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The erosion of state capacity and the European innovation policy dilemma: a comparison of German and EU information technology policies

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The Erosion of State Capacity and the European Innovation Policy Dilemma

A Comparison of German and EU Information Technology Policies

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September 2000

Institut für Höhere Studien (IHS), Wien
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Founded in 1963 by two prominent Austrians living in exile – the sociologist Paul F. Lazarsfeld and the economist Oskar Morgenstern – with the financial support from the Ford Foundation, the Austrian Federal Ministry of Education, and the City of Vienna, the Institute for Advanced Studies (IHS) is the first institution for postgraduate education and research in economics and the social sciences in Austria. The **Political Science Series** presents research done at the Department of Political Science and aims to share "work in progress" before formal publication. It includes papers by the Department's teaching and research staff, visiting professors, graduate students, visiting fellows, and invited participants in seminars, workshops, and conferences. As usual, authors bear full responsibility for the content of their contributions.

Das Institut für Höhere Studien (IHS) wurde im Jahr 1963 von zwei prominenten Exilösterreichern – dem Soziologen Paul F. Lazarsfeld und dem Ökonomen Oskar Morgenstern – mit Hilfe der Ford-Stiftung, des Österreichischen Bundesministeriums für Unterricht und der Stadt Wien gegründet und ist somit die erste nachuniversitäre Lehr- und Forschungsstätte für die Sozial- und Wirtschafts-wissenschaften in Österreich. Die **Reihe Politikwissenschaft** bietet Einblick in die Forschungsarbeit der Abteilung für Politikwissenschaft und verfolgt das Ziel, abteilungsinterne Diskussionsbeiträge einer breiteren fachinternen Öffentlichkeit zugänglich zu machen. Die inhaltliche Verantwortung für die veröffentlichten Beiträge liegt bei den Autoren und Autorinnen. Gastbeiträge werden als solche gekennzeichnet.

Abstract

The article analyzes the impact of the globalization of markets, technologies and companies and of the Europeanization of public policies on state capacities in technology policy. Based on empirical examples from the field of information technology, the article argues that technology policy has been characterized by two contradictory developments in the last two decades. On the one hand, the concepts and strategies guiding public policies have become more and more complex, resulting in comprehensive programs for national and European „innovation policies“. On the other hand, as a result of the economic globalization; as well as of changes in the internal structure of the state, the state capacities to implement these ambitious strategies successfully have been eroding. As a consequence, technology policy both on the national and on the supranational level has been confronted with an intensifying strategic dilemma. Finally, the article discusses policy options to cope with this strategic dilemma in innovation policy.

Bemerkungen

Hier können allgemeine Bemerkungen eingefügt werden. Falls das nicht gemacht wird, muss hier eine leere Seite stehen (damit das Inhaltsverzeichnis auf einer ungeraden Seite beginnt).

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1. Economic Globalization and National Technology Policy

For decades, the public support of scientific and technological innovations has been regarded as being one of the major functions of the modern welfare state. The pursuit of "national interests" and the international competition between states and between companies have guided the establishment and the expansion of national research capacity, and have shaped the development of modern technologies – for both civilian and for military purposes. The globalization of companies, markets and technologies, however, has significantly affected this role of the nation state and its capacity to act in technology policy.

The challenges which confront the nation state in technology policy at the turn of the century are highly ambiguous. On the one hand, since the late 1980s a rapidly expanding number of authors has argued that, in the process of globalization, both the importance of technology for the public welfare of modern democracies and of the nation state as a promoter of technological advances and of industrial competitiveness have been increasing (see e.g. Brandin, Harrison, 1987; Porter, 1990; Stopford, Strange, 1991; Tyson, 1992; Thurow, 1992; Luttwak, 1993). According to the new "logic of technology wars", states are no longer competing for power over more territory, rather they are competing for the means to create wealth within their territory (cf. Stopford, Strange 1991, p. 1). And "technology, because it affects standards of living and wealth and because it is the source of the superweapons of the future, is the new area of competition. But it is not the traditional competition of capitalism. This conflict is more sophisticated than the competition found in most of the existing political and economic systems. Only the most clever and enduring competitors will be rewarded in the arena. Those that prevail in this war will control the resources of the world; they will control their Lebensraum; they will be the next global powers" (Brandin, Harrison, 1987, p. V).

On the other hand, there are frequent claims that, due to the globalization of companies, markets and technologies, the very capacity of the nation state to promote and to control the creation, distribution and utilization of advanced technologies has been declining (Ohmae, 1990; Camilleri, Falk, 1992; OECD, 1992; OECD, 1999; Muldur, Petrella, 1994; Gerybadze et al., 1997). Most important in this respect is the growing asymmetry between the limited, territorially-based scope of the state's jurisdiction and the global, borderless range of action of companies. According to the "logic of global capitalism", the notion of a "national interest" has lost its significance: "The global economy follows its own logic and develops its own web of interest, which rarely duplicate the historical borders between nations. As a result, national interest as an economic, as opposed to a political, reality has lost much of its meaning" (Ohmae, 1990, p. 183) – and, one could add, states have lost most of their functions in technology policy.

Against this background, it is the purpose of the following article to give an empirical account of the development of state capacity in German and European information technology. Based on a concept of state capacity derived from neo-institutionalist policy analysis (Section 2), the article first looks at the development of national state capacity in the German IT sector (Section 3). The results indicate that there has been a significant decline in national state capacity to influence this sector. The crucial question addressed in the second part of this article (Sections 4 and 5) then, is whether the transfer of policies from the national to the European level has compensated for this loss of national state capacity. Has it been possible to "bring the state back in" within a more complex institutional architecture, thus strengthening Europe in the global technology race? Or has the Europeanization of technology policy reinforced the erosion of state capacity in Europe?

