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Peter Weiss*

Techno-Globalism and Industrial Policy Responses in the USA and Europe

While there are considerable differences between the industrial policies of the United States and Europe, both have concentrated on the promotion of competitive national industries in information and communication technologies and other high-technology fields. They have followed nationalistic industrial policies at a time when business and technology have become more and more transnational, leading to the distortion of competition and the misallocation of investments. What do the possible results of these interventionist policies suggest for the future?

The demand for industrial policies in developed market economies (DMEs) was at the latest triggered off by the beginning of world-wide recession in 1991, when the leading economies had been facing a steady decline of annual average growth rates on the one hand and a rising level of unemployment on the other hand over the past quarter century. But not only has the bad economic performance of the past prompted the suggested new and more responsible role of governments; the supposed success of the actions of the Japanese MITI has also led to reinforced faith in the potential of governments to stimulate economic growth. The pace of Japanese industry's catching up and its power in important new technologies seemed to confirm the importance of government action in defining and targeting "strategic" technologies of the future. This seemed to be true at least until the moment when Japan started to face economic problems similar to those of its major counterparts at the beginning of the 1990s and it was clearly shown by several analyses at that time that the central role of MITI in empowering high technology was strongly over-emphasized and more myth than reality.

Nevertheless, the Japanese success in high-technology fields was sufficient not only for the European Commission but also for the Clinton/Gore administration to formulate new industrial policy agendas for the forthcoming decade.

Before taking a closer look at the traditions and the development of industrial policy in Europe and the

United States, it has to be described what industrial policy means in order to cope with the variety of different definitions published in articles and books. Following Stolpe,¹ industrial policy in a broader sense can be described as the set of economic policy measures aimed at supporting the economic performance of national industries, and thus influencing the allocation between sectors. Within this broader definition industrial policies use a conglomerate of instruments mainly derived from technology policy, competition policy and trade policy. Although the distinction between industrial policy and general economic policy is often difficult to define, Casey² names three fundamental differences: first, industrial policy follows a sectoral orientation in contrast to the broad approach of economic policy, second, it uses selective incentives that are usually targeted to specific sectors and firms, and finally, it tries to adjust the direction of investment rather than its volume. The promoting of potential "winners" in the future thus becomes the dominant task,³ while in addition a "protecting-the-losers" strategy is often chosen to absorb the shocks for obsolete industries stemming from international competition.

New theoretical developments have supported the industrial policy resurrection in the past 15 years, even if this was not intended by their inventors. The

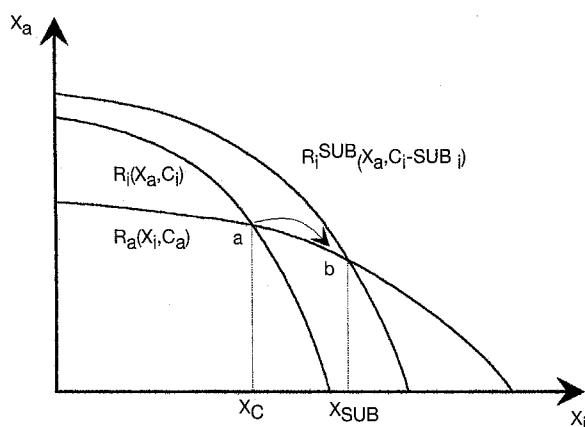
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¹ M. Stolpe: Industriepolitik aus der Sicht der Neuen Wachstumstheorie, in: Die Weltwirtschaft, 1993, No.3, pp. 361-377, here p. 361.

² T. C. Casey: The Clinton Administration and the Industrial Policy Question, in: Journal of Social, Political and Economic Studies, Vol. 18, 1992, pp. 29-60, here p. 30.

³ P. R. Krugman and M. Obstfeld: International Economics, 2nd ed., New York 1991, p. 263.

Figure 1
Cournot-Equilibrium in the
Brander/Spencer-Model



strategic trade theory differs from classical trade theory in that it denies the assumption of markets working under perfect competition. Rather, firms compete under oligopolistic market structures. Increasing returns to scale, externalities, and imperfect markets are therefore its core assumptions. The models developed supply the basis for strategic trade theory through governmental activities. Under imperfect oligopolistic competition on the world markets for tradable goods it is possible for a government to increase the nation's welfare at the expense of foreign countries by shifting the existing oligopolistic rents from abroad to the domestic economy. Besides this rent shifting strategy there is also the possibility of creating rents when complete new industries are established by means of interventionist government activities. In both cases the interventions weaken the existing foreign suppliers.

