have high growth rates but their size is still very small in comparison to Western computer markets. The PC market segment is by far the most important in all the Eastern European countries.¹⁷ The domestic PC assemblers are well established in the PC business and in Russia, Poland and Hungary the *market leaders are domestic enterprises*.¹⁸

PC assembling is a labour-intensive, low-tech activity. Because PC components are highly standardised, the production of PCs is reduced to a screwdriver assembling business. R&D is carried out entirely by the highly specialised computer component suppliers. Internal R&D is no longer carried out by the PC producers and the

¹⁴ See Bitzer/Hirschhausen (1997) for a detailed discussion and analysis of the shipbuilding sector and further references.

¹⁵ See Bitzer (1997a) for a detailed discussion and analysis of the computer sector.

¹⁶ EITO (1993).

¹⁷ E.g. in Russia 88 %, in Poland 85 %, in the Czech Republic 80 % and in Hungary 78 % of the computer market is apportioned to the PC segment in terms of value EITO (1997) (own calculations).

¹⁸ In the market segments for higher computer classes, international computer enterprises dominate the market. The different development in the PC business and the higher computer class business can be explained by the differences in production technology.

organisation of PC production is similar all over the world. Only a few very large computer producers, like IBM, still maintain capacities for R&D in PC components. This element of PC production enables Eastern European PC producers to build up competitive assembling facilities very quickly, while the required components are purchased from the USA or the Far East.¹⁹ This special kind of PC production shows that endogenous S&T as part of *the national S&TS is not being used and will not be needed in the foreseeable future.*

Considering the situation on the Eastern European computer markets and the particularities of production, the main result of the investigation is that a special S&T policy for computer technology is not required in Eastern European countries. The domestic enterprises which participate in the PC business are competitive and use similar production structures to Western producers. Technological bottlenecks cannot be observed. Their firm establishment in their markets indicates no need for a S&T policy. A S&T policy in the fields for high performance computers does not seem to be a promising strategy in the foreseeable future and should therefore not be carried out.

6. Conclusions

The collapse of socialism implied a radical change of the science & technology systems (S&TS) in all Eastern European countries. A scientific policy must targeted at the predominant general conditions in the Eastern European countries instead of emulating western models which are condemned to fail in the prevailing underlying conditions.

Instead of simply copying Western-type supply-sided S&T-policies, we suggest the application of a demand-oriented S&T policy, targeting the competitiveness of enterprises.

We propose two guidelines for the development of such a demand-oriented policy: i) identification of the enterprise networks and their links to the S&TS, ii) evaluation of S&T requirements and corresponding adaptation of the post-socialist institutions. Old institutions for which there is no demand should be closed in favour of competitive and innovative institutions.

A demand-oriented strategy has advantages when compared to the traditional, supply-oriented S&T policies that is common in Western countries. The starting point for the demand-oriented S&T policy is at the micro level where the radical structural changes have taken place. This should guarantee that they are taken up in the development of S&T policies. Through the orientation towards existing demand, the predominant conditions are systematically taken into account. Furthermore the focus on the micro-level ensures that differences between sectors are noticed and the required instruments are chosen accordingly. Lastly it enables to systematically identify competitive and required institutions which are still eligible for public funding.

A demand-oriented S&T policy is also worth considering in a non-post socialist context. In Western countries where the state budgets are rapidly decreasing, a reorientation of the S&T policies will be necessary over the next few years. The research done under the restrictions in Eastern Europe today will possibly offer strategies for the future and a demand-oriented S&T policy could be a part of this.

¹⁹ In contrast to this, the production of high performance computers is still characterised by proprietary technology and a high R&D intensity. Eastern European enterprises failed to catch up with international computer producers in terms of technology, and therefore the market segment for high performance computers is dominated by international computer producers, such as IBM, Fujitsu, Siemens etc. Even in Western countries the attempt to break US and Japanese enterprises' leadership in computer technology with the support of the state failed and has declined in recent years, see Vickery, 1996.

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Zusammenfassung

Wissenschafts- und Technologiepolitik in Osteuropa — Ein nachfrageorientierten Ansatz

Das Papier analysiert die Umstrukturierung osteuropäischer Wissenschafts- und Technologiesysteme (W&T) auf dem Weg vom Sozialismus zur kapitalistischen Marktwirtschaft. Arbeitshypothese ist, daß durch den Systembruch der größte Teil sozialistischer W&T-Kapazitäten entwertet wurden; übrig bleiben fragmentierte W&T-Systeme, die sich jenseits der neu strukturierten, überwiegend international ausgerichteten Unternehmensnetzwerken entwickeln. Unter diesen Bedingungen kann sich eine Innovationspolitik nicht auf die Bereitstellung eines W&T-Angebots beschränken. Wir schlagen alternativ einen nachfrageorientierten Ansatz vor, bei dem i) der von der tatsächlichen Nachfrage der Unternehmen nach W&T-Inputs ausgeht sowie ii) eine beschleunigte Umstrukturierung, Verkauf oder Schließung derjenigen Einrichtungen vornimmt, deren Leistungen nicht mehr nachgefragt werden. Wir wenden den Ansatz exemplarisch auf drei unterschiedlich strukturierte Branchen an: Software, Schiffbau und Computer. Es stellt sich heraus, daß der Spielraum für eine nachfrageorientierte W&T-Politik im Postsozialismus sehr begrenzt ist. Der grundlegende Strukturwandel, an dem sich eine post-sozialistische Innovationspolitik anpassen muß, erfordert ein Vorgehen auf Unternehmensebene; Politiken können sich nicht auf aggregierte W&T-Indikatoren auf Makroebene beziehen. Die Analyse des Neuanfangs in Osteuropa birgt auch Lehren für eine stärkere Nachfrageorientierung der Innovationspolitik in Westeuropa.