2. State Capacity in Technology Policy – A Neo-Institutionalist Approach

Any attempt to identify the capability of public actors to reach their strategic goals in a distinct policy field, such as technology policy, is confronted with the problem of finding an appropriate concept of "state capacity" which could be employed in empirical research. This is not to say that a grand theory of "The State" is needed in the first place. As historical and comparative institutionalist research has shown, "possibilities for state interventions of given types cannot be derived from some overall level of generalized capacity or 'state strength'" (Evans et al., 1985b, p. 353). But state capacity is not simply the sum of the state's legal competencies and of its financial, human and military resources either (on the various concepts of "state capacity", see Weiss, 1998, pp. 14–40). According to neo-institutionalist policy analysis, policy outcomes can be interpreted as the composite effect of a large variety of institutional variables, i.e. institutions are the main explanatory variable. In contrast to older concepts of institutionalism, neo-institutionalist policy-analysis is guided by a much broader understanding of institutions. The neo-institutionalist concept includes "both formal organizations and informal rules and procedures that structure conduct" (Thelen, Steinmo, 1992, p. 2); and, in addition, this concept goes beyond the realm of public actors and organizations, including private actors and organizations as well. Based on this broader concept of institutions, neo-institutionalist policy research has identified a number of "institutional" variables which can be instrumental in explaining policy outcomes and which, in sum, can contribute to a state's capacity in a particular policy field (Zysman, 1983; Evans et al., 1985a; Hall, 1986; Scharpf, 1987; Steinmo et al., 1992; Weaver, Rockman, 1993; Mayntz, Scharpf, 1995; Hall, Taylor, 1996; Weiss, 1998). Among these variables are the rules of electoral competition; the structure of party systems; the organization of government and the relations among its various branches and levels; the governance of markets; and, the structure and organization of economic actors such as companies, business organizations

and trade unions. Most important for the purpose of this article are the following three sets of variables:

- first, the state's internal structure and its resources, e.g. the horizontal and vertical division of power, and the norms, rules and habits guiding the behavior of politicians and public officials;

- secondly, the internal organization of the relevant societal sub-sectors, e.g. the governance of markets, the organization of an industry and the internal resources of companies;

- thirdly, state-society relations, i.e. the (formal and informal) relations between the state and the actors and organizations in the relevant societal sub-sectors, e.g. the inter-organizational relations between government departments and companies.

In this analytical perspective, state capacity is the product of a complex configuration of public and private actor constellations with their respective interests, strategies and resources. First of all, the success of public policies depends on the state's capability to strategically provide and allocate resources. Without adequate institutional capacity, appropriate policy instruments, or a certain degree of strategic coherence, governments would certainly not be able to influence the activities of companies or research laboratories. However, even the most generous and well-administered public program would miss its target if the companies ignore it or if they only use public money to replace internal funds which are already available. Hence, the success of industry-related public R&D policies also depends on the structural opportunities and restrictions the companies offer, i.e. their competitive environment, their strategies, their internal organization, etc. Moreover, successful policies are often based on close and stable relations between public actors and companies. Without such links and without the trust developed within these networks, the government lacks sufficient knowledge about possible and necessary interventions which can easily result in the exploitation of its activities through opportunistic behavior by the companies.

In the perspective of a neo-institutionalist state theory, the approach outlined here is broader than the neo-Weberian approach as emphasized, for example, by Theda Skocpol and others (Evans et al., 1985a). Rather, it builds upon Peter Katzenstein's concept of a "policy network" as presented in "Between Power and Plenty" (Katzenstein, 1978), and the institutionalist approach advanced by Peter Hall in his book "Governing the Economy" (Hall, 1986). In the perspective of empirical policy research, the approach employed in this article combines the usual "top-down" approach with a "bottom-up" analysis, as suggested by Paul Sabatier (1986).

3. The German State and the IT Industry

For a better understanding of some of the recent problems in European technology policy, historical comparisons with German technology policy in the 1970s and 1980s can be highly instructive. Both the German state and the German research system show some features which also characterize the institutional architecture of European technology policy (Reger, Kuhlmann, 1995). In regard to German technology policy, it is important to emphasize four basic characteristics:

– first, the German state is highly fragmented. The organization of the national government gives its various branches a high degree of autonomy and, in addition, the national government has to share considerable powers with the federal states (Länder). In technology policy, the national government commands the largest budget. This is indicated, for example, by the distribution of public expenditures for R&D outside the universities. In 1997, 16.3 billion DM were spent by the national government, compared to 4.8 billion DM spent by the sixteen federal states (Länder) (BMBF, 1998b, p. 374). However, outside their own budgets, the federal states have a number of possibilities to participate in national policy-making;

– secondly, the German R&D system is regarded as highly differentiated. In a comparative perspective, the most striking feature is the institutional differentiation of strong public research organizations outside the university system responsible for basic and applied research (among them the Max-Planck-Society and the Fraunhofer Society) which enjoy considerable autonomy from government (see Hohn, Schimank, 1990);

– thirdly, despite the existence of a considerable number of public research organizations, industry accounts for the major share of R&D in Germany, although its share of R&D expenditures has been declining significantly during the 1990s – from 64 per cent in 1990 to 60.8 per cent in 1996 (BMBF, 1998b, p. 6). In 1997, 61.6 per cent of research and development expenditures came from industry. Applied research and experimental development are almost exclusively the province of industry;

– fourthly, the societal sub-systems involved in technology policy, namely science and the economy, enjoy a high degree of functional autonomy from the state. According to the self-image of the major actors in politics, science and industry, this autonomy is one of the preconditions for the efficiency of the German R&D system. This is not to say that there are no networks between government and the research community or business. Empirical analysis has shown that there is a multitude of formal and informal contacts (see Meyer-Krahmer, 1989; Grande, Häusler, 1994). However, it implies that the government's scope for direct, hierarchical intervention is limited.

As a consequence of this constellation, German technology policy has been, for most of the time, characterized by a feature which has become typical for European technology policy too. Rather than establishing and controlling public research laboratories, the state had to guide and control private R&D activities without destroying the autonomy of science and industry. This means that from the very beginning of a deliberate national technology policy in the early 1960s, public authorities had to employ the techniques of an "indirect management", as analyzed by Lax and Sebenius (1986) in the case of industrial companies: they had to provide positive incentives for companies, coordinate programs and policies, negotiate with research organizations and with companies, etc. Of course, the crucial questions then became: Did the German state actually have the capacity to purposefully intervene into the R&D activities of industry by these means? Was it possible to promote the technological and economic competitiveness of companies?