The possibilities of rent shifting were first shown by Brander and Spencer in 1983.⁴ Starting with the assumptions of entry barriers from increasing returns to scale and monopoly profits in an international industry, they view two companies supplying a third country, where all turnovers and profits are realized. Both of the companies are producing as Cournot-duopolists. In Figure 1 the response function R_i shows what output X_i the domestic company produces under consideration of its cost function C_i , when it assumes the output X_a of its competitor as given. Under consideration of the response function R_a of its competitor, point (a) describes a Cournot-equilibrium. Brander and Spencer have shown the possibilities for governments to shift rents from the foreign to the domestic company by providing R&D grants or export subsidies. With that, the domestic company takes on

the role of the Stackelberg leader. R&D subsidies move the response function R_i to R_i^{SUB} , where the market share of the domestic company has increased and the share of the foreign company has decreased. The new equilibrium is reached at (b). Under the condition that the foreign company will be content with its sunk market shares, the net profits of the subsidized domestic company will increase.

Another justification for a stronger role of governments in the stimulation of industrial innovation derives from the new growth theory. The fundamental characteristic of these models is to be seen in their endogenous view of technological progress. Growth therefore can be explained as an endogenous process. The basic papers by Romer and Lucas⁵ established two main categories within the new growth theory: models of "learning by doing" and R&D-models. Both of them work under the assumptions of increasing returns within goods production and positive externalities in the form of spillovers within the production of new knowledge. Because investors can not appropriate the complete returns of their investment, be it investment in R&D or in education, spillovers induce production possibilities for other firms. That is why under free market conditions the investment in new knowledge reaches only a suboptimal level.

While some representatives of the new growth theory have summarized these new results with recommendations for economic policy fostering growth by incentives, others have suggested a far stronger role of government with direct financial support for the creation of new technologies, for the formation of human capital, and for the strengthening of physical investment.

These new theoretical developments constituted the platform for a new wave of industrial policy especially in Europe and the USA.

European Industrial Policy in the 1980s

Industrial policy in Europe has always been a controversial issue. Based on the analysis by Servan-Schreiber of losses in technological competitiveness

⁴ J. A. Brander and B. J. Spencer: International R&D-Rivalry and Industrial Strategy, in: *Review of Economic Studies*, Vol. 50, 1983, pp. 707-722.

⁵ P. M. Romer: Increasing Returns and Long-run Growth, in: *Journal of Political Economy*, Vol. 94, 1986, pp.1002-1037; P. M. Romer: Endogenous Technical Change, in: *Journal of Political Economy*, Vol. 98, 1990, pp. 71-102; R. J. Lucas: On the Mechanics of Economic Development, in: *Journal of Monetary Economics*, Vol. 22, 1988, pp. 3-22.

by European industries and the advent of a technological gap to the USA in 1967, the EC Commission formulated the so-called "Colonna-Memorandum" as early as 1970, a strategy paper that planned to restructure obsolete industries, to promote high-technology industries and to allow Europe-wide collaborations and mergers.⁶ Although the guidelines of this strategy paper have never been applied, the paper demonstrated the general necessity for the Commission to continually find and formulate compromises in order to handle the different approaches of the member countries towards industrial policy and to push forward the process of European integration. But it was also a sign of the general tendency to implement interventionist policies on the supranational level. After that the industrial policy debate receded and did not grow until the Single European Act in 1986 and the enactment of the Maastricht Treaty in 1991, when two major provisions were established to legitimate industrial policy in Europe. With the chapter "industry" (Title XIII) of the Maastricht Treaty the European Community and its Member States were required to "ensure that the conditions necessary for the competitiveness of the Community's industry exist" and to ensure that competition is not distorted as also laid out in Article 3 of the treaty.

But even before this legitimization, the Commission had started to use its potential and resources in technology policy to push forward "strategic" industries as of the beginning of the 1980s. Looking at the core of industrial policy in Europe, technology policy, one has to distinguish between the perennial framework programmes and the specific programmes of the Commission. Within the perennial framework programmes the general scientific and technological goals as well as the priorities and essentials for the future period are fixed. It therefore represents only the enactment of a budgetary restriction at the supranational level. From the beginning of the framework programmes, not only could the accumulation at the supranational level of former national competences be observed, but also the concentration on sectoral and structural goals. With the start of the first

framework programme in 1984 covering the period to 1987 the existing level of R&D subsidies was nearly doubled to ECU 3.7 bn and priorities were set in microelectronics and new materials. While the second (1987-91) and third (1990-94) framework programmes shifted the emphasis more and more to information and communication technologies (including microelectronics) and to biotechnology, and led to an increase in the budget to ECU 5.7 bn, the fourth framework programme meant a strong quantitative break: not only was the budget nearly doubled to ECU 11.04 bn for the period of 1994-98, but the accent on information and communication technologies (ECU 3.4 bn), on new materials (ECU 2.0 bn), and on biotechnology (ECU 1.57 bn) was reinforced.⁷