The following empirical analysis is based on a sector study of the German IT industry, mainly covering data processing, micro-electronics and telecommunications. The IT sector is highly instructive for an analysis of state capacity in technology policy since this sector has been regarded as being of strategic importance for both military power and the industrial competitiveness of every major industrial country. Hence, this sector has been one of the major targets of technology policy and one of the most desirable assets in the "technology race" between advanced industrial countries (Arnold, Guy, 1986).

Germany has been no exception. An empirical analysis of the role of the state in the German IT sector (see in particular Grande, Häusler, 1994) shows that industrial R&D activities and public R&D policies have been closely linked for a long time. Despite the public commitments to a free market economy, every government – regardless of its ideological profile – has tried to promote industrial research in information technology. Since the late 1960s, the state has launched numerous programs intended to influence and to stimulate companies' R&D activities or, sometimes, to overcome their reluctance to innovate. All of these programs were "obsessed" by the goal to improve the "competitiveness" of the "national" industry vis-à-vis their foreign competitors, IBM in particular. For this reason, the programs were adressed to the small "club" of "national" companies and were formulated in close cooperation with the companies.

As of 1967, when the first national program for the computer industry started, until 1989, the Federal Research Ministry spent about 10 billion DM to promote information technology (i.e. data processing, micro-electronics, telecommunications and industrial automation). More than half of this money (approximately 5.5 – 6 billion DM) was given directly to the German IT industry. Quite obviously, the German state was very active in promoting the IT industry with the aim of improving its competitiveness on the domestic market and abroad. But did the state actually have the capacity for successful interventions?

If one takes the industry's market performance as an indicator for the policy's success, the German R&D programs promoting the IT industry can hardly be regarded as being particularly successful. The number of "national" companies has been very small in the past decades anyway. In micro-electronics, the domestic supply mainly came from Siemens and AEG; in data processing, in addition to Siemens and AEG, some smaller companies such as Nixdorf, Kienzle and Triumph-Adler entered the market in the 1970s. Because of the de facto closure of the national telecommunications market, the market position of domestic telecommunications companies was stronger, with Siemens being the major supplier of the national PTT (the Deutsche Bundespost).

At the end of the 1990s, Siemens is the only major "German" IT company which has survived, and even Siemens has decided to sell its micro-electronics business. Its former long-time competitor AEG was taken over by Daimler Benz in the early 1980s, and most of its IT activities were either sold or closed. Most of the smaller German IT companies have been taken over by foreign companies, for example Mannesmann-Kienzle by DEC and Triumph-Adler by Olivetti. Promising new start-ups have been extremely scarce and even the most promising ones, like Nixdorf, have been unable to survive.

Even without a comprehensive evaluation of the IT programs, it is obvious that German IT policy has failed to meet most of its goals most of the time. Success stories, like those of the Japanese governmental programs in the 1960s and 1970s in the fields of data processing, micro-electronics and telecommunications (Anchordogay, 1989; Fransman, 1990), are missing completely. This poor record could well be taken as evidence that it is useless in principle for the state to intervene in the economy and in the proper working of markets. Upon closer inspection, however, it becomes obvious that the organization of the German IT industry offered opportunities for purposeful and selective intervention. In principle at least, public programs could have (and have!), to some extent, influenced the course and the scale of the companies' research (for telecommunications, see Schnöring, Neu, 1991). However, the use of these opportunities has been restricted by various institutional factors both within the companies and within the state structure. In fact, empirical studies have shown that very particular constellations of factors were responsible for the programs' limited success. Two examples may suffice to illustrate this point (for more details see Grande, Häusler, 1994).

The first example comes from the field of data processing. In data processing, the German government chose a highly ambitious strategy in the 1970s: to make a frontal attack on the market leader IBM in the market in which IBM was strongest, which at that time was the mainframe business (cf. Flamm, 1988). Such a strategy would have been very demanding and risky anywhere; and in the German case it soon turned out to be too much for both the companies as well as the state. As far as the state's role was concerned, the strategy chosen would have required at least an effective coordination of R&D programs and of public procurement, as emphasized in the literature on successful technology policies (cf. Nelson, 1982; Lundvall, 1985). Such a comprehensive approach of combining "technology push"

programs and “demand pull” policies was already advocated by the German computer industry in the mid-1960s and the Federal Research Ministry repeatedly tried to employ this approach in its data processing programs. However, for institutional reasons, particularly the decentralized structure of the “semi-sovereign” German state and its bureaucracy (cf. Katzenstein, 1987), such a coordination came to nothing. As a consequence, the share of domestic IT companies (mainly Siemens) receiving government contracts for data processing equipment in Germany was well below the respective shares in other countries with a national computer industry (France, Japan, the U.S.). In the end, the technology policy strategy that emerged within this sector in the 1970s was a plain technology push strategy with very limited success.

The second example comes from the field of telecommunications. At first sight, the telecommunications sector seemed to offer much more favorable conditions for national technology policy in Germany. In this sector, there was a centralized public agency, the Deutsche Bundespost, which enjoyed a full-range monopoly on networks, services and equipment, and close, well-established links to a small “club” of domestic equipment suppliers. The problem in this case was, that the Deutsche Bundespost, for various organizational reasons, turned out to be a rather conservative force and in the late 1970s, was blamed for being responsible for the declining international competitiveness of the German telecommunications equipment industry. The close links between the Deutsche Bundespost and the equipment industry were regarded as a handicap rather than an advantage. And because of the strong institutional autonomy of the Deutsche Bundespost from direct government intervention, the Federal Research Ministry’s attempts to make the PTT more receptive to technological innovations came to nothing. In this constellation, the Federal Research Ministry tried to loosen relations between the PTT and the industry by offering a R&D program in telecommunications and by advocating the liberalization of the telecommunications equipment market. As in data processing, the program’s success has been limited, partly because the major industrial players, like Siemens, were reluctant to participate, and partly because the PTT failed to efficiently absorb the companies’ growing technology potential in its procurement policy. The main beneficiaries of the program were Siemens’ smaller competitors, mainly SEL (then an ITT-subsidiary) and AEG, which were later taken over by foreign competitors like Alcatel and Philips (and, most of AEG’s telecommunications business, by Bosch).

In both examples, it was not a lack of money or a lack of knowledge on behalf of the state, or the companies’ unwillingness to participate in national programs, which were responsible for the policy’s disappointing results. Rather, it was a highly contingent constellation of institutional factors in each sector which explains most of the programs’ poor performance.

In the 1980s, German technology policy for the IT sector responded to the obvious shortcomings of its programs not by reformulating its goals, but by refining its underlying strategy. In the face of intensifying international competition, the Federal Government

adopted a comprehensive innovation policy strategy, articulated in two national framework programs for information technology, the "Regierungsbericht Informationstechnik", effective as of 1984, and the "Zukunftskonzept Informationstechnik", enacted in 1989. Both programs included a broad range of activities and instruments distributed over a number of policy fields. In addition to public R&D subsidies, policy fields such as competition policy, public procurement, standardization, data protection, education policy, the modernization of the public telecommunications infrastructure, and the liberalization of the national and European telecommunications markets, to mention only a few of the most important, would be designed in such a way that they would contribute to the international competitiveness of the German IT industry. These approaches corresponded very well with theoretical approaches which advocate more comprehensive strategies in innovation policy (cf. in particular Porter, 1990). In the German context, however, these integrated innovation policy approaches were over-ambitious and had no chance to be realized. A proper implementation of these approaches would have required an intensive "positive" coordination of governmental policies; however, in the German system of government – with its high autonomy for each Federal Ministry – such an effort was unrealistic (Mayntz, Scharpf, 1975).

In sum, we can see that German technology policy for the IT sector was confronted with a protracted strategic dilemma: Those technology policy strategies which were feasible within the existing institutional structures of the German state turned out to be under-complex and, thus, inadequate to reach the programs' goals; however, more adequate, comprehensive policy strategies tended to be over-complex, thus overstraining the institutional capability of the German state. This innovation policy dilemma has intensified during the 1990s as a consequence of the globalization of markets, companies and technologies on the one hand, and as a consequence of the Europeanization of technology policy on the other.

4. The Erosion of State Capacity in German IT Policy (I): The Globalization of Markets, Firms and Technologies

At about the same time as the German state started its most ambitious attempt to support the "national" IT industry in its intensifying competition with foreign rivals, state capacity in technology policy had significantly begun to decline. Meanwhile, plenty of empirical evidence illustrates that public interventions in the companies' R&D activities have become much more difficult, if they are still possible at all (cf. Grande, Häusler, 1994; Gerybadze et al., 1997; Hack, 1998; Meyer-Krahmer, 1999; OECD, 1999). The first and most important factor responsible for the erosion of the state capacity to intervene is the globalization of technologies, markets and companies. In the case of IT industry – one of the industrial sectors affected most -, globalization has triggered various changes both in the companies'

internal structures and in their external relations. In the context of national technology policy, three processes have been of particular importance:

First, the decentralization of R&D activities: One of the major changes in business R&D has been a reorganization of research: “Large firms are pulling back from long-term projects, and instead integrating R&D into product development” (OECD, 1999, p. 7). In the IT sector, this development has been particularly vivid. Already in the 1980s, IT companies had started to reorganize their R&D activities with the goals of exploiting their R&D more effectively, speeding up the development of new products, and making R&D departments more responsive to customer needs. In practice, this means that they have cut back their central R&D laboratories and integrated R&D activities into the various product divisions. A clear indication of this development is the decline of basic research in the large German IT companies (Siemens, Daimler, Bosch). In 1979, 8.2 per cent of their overall R&D expenditures was for basic research; whereas in 1987, only 4.8 per cent was for basic research (Grande, Häusler, 1994, p. 374). Meanwhile, in some fields such as telecommunications, basic research performed in central research facilities has almost disappeared.

Secondly, the internationalization of R&D activities: The assumption that the companies’ R&D activities would be an “important case of Non-Globalization” (Patel, Pavitt, 1991) has by and large turned out to be wrong. Recent data from the OECD indicate that the R&D activities of multinational corporations “are no longer firmly anchored to their home bases” (OECD, 1999, p. 8). In the major OECD countries, foreign subsidiaries already account for 12 per cent of total industrial R&D spending (OECD, 1999, p. 8). It is true that there are significant cross-national and cross-sectoral variations. Whereas U.S. and Japanese companies still execute more than 90 per cent of their R&D activities in their home country, in smaller countries a considerable share is already abroad. In the Swiss case, for example, about 50 per cent of the companies’ R&D is abroad (Boutellier et al., 1996, p. 283). In the German case, the foreign subsidiaries of German companies spent about 10 billion DM on R&D in 1995, which was about 17 per cent of the companies’ total national R&D expenditures; conversely, about 16 per cent of the industry’s R&D expenditure in Germany come from the subsidiaries of foreign companies (BMBF, 1998b, p. 7). In information technology, the major “national” company, Siemens, is well above this average. The share of its foreign R&D employees doubled from 15 per cent in 1985/86 to 30 percent in 1998. In 1998, Siemens occupied about 14,000 R&D employees abroad, dispersed over 28 countries and 56 locations (Weyrich, 1998).

Thirdly, the integration of R&D activities into global networks of inter-firm cooperations: Although cooperation between firms has a long tradition in the IT sector, the 1980s witnessed a tremendous increase in the number of joint ventures, strategic alliances and R&D co-operations: “From 1980 to 1994, the total number of science and technology alliances grew at 10.8 per cent per year, and about 65 per cent of those alliances involved

two partners from different countries" (OECD, 1999, p. 13). In the case of German IT companies, already in the early 1990s, approximately 90 per cent of the technological collaboration efforts involved a foreign partner. Siemens, for example, in 1991/92 was involved in about 1,400 cooperative projects; and there were only two German companies among the company's major partners

As a consequence of all these developments, the target of public R&D policies has been fundamentally changing. In contrast to the heyday of national technology policy, when the state dealt with a small number of clearly distinct national companies, the target of public policy is now an ever-changing, intricate network of "multi-domestic" corporations. This new constellation raises several problems for any purposeful political intervention into corporate R&D trying to create national competitive advantages. First of all, since it was the central R&D laboratories with their long-term, generic research which used to be most receptive to public R&D programs, the decentralization of corporate R&D implies that the "window of opportunity" for purposeful government intervention into the companies' R&D activities has become much smaller. Moreover, since the distinction between "home" and "host" countries has been blurred, any "national technology policy to support specific forms of activities becomes increasingly meaningless because there are so many leakages – in both financial advantages and research results – to non-national companies" (OECD, 1991, p. 100).