Although the Commission is able to set the priorities for future financial R&D support in a top-down process, the specific programmes are atuned with enterprises in a bottom-up approach. So industry, but also scientists and national governments are responsible for the initialization of specific programmes in most of the cases. The most important single programme launched by the European Commission until now was ESPRIT,⁸ which was developed in 1980 through a joint initiative of the former EC Commissioner Davignon and the twelve largest European enterprises dealing with information technologies. It can be seen as one of the most negative examples of European attempts at industrial policy, because control over the definition and completion of the R&D projects moved from the Commission to the Big-12 enterprises over time, thus impeding access to R&D support by competitive outsiders and monopolizing the demand for R&D subsidies in the programme.⁹ While the Big-12 had a share of 80 per cent of the complete financial support in the pilot phase of ESPRIT-I in 1983, their share was reduced to only 62 per cent in the period 1988-92 during ESPRIT-II.¹⁰ In this context it should be remembered that ESPRIT was the biggest single support initiative with ECU 3 bn support for the period of 1988-1994 alone. Complementary to this, under pressure from the French government the Commission launched the EUREKA¹¹

⁶ For the history of industrial policy in Europe see F. Bilger: *Industriepolitik für die Europäische Union – Titel XIII des Vertrages von Maastricht*, in: K.-H. Hartwig (ed.): *Veränderte Arbeitsteilung in Europa – Brauchen wir eine Industriepolitik?*, Baden-Baden 1994, pp. 203-228.

⁷ See BMFT: *Forschung in Europa*, Bonn 1994.

⁸ "European Strategic Programme for Research and Development in Information Technologies".

⁹ H. Ullrich: *Europäische Forschungs- und Technologiepolitik und die Ordnung des Wettbewerbs im Gemeinsamen Markt*, in: *Jahrbuch für Neue Politische Ökonomie*, Vol. 9, 1990, pp. 169-195, here pp. 191-192.

¹⁰ J. Peterson: *Technology policy in Europe: Explaining the framework program and EUREKA in theory and practice*, in: W. Grant (ed.): *Industrial Policy*, Aldershot 1995, pp. 518-539, here pp. 525-526.

¹¹ "European Research Coordination Agency".

programme to reduce the threatening dominance of Japanese enterprises in microelectronics through cooperation by enterprises and laboratories. But not only did the most popular single programme within this initiative, JESSI,¹² which was conceived to help the European industries to reduce the technological gap in semiconductors in comparison to Japan and the United States, fail in that there was no significant increase in market shares, but the HDTV initiative of the European Commission for research and development of a high density TV also failed. Both initiatives were strongly subsidized by the Commission, favouring mainly the Big-12 enterprises.¹³

The selective orientation of European technology policy towards catching up in information and communication technologies, but especially in microelectronics, was accompanied by trade policy measures. The Commission used antidumping tariffs against Japanese and South Korean DRAM producers in 1990 to "buy time" for the European microelectronics industry and to improve its competitiveness, following the infant-industry argument.¹⁴ As stated in a recent analysis by the European Parliament, most antidumping measures by the EC were used against products from the Far East which the Commission defined as "strategic".¹⁵ In addition, competition policy on the European level has been able to pursue industrial policy goals since 1989, because the established European merger control includes the option to allow any merger, if the development of technical or economic progress benefits consumers and does not lead to distortion of competition in the Single Market (Art. 2 FKVO). This "French clause" is the Commission's central point of attachment for allowing or creating the rise of "European Champions". Besides the increased responsibilities and power of the

supranational level in industrial policy, the major source of possible industrial policy still remains the member countries with multiple higher funds. For example, Great Britain pursued the Alvey Programme parallel to ESPRIT, while France directed the Filière Electronique Programme towards the support of the electronics industry.¹⁶