In principle, there are three strategic options for technology policy to overcome these difficulties: first, to adapt its strategic goals to the new constellation; secondly, to develop new instruments which are better suited to the new constellation; and thirdly, to adapt the institutional architecture of technology policy to the new global context.

In practice, technology policy has to some extent tried to make use of all these options: "As a reaction to the globalisation of the research base, many governments are experimenting with new science and technology policy goals and new tools to reach these goals" (OECD, 1999, p. 9). German technology policy has been no exception from this general trend. In the course of the 1980s, the promotion of basic research, mainly in public research organization, was given priority over the public support of corporate R&D. Consequently, the volume of national R&D subsidies to industry has been stagnating since 1981, whereas expenditures for public research organizations have almost doubled. In the case of Siemens, the share of public subsidies to the company's budget for R&D declined from 10 per cent in 1980 to 2.9 per cent in 1990 (Grande, Häusler, 1994, p. 377). In addition, new instruments to promote R&D in small and medium-sized companies, and to stimulate technology based start-ups, have been employed – to mention only a few of the new programs developed in the 1980s and 1990s. The institutional architecture of technology policy has also been changing significantly since the early 1980s. Partially, at least, as a response to the globalization of technologies, markets and companies, new institutional levels of technology policy-making above ("Europeanization") and below ("regionalization") the nation state have been emerging.

5. The Erosion of State Capacity in German IT Policy (II): The Europeanization of Technology Policy in the IT Sector

Most important in this respect is the Europeanization of technology policy, which gained new momentum in the 1980s. It is true that European cooperation in technology policy was one of the earliest examples of supranational integration with the European Atomic Energy Community (EURATOM) founded already in 1957. However, after the crisis of EURATOM in the mid-1960s, it rather seemed as if the European countries would cooperate only outside the Community framework, if at all. In the aviation sector, bilateral agreements such as the Anglo-French Concorde and the Franco-German Airbus have been the predominant mode of cooperation; in the space sector, cooperation took place in the framework of international organizations such as the European Space Agency (ESA), founded in 1975. Attempts at European cooperation within the Community framework in data processing (Eurodata, Unidata) and in micro-electronics, initiated in the late 1960s and 1970s, failed completely (cf. Sharp, Shearman, 1987, pp. 24–41).

In the 1980s, however, economic and technological changes radically transformed the perceptions about technological and industrial competitiveness in Europe and about the need for collaborative efforts on the European level (Peterson, 1993; Sandholtz, 1992; Sharp, Shearman, 1987; Peterson, Sharp, 1999). The dramatic decline of European industries in strategic sectors such as micro-electronics and data processing, U.S. predominance on globalizing markets, and the rise of Japan as a technological power combined to trigger a new "technology gap" debate, thus creating a favorable climate for a "common European response". Compared to the frustrating national efforts (see e.g. Cawson et al., 1990), a common European response was expected to offer several advantages. It would help to overcome the fragmentation of national resources and programs, and it would offer a common cooperation platform for the European companies. In brief, by transferring competencies and resources from the national to the supranational level, both the scope and the scale of technology policy would be expanded, and the growing gap between globalizing markets and national policies would be bridged.

Based on this rationale, the European Community became a major player in technology policy in the 1980s. With the adoption of the "First Framework Programme" in the summer of 1983, a fundamental strategic reorientation of the Community's science and technology policy was introduced. A new emphasis was given to activities designed to improve the competitiveness of European industry, and a new generation of sectoral programs was initiated, targeted at a number of high-tech industries whose competitiveness was expected to be crucial for the industrial development of Europe. In the following years, the EC established a very comprehensive framework of programs aimed at improving the competitiveness of European industry.

In addition to research funding, the European Community (resp. Union) has acquired competencies in a multitude of areas, which are of importance for the regulation of technological developments and the improvement of industrial competitiveness. When it comes to such issues as the establishment of guidelines for environmental protection, the regulation of genetic engineering, the liberalization of the telecommunications markets or data protection, agreement on technical norms and standards, or the approval of corporate mergers, the EU has become a crucial actor, in some areas even the most important actor. And by strictly monitoring R&D funding in the member states on the basis of its competencies in competition policy, the Community has, for quite some time now, restricted their capacity to act in the area of technology policy.

The sector that has gained most attention in the Community's new strategy has been information technology. ESPRIT, the Community's new program for the promotion of R&D in the information technology industry, prepared in the early 1980s, became the "flagship" of the Community's technology policy (Sandholtz, 1992; Grande, Häusler, 1994; Peterson, Sharp, 1999). Other programs based on the "ESPRIT model" in telecommunications (RACE), and on the use of telematics in various sectors of society (transport, medicine etc.) were swift to follow. In its first four "Framework Programmes", the Community spent about 9 billion ECU on its various IT programs. In the late 1980s and the early 1990s, about 40 per cent of the Community's research budget was devoted to information technology. In the fifth "Framework Programme", which started in 1999, 24 per cent will be spent in the field of information technology, i.e. 3.6 billion ECU (BMBF, 1998a, p. 25).

In the 1980s, the main target of the respective programs were the big IT companies in the EC member states (GEC, Philips, Siemens, Thompson etc.). In the heyday of the ESPRIT program, the European IT companies received more than half of their public R&D subsidies from Community programs. It is true, however, that these subsidies were only a small share of the companies' overall R&D budget anyway. In the case of Siemens, for example, only 2 per cent of the company's research is currently financed by public funding. This should not be taken as an indicator, however, that public R&D subsidies have become irrelevant for the large, globally-operating companies. A closer look reveals that these subsidies can still be highly significant. For example, in the early 1990s, 20 to 30 per cent of the European IT companies' long-term generic research was conducted within the various EC programs.

Despite all these programs and activities, the Community's technology policy has not been particularly successful either – if success is measured by the policy's contribution to the competitiveness of the European IT industry (Peterson, Sharp, 1999, pp. 205–207). It is true that the programs have contributed to intensifing cooperation between European researchers and research institutes in Europe. However, the European companies have failed to gain significant shares of the IT world market. At the end of the 1990s, the industry's international market position was still feeble. In 1995, after ten years of massive Community support for the European IT industry, the Commission had to concede that "over the last

fifteen years its (i.e. the EU's; EG) technological and commercial performance in high-technology sectors such as electronics and information technologies has deteriorated" (European Commission, 1995, p. 5).