American Industrial Policy

The United States, in contrast, had a far less established government role for targeting critical or strategic¹⁷ technologies. This first impression must partly be revised, though, if a closer look is taken at federal R&D spending in the past three decades. The funding of military R&D dominated the federal R&D budget during the cold war: while the defence share of federal R&D hovered around the 50% level until the early 1980s, it strongly increased with the SDI initiative of the Reagan administration, reaching its peak point at 67% in 1988.¹⁸ Because of the dominant role of defence R&D, the distribution of the federal R&D budget across industry sectors was highly concentrated on the aircraft and missiles industry (43.5%) as well as electrical machinery (27%) in 1986. By developing technology for public missions, mainly defence, space and energy, the government has also influenced commercial innovations like the jump-start of the US semiconductor industry through procurement for the NASA's Apollo programme and development of the Minuteman missile system; defence R&D is also held responsible for spin-offs to telecommunications and computing industries.¹⁹ The intense engagement of the United States in the promotion of leading technologies with substantial subsidies from Defense Department programmes in the past has often been seen in Europe as a de facto industrial policy, inducing counter-initiatives like EUREKA as a direct answer to the United States SDI initiative.²⁰

¹² "Joint European Submicron Silicon Initiative".

¹³ J. Meyer-Stamer: *Industriepolitik in der Europäischen Union: Alte Dilemmata und neue Optionen*, Reihe Eurokolleg der Friedrich-Ebert-Stiftung, No. 33, 1995, Bonn; and J. Peterson, *op.cit.*

¹⁴ H. Berg and E.-M. Peters: *Antidumping: Instrument der EG-Industriepolitik?*, Discussion papers in Economic Policy of the University of Dortmund, No. 69, 1995, Dortmund, pp. 29ff.

¹⁵ European Parliament: *The Economic Impact of Dumping and the Community's Anti-Dumping Policy*, Working Papers 1/93, Brussels 1993, p. 66.

¹⁶ S. Ostry and R. R. Nelson: *Techno-Nationalism and Techno-Globalism. Conflict and Cooperation*, Washington, D.C. 1995, p. 53.

¹⁷ The distinction between critical and strategic technologies is obsolete, when the term strategic is divided into its three basic meanings as done by L. Soete: *National Support Policies for Strategic Industries: The International Implications*, in: OECD (ed.): *Strategic Industries in a Global Economy: Policy Issues for the 1990s*, Paris 1991, pp. 51-80, here pp. 54ff.

¹⁸ For the development of defence and federal R&D see the article by D. C. Mowery and N. Rosenberg: *The U.S. National Innovation System*, in: R. R. Nelson (ed.): *National Innovation Systems. A Comparative Analysis*, New York 1993, pp. 29-75, here p. 42 and table 2.2. on p. 37.

¹⁹ Office of Technology Assessment: *Innovation and Commercialization of Emerging Technologies*, OTA-BP-ITC-165, Washington D.C. 1995, p. 17.

²⁰ M. Sharp and K. Pavitt: *Technology policy in the 1990s: Old trends and new realities*, in: *Journal of Common Market Studies*, Vol. 31, 1993, pp. 129-151, here p. 136. As a counterinitiative to the U.S. SEMATECH initiative that was closed to all foreign subsidiaries in the United States, JESSI was restricted to European owned companies within Europe. But the strategic alliance between Siemens and IBM indirectly opened up both programmes for these enterprises, followed by a number of imitators. See S. Ostry and R. R. Nelson, *op.cit.*, p. 53.

The end of the 1980s and the early 1990s were characterized by a major shift in United States technology policy and its former concentration on pure technology generating activities. Moreover, it was attempted to establish support for civilian technologies as a legitimate objective of government.²¹ After denying any role for federal government in the development and commercialization of new civilian technologies for the first years of the Reagan administration, the orientation of technology policy was sharply changed, when the government forced attempts to speed up the development of commercial applications of high-temperature superconductivity (HTS).²² But even before that the government simplified the formation of cooperative research ventures for the semiconductor and computer industries by the National Cooperative Research Act (NCRA) in 1984 and removed some of the threat of prosecution under antitrust as a reaction to Japan's VLSI programme.²³ With the end of the Cold War, US technology policy took up this direction and shifted its emphasis to the enhancement of economic performance in private industry.²⁴ In 1987, the SEMATECH programme was launched, providing public funding for the computer industry by the Department of Defense, dedicated to the development of commercial technology and expressly designed for catching up.²⁵ Furthermore, the establishment of the Advanced Technology Programme (ATP), providing cost shared funding to commercial firms or consortia of firms to support the development of commercial technology, confirmed the new orientation of the United States federal government.