There are many reasons for the disappointing performance of the Community's IT programs. First of all, it soon became obvious that European programs were unable to overrule the global logic of markets, companies and technologies. Initial hopes that the companies would prefer to cooperate within Europe and compete outside Europe turned out to be illusionary. In the 1990s, the companies adopted complex strategies with a mix of national, European and global partnerships and rivalries. In micro-electronics, for example, ideas to establish a "European" chip factory with the help of Community funding were not only at odds with the Community's competition policy, but also with the companies' global strategies. Siemens, one of the prime targets of plans like these, not only participated in the various national and European programs available, but also cooperated with U.S. (IBM, Motorola) and Japanese (Toshiba) competitors in the development and production of advanced semiconductors.

In addition, Community R&D programs in IT initially suffered from a considerable strategic deficiency. Programs such as ESPRIT, BRITE and EURAM were designed purely as "technology push" programs. The aim of these programs was to produce a "technology push" which was expected to lead to a substantial improvement in the industrial competitiveness of the EC. Similar to the German IT programs of the 1970s and 1980s, the effectiveness of such "technology push" programs was very limited. For example, the most in-depth evaluation of the ESPRIT program concluded that "In particular the industry led, technology push, approach of ESPRIT, whilst demonstrably capable of producing good results, is not achieving the lift in European competitiveness which is now called for" (Dekker Report, 1992, p. 33).

By the end of the 1980s, the European Commission began to realize the shortcomings of its technology policy and started developing a more comprehensive innovation policy approach, similar to German technology policy a decade ago. Inspired by Michael Porter's seminal work on the "Competitiveness of Nations" (Porter, 1990), which was to become the new holy book for the Commission's technology policy, the Community modified its strategy in this policy field. The new strategy was based on the assumption that the existing problems of competitiveness in European industry are caused not so much by technology "gaps" or lack of funds for research, but rather by severe deficiencies in the diffusion and application of generally well-known technologies and their integration into complex technical systems. The European Commission repeatedly emphasized "that the main problem of European firms is not primarily the amount of their R&D expenditures, but rather their inadequate ability to turn their research and technology developments into inventions and to turn their inventions into market shares and profits". The result, as the Commission concluded, is "a distinct gap between Europe's efforts in basis research and R&D investments on the one hand and the

results in the area of innovation and competitiveness on the other" (European Commission, 1992, p. 10).

This problem, called the "European paradox" (European Commission 1995: 5; see also Andreasen et al. 1995), was addressed in several expert reports to the Commission (e.g. the Ciampi report; Consultative Group on Competitiveness, 1995), and in various White and Green Papers presented by the Commission in the 1990s on industrial, economic and innovation policy (European Commission, 1990; 1993; 1995). In its White Paper on industrial policy, for example, R&D policy (as an "accelerator") was integrated in a comprehensive framework including competition policy, education policy, cohesion policy, environmental policy, trade policy and policies for small and medium-sized companies (European Commission, 1990). In its Green Paper on Innovation, the Commission stated: "Strengthening the capacity for innovation involves various policies: industrial policy, RTD policy, education and training, tax policy, competition policy, regional policy and policy on support for SMEs, environment policy, etc. Ways must therefore be found of identifying, preparing and implementing – in a coordinated fashion – the necessary measures covered by these various policies" (European Commission, 1995, p. 3).

The experiences of German IT policy in the 1980s would suggest that the major problem is not the identification of policies, rather, it is their coordinated preparation and implementation. And the crucial question, in fact, is whether European policies are able to overcome the deficiencies of national policies in this respect. Empirical analyses of European technology policy confirm this assumption (Grande, 1994; 1995). The EU's political and administrative structures are to a limited extent only, able to meet the demands placed on an integrated innovation policy at the Community level. It is common knowledge that the decision making process is protracted, that its results often consist of unsatisfactory compromises and that the administrative implementation of decisions is cumbersome.

However, it would be wrong to only blame the European Commission for these institutional deficiencies. The core of the institutional problems of European technology policy is the fact that policy must be developed and implemented in a multi-level framework of governance with complicated interactions among national and European actors and institutions (Grande, 1999). In this institutional context, the representatives of the national research administrations play a key role in the European decision-making process. Due to the unstable balance of power between the Council, the Commission and the Parliament on the one hand, and between the EU and its member states on the other, these processes are usually extremely complicated and correspondingly lengthy, insofar as they are formalized at all.

In such an institutional framework, a high degree of consensus on the goals and priorities of European technology policy among the participants of negotiation processes would be necessary in order to make quick and appropriate decisions. In the previous two decades,

this has not been the case. The negotiations concerning the Community's "Framework Programmes" and its numerous "specific" programs have shown that there are not only multi-faceted cultural differences among the EU member states, but also a number of fundamental conflicts of interest, be they motivated by economic, regional or socio-political reasons (cf. Grande, 1995). As a result, programs "turn out to be shopping lists of national priorities, often with low coherence and little European value added", as, for *example*, the Davignon Panel concluded in its 5-year assessment of the EU's "Fourth Framework Programme" (Davignon Panel, 1997, p. 14). In the actual practice of funding, a complicated mix of political selection criteria, such as the "adequate" participation of small and medium-sized companies, the "just" return of funds to the member states or the "adequate" participation of economically less-developed member states, has always had to be taken into consideration – in addition to criteria of excellence. As a result, the programs' strategic coherence has been rather low.