As in Europe, trade policy measures were used in the United States to complement the industrial policy initiatives. For example, in 1986 the Reagan administration forced Japan during bilateral trade negotiations culminating in the Semiconductor Trade Agreement (STA) to increase its future purchases of foreign-made semiconductors to twenty per cent of the Japanese market within a five year period. This Voluntary Import Expansion (VIE) of Japan was reaffirmed in 1991.²⁶ Furthermore, in 1991 the Bush

administration used anti-dumping duties to protect the infant American flat panel display industry, thereby placing a disadvantage on the successful American computing industry.²⁷

New Directions

Both Europe and the United States used the world-wide recession in 1991 to formulate new industrial policy agendas and partially to implement new programmes.

Armed with much more optimism about the appropriateness and the potential effectiveness of governmental industrial targeting than former administrations, in 1993 the Clinton-Gore administration imbedded some of its predecessors' initiatives in its economic agenda for the forthcoming legislature period and took up a new course in government-industry relationships to perform as a partner to industry by facilitating commercial technology development and application. The administration's technology policy (ATP) therefore not only aims at the acceleration of technology development and commercialization but also at the promotion of technology diffusion in strategically important new technologies. High-priority technologies shall be identified in co-operation with industry and incentives should be provided to industry to undertake high-technology development in those fields that have not attracted private-sector investment because of high technical risks, prohibitive costs, long payback horizons, or problems in the appropriability of future returns. This major re-orientation of federal technology policy was planned to be accompanied by an increase in the civilian share of the federal science and technology budget to more than 50 per cent by 1998, by the fostering of dual-use technologies, and the supply of an information infrastructure fitting the needs of the future.²⁸

Therefore, the Clinton administration planned to expand the funding for ATP from \$54 million in financial year 1993 to \$680 million in financial year 1997²⁹ with the goal of enabling high-risk, high-return research on pre-competitive, generic technologies, which are, as the Competitiveness Policy Council formulates, in the national interest.³⁰ For that reason,

²¹ S. Ostry and R. R. Nelson, *op.cit.*, p. 57.

²² D. C. Mowery and N. Rosenberg, *op.cit.*, p. 58.

²³ S. Ostry and R. R. Nelson, *op.cit.*, p. 57.

²⁴ L. M. Branscomb: Targeting critical technologies, in: STI-Review, No.16, pp. 33-57, here p. 42.

²⁵ D. C. Mowery and N. Rosenberg, *op.cit.*, p. 58.

²⁶ S. Ostry and R. R. Nelson, *op.cit.*, p. 76.

²⁷ S. Charnovitz: Designing American industrial policy: General versus sectoral approaches, in: Stanford Law & Policy Review, Vol. 5, 1993, pp. 78-92.

²⁸ For the strategy of the Clinton administration see W. J. Clinton and A. Gore: Technology for America's Growth: A New Direction to Build Economic Strength, Washington, D.C. 1993.

²⁹ Cf. *ibid.*, p. 80.

the ATP may be a useful instrument for picking winners in the broadly selected areas by the National Institute for Science and Technology. In addition to this substantial increase in ATP funding, in 1994 the Clinton administration set up a \$600 million programme to support the manufacture of flat panel displays in the United States. The administration's subsidization aims at the creation of at least four domestic production facilities, which should capture about 15 per cent of the world market by the year 2000.³¹ The redirection of government-led work by the national laboratories to perform more industry-led work as begun in the mid-1980s is another major sign of the change in industrial policy that pushes the federal laboratories to allocate a fundamentally higher share of their efforts to R&D activities of direct relevance for American industry.³² Such a redirection has taken place in military R&D expenses, too, because the administration has been trying to put the focus of several Defense Department projects on to dual-use technologies, and for that on to those technologies that may be as useful for military purposes as for civilian markets.³³ Furthermore, competition policy was used for industrial policy purposes: in addition to the NCRA of 1984 cooperation opportunities were expanded in 1993 by amendments by the Clinton administration to joint manufacturing efforts that have been created through cooperative research. In contrast to these new developments of federal R&D support the R&E tax credit, one of the major sources for overall and non-discriminating support of technology creation with an annual budget of \$1.5 billion, expired in June 1995 after a 15-year period of existence.³⁴

While the industrial policy measures set up by the Clinton administration until now have been both few in number and relatively poorly equipped financially, the industrial policy recommendations of the President's advisors give more cause for concern. Thus, the CPC reiterated its support for an aggressive technology policy, with complimentary roles by government and industry, and with the crucial point on assistance by the ATP in the development of critical new techno-

logies that are in the public interest.³⁵ Moreover, the CPC criticizes the fragmentation of the R&D budget in Congress and recommends a more streamlined process "to bring more key technologies under a smaller number of subcommittees".³⁶ Furthermore, it urges re-establishing and permanently extending the R&E tax credit, "sending a strong signal to capital markets that they place a high premium on investment in new technologies, especially those which are developed and commercialized in the United States".³⁷ Hence, the new orientation of governmental activities in technology policy and competition policy shall be accompanied by a proposed flanking strategy of trade policy, as recommended in the first report to the Clinton administration by the Advisory Committee for Trade Policy and Negotiations using " 'temporary quantitative indicators' in sectors where 'invisible barriers' exist and focusing on increased market access for 'strategic' sectors".³⁸

Although the Clinton administration seems to have a strong intention of redesigning the role of federal government within the industry-government relationship, the few industrial policy measures implemented and expanded until now are the reflection of the conservative leadership in Congress and their blockade of further government interference in the innovation process, stemming from the fear of misallocation and the crowding out of private sector investment. For that reason, congressional leadership has proposed a return of governmental activities to the support of basic research, the revision and extension of the R&E tax credit, and the removal of regulatory barriers to innovative activities.³⁹

The European White Paper

While the Maastricht Treaty constituted and legalized the Commission's possibilities for using industrial policy measures and setting the goal of increasing European firms' competitiveness, the European "White Paper" provides the first concrete clues for the future strategy of a European industrial

³⁰ Competitiveness Policy Council (1995): *Saving More and Investing Better. A Strategy for Securing Prosperity. Fourth Report to the President and the Congress*, Washington, D.C. 1995, p. 39f.

³¹ C. E. Barfield: The Pentagon's "Flat Panel Display" Boondoggle, in: *The American Enterprise*, Vol. 7, 1996, pp. 68-69.

³² S. Charnovitz, *op.cit.*, p. 86; and S. Ostry and R. R. Nelson, *op.cit.*, p. 59.

³³ S. Ostry and R. R. Nelson, *op.cit.*, p. 59.

³⁴ Competitiveness Policy Council (1995), *op.cit.*, p. 40-41.

³⁵ At least they did it in their report in September 1995. Cf. *ibid.*, p. 39.

³⁶ Competitiveness Policy Council (1994): *Promoting Long-Term Prosperity. Third Report to the President and Congress*, Washington, D.C. 1994, p. 21.

³⁷ Competitiveness Policy Council (1995), *op.cit.*, p. 40.

³⁸ S. Ostry and R. R. Nelson, *op.cit.*, p. 77.

³⁹ Office of Technology Assessment, *op.cit.*, p. 20.

⁴⁰ EU-Commission: *White Paper on growth, competitiveness, and employment. The challenges and ways forward into the 21st century*, COM (93) 700 final, Brussels 1993.

policy.⁴⁰ The high level of unemployment in the member countries of the European Union can be seen as responsible for the development of the White Paper. Although it is true that the EU economies have changed in the past, the Commission argues that the world has changed even faster, and thereby uncovered especially the drastic European technological disadvantages in comparison to its main competitors.⁴¹ The Commission's suggestions can be divided into a global growth policy and a specific industrial policy directed to the strengthening of industrial competitiveness.

As in the United States, the Commission focuses in a large section of the White Paper on the development of an adequate European infrastructure. The so-called "Trans-European Networks" (TEN) in the areas of transport, energy, environment, and especially in the field of new information and communication technologies are designed to supply the necessary pre-conditions for long-run economic growth. For the area of information and communication infrastructure the proposed initiatives can be seen as a direct response to the earlier passing of infrastructural offensives in the United States and Japan, considering the fact that both of these countries have made stronger advances than Europe in the past. Besides this, the Commission formulated the aim of completing deregulation within the Single Market.⁴²

While these infrastructural and deregulative initiatives for the support of economic growth not only suit the competition principle of the Single Market but also take the federalist subsidiarity principle into consideration, the industrial policy strategy of supporting industrial competitiveness is fundamentally more interventionist, and designed towards the enhancement of structural change. In this context the Commission formulates the necessity for European R&D policy to make stronger efforts to identify and fix the "major priorities" for the future, and points out that the future R&D priorities should be directed towards the fields of information technologies, biotechnology, and environmental technologies.⁴³ The fourth framework programme for the period 1994-98 is the major result of the now officially legitimated industrial policy at the European level.

In the field of interfirm cooperation the Commission describes the international spreading of alliances as a serious danger for European enterprises