In addition to these political and institutional deficiencies of the European policy process, the organization of competencies for technology policy in the European Commission is also ill-suited to implement an integrated policy strategy. Within the Commission, competencies are highly fragmented and the available coordination mechanisms available are weak. The administration of the research programs is divided among numerous offices and in the 1990s, even in information technology, two Directorates General (DG III and DG XIII) were responsible for the respective programs. The same is true for other domains vital to technology policy (e.g. transportation, telecommunications). In the past, the organization of offices was often governed by short-term political expediency rather than sound, task-oriented planning. In such an organizational setting, a close policy coordination would be particularly important. However, policy coordination within the Commission in general is said to be weak, and in the field of technology policy, it has clearly been inadequate (Agrain et al., 1989). By the end of the 1990s, John Peterson and Margaret Sharp arrive at the disillusioning conclusion that "It is difficult to see where RTD policy has been coordinated effectively with other EU policies – such as energy, transport, agriculture, the environment, or industry – despite the vastly increased importance of science and technology in all these sectors" (Sharp, Peterson, 1999, p. 221). Inter-Commission rivalries have been frequent, and rather than weakening, they even "appeared to be intensifying" (Peterson, Sharp, 1999, p. 218); and the Task Forces established in the mid-1990s, with the goal of improving policy coordination within the Commission, have been failing. The overall result has been a fragmented assessment of problems and an incremental development of programs – sometimes even working at cross-purposes, rather than an integrated policy approach.

Hence, there are good reasons why recent studies of European technology policy "stress the need for greater co-ordination of the various policies not only at the sectoral but also on the transnational level in order to better face the challenges of globalization. Stress laid on the co-ordination of the research, innovation and education policies supports the efforts of the European policy in these sectors which could find increased effectiveness if a similar

approach were followed in the Member States" (Lundvall, Borras, 1998, p. 3). However, there is no basis for the assumption that the EU is better equipped to cope with the problem of horizontal and vertical policy coordination than was Germany with its technology policy in the 1970s and 1980s.

At the end of the 1990s, it seems as if European technology policy has hit the same dead-end as German technology policy in the decades before. This is not to deny the theoretical plausibility and the heuristic value of an integrated innovation policy approach. But empirical evidence seems to indicate that the political and institutional preconditions for the coherent formulation and proper implementation of such an approach are unrealistic. As long as this coordination problem has not been solved, the Europeanization of technology policy only adds to the political and institutional complexity of technology policy-making without increasing the problem-solving capacity of the state. Hence, the European policy making process is confronted with the same innovation policy dilemma as that of Germany.

6. Conclusions: Towards a New Paradigm in European Technology Policy?

During the last two decades, technology policy in Europe has been characterized by two developments running in opposite directions. On the one hand, the concepts and strategies guiding public R&D policies have become more and more complex, resulting in encompassing programs for national and European „innovation policies". On the other hand, as a result of the globalization of technologies, markets and companies, and of changes in the internal structure of the state, the state's capability to successfully implement these ambitious strategies have been eroding. As a consequence, public R&D policy both on the national and on the supranational level has been confronted with an intensifying strategic dilemma: Policy strategies which have been feasible within the existing institutional structures turned out to be under-complex and, hence, inadequate to improve industrial competitiveness in the IT sector; however, more adequate, comprehensive innovation policy strategies tended to be over-complex and overstrained the state's institutional capability, in particular its capacity for horizontal and vertical policy coordination.

This has been one of the main reasons why the performance of the "competition state" (Peterson, 1993) in Europe has been rather disappointing in the past decades. Hitherto, national and European technology policy has responded to the problem of policy failure by designing even more ambitious, more comprehensive and better integrated programs and by tightening the networks between public authorities, companies and research organizations even more skillfully. The Commission's recent proposal for a "European research area" based on a "more co-ordinated implementation of national and European research programmes" is another example of such efforts (European Commission, 2000). If the

argument developed in this article holds true, these efforts would be futile. However, this does not imply that technology policy on a supranational level is useless or that it is impossible for the EU to pursue an ambitious strategic approach in this field. Rather, the argument implies that the deliberate strategies based on a full-scale "steering" of public policies and industrial activities are unsuited for a highly fragmented and decentralized institutional setting as exists both in Germany and in the EU.

The crucial question then, is whether or not there are possibilities to improve the performance of EU technology policy. In principle, there are at least three options which provide a way out of the innovation policy dilemma outlined above without giving up the substance of the policy's goals. The first option would be to concentrate and to centralize the institutional setting, the second one would be to decentralize the policy, and the third would be to adopt a policy strategy which is better suited to the institutional framework of the EU.

The first option, a stronger concentration and centralization of competencies and resources in innovation policy, is the most obvious solution to the coordination problems within the EU. The use of "hierarchy" as an organizing principle to cope with complexity is well known in organization theory (Simon 1962), and in fact, this was the strategy pursued in German technology policy in the 1960s and 1970s. Within the national government, competencies were concentrated within a single ministry (Stucke 1993), and at the same time, the importance of the federal states in technology policy declined. However, the German example has also given some indications of the limits of such a strategy. The limits of any concentration of resources and competencies are reached as soon as the genuine competencies of other major ministries are touched, for example the legal competencies of the Ministry of Finance in tax policy. In addition, both in federal states like Germany and in the EU, there are strict constitutional (respectively contractual) limits to a full-scale centralization of resources and competencies. Hence, in practice a stronger concentration and centralization of competencies in European innovation policy is not realistic.

The second option to cope with the European innovation policy dilemma, a decentralization of technology policy, seems to be more promising. Such a strategy, as advocated for example by John Peterson and Margaret Sharp (1999, 232–233), is supported by the experiences of EU activities financed by the structural funds on the regional level and, most of all, by the success of regional innovation policies in high-technology industries such as IT and biotechnology (Braczyk, Cooke, Heidenreich, 1998; Braczyk, Fuchs, Wolf, 1999). These examples seem to indicate that the institutional framework of innovation policies on the local and regional level is less complex, and, moreover, that local and regional governments – because of the proximity of actors – are better equipped with "soft", trust-based instruments of political intervention.

Hence, there are good reasons to argue that the most promising measures of technology policy "are best designed and delivered at the regional or even subregional level of

government. What are needed from Brussels are programmes that provide a catalyst but, as with the structural funds, essentially promote such action at lower levels of government" (Peterson, Sharp, 1999, p. 233). There is no need to deny the benefits of regional innovation policies in many instances, but there are some doubts that they actually allow to escape from the innovation policy dilemma as described for national and supranational policies. First of all, at the regional and local level, there is an extreme heterogeneity of institutions which make for considerable variation in the effectiveness of policy implementation. For this reason, proposals advocating a decentralization and regionalization of innovation policies are inevitably faced with the problem how the multitude of activities on the various levels can be integrated into a coherent strategic framework.

The third option tries to solve the European innovation policy dilemma by adopting a policy strategy which is better suited to the EU's fragmented and decentralized institutional framework. The key to such a strategy could be a distinction introduced in organization theory by Hugh Mintzberg and Alexandra McHugh (1985). They distinguish between "deliberate strategies" on the one hand, i.e. plans intentionally designed and implemented, and what they call "emergent strategies", i.e. an "unintended order" emerging from the uncoordinated activities of individual actors or organizations that nevertheless can be both rational and socially acceptable. "Strategy" in the latter case is not defined with respect to intentions, but with respect to realization. Whereas deliberate strategies emphasize the implementation of pre-given goals, emergent strategies emphasize processes and results: Emergent strategies "are the product of a process. In the course of this process, the individual or collective aims and interests of the participants in a widespread debate are generated, formulated and transformed. The final, composite result of these independent efforts may be said to be rational" (Fach, Grande, 1992, p. 17). Emergent strategies must not be confused with a neo-liberal market model or with a laissez-faire approach. They can well very be the object of purposeful political action. However, strategy formation follows a different logic and employs different instruments.

Most important for the purpose of this article, these different approaches can be related to different organizational settings. Deliberate strategies are best suited to ideal-type hierarchies, whereas emergent strategies are better suited to organizations with distributed power or "adhocracies". Quite obviously, the EU, with its multi-level system of governance and its complicated mix of interests, comes closer to the latter type than to the former. Against this background, the fundamental failure of European technology policy was that it employed a strategic approach which did not fit the basic characteristics of its institutional framework. And this would imply that EU policy-making, if possible, should employ a "grass-root model" of strategy formation as suggested by Mintzberg and McHugh and some kind of emergent strategy rather than deliberate ones.

This is not the proper place to develop such a "grass-root model" for European technology policy in full detail. Rather, I will outline a few basic elements which seem to be characteristic

of an emergent strategy in European technology policy. The common rationale of all these activities would be to stimulate, intensify, promote and guide the self-coordination of independent actors and organizations in order to make European technology policy a joint effort, instead of relying on purposeful policy-coordination by a supranational institution. Key elements of an emergent strategy in technology policy could be: (i) forecasting, (ii) frameworking, (iii) activating and mediating, and (iv) financing.

i. Forecasting: Forecasting exercises have become an important element of any technology policy approach (Cuhls, 1998). For an approach relying on the emergent results of uncoordinated and uncontrolled individual activities by companies and public research institutes, the identification of long-term problems and opportunities, and the formulation of long-term tasks for research and policy-making, systematic forecasting is essential. However, in such an approach the results of forecasting exercises are not interpreted as being "substantive" knowledge for deliberative policy making. Rather, they are used as cognitive maps and guidelines for open public debates. The final result should not be unanimous decisions, but common visions guiding the independent activities of politicians, civil servants, researchers and citizens.

ii. Frameworking: In an emergent policy strategy, it is more important to provide an appropriate institutional and organizational framework for (individual, organizational and collective) learning, both in politics and in economics, than it is to make a definite decision, once and for all. As Bengt-Ake Lundvall and Susana Borrás (1998, p. 35) have rightly emphasized, in a context of increased market competition and rapid innovation, it is the capacity to learn which is of crucial importance for companies. And the same holds true for policies. What makes a political strategy brilliant in such a context is not foresight and decision-making power, "but a capacity and willingness to learn, supported by a tolerant organization and its committed personnel" (Mintzberg, McHugh, 1985, p. 194). Thus, it would be a major function of an emergent strategy in technology policy to establish the framework for a "learning" economy and society.

iii. Activating and mediating: In an emergent policy strategy, the public's active participation in the design and use of technical systems is crucial. In such a strategy, interested citizens are not forced into the role of mere consumers; instead, their practical experiences, imagination and creativity are used in the development of socially acceptable new technologies. Hence, it must be an integral part of an emergent strategy in technology policy to promote and cultivate democratic participation in technology policy making.

This includes the organization of an efficient public mediation process, in which the different interests that have been articulated are aggregated and reconciled. In national research systems, this is the function of intermediary institutions. In the Dutch research system, for example, "the intermediary layer is densely populated, and there are many

network links between the institutions, committees, councils, programming bodies, etc. Horizontal co-ordination occurs easily" (Van der Meulen, Rip, 1998, p. 758). In the case of the EU, this intermediary layer is clearly underdeveloped (Grande, Peschke, 1999a; 1999b). Although there are a host of national and transnational organizations active in European R&D policy, horizontal links are weak and the inter-organizational networks are fragmented. Hence, the establishment of intermediary institutions and the promotion of inter-organizational networks must be an important part of an emergent policy strategy in the EU.

iv. *Financing*: Money matters and public research funding on both a national and a supranational level must also be part of an emergent strategy in technology policy. Rather, it is the basic philosophy of funding which distinguishes the different strategies. Whereas deliberate strategies in recent years have been based on an ever tighter coupling of basic research and socio-economic objectives, an emergent strategy emphasizes the open-ended character of basic research instead. As Barend van der Meulen and Arie Rip have recently argued, "Research results need not have an unambiguous link with socio-economic objectives. Their results are useful in the sense that these become part of a knowledge reservoir, and, thus, building blocks for 'new combinations' that are formed with specific socio-economic objectives in mind". And as a consequence, "The way (research; EG) results become part of the reservoir, and the access to the reservoir (including knowledge structuring efforts) may well be more important than the fine-tuning of research projects to socio-economic objectives" (van der Meulen, Rip, 1998, p. 767).

This last aspect indicates best, that a shift to a new, emergent strategy in EU technology policy does not require completely new instruments, additional resources or new competencies. Rather, it implies a new *paradigm*, i.e. a new way of looking at problems, of selecting policy instruments and of using them. Most importantly, in an emergent strategy, solutions to problems grow "like weeds in the garden; they are not cultivated like tomatoes in a hothouse" (Mintzberg, McHugh, 1985, p. 194). Admittedly, compared to the "hothouse" approaches with their high ambitions and their big promises as employed in EU technology policy during the last two decades, a "gardening" approach as advocated here seems to be much more modest and much less appealing. However, it also seems to be the most promising way for Europe to escape the existing strategic dilemma in innovation policy.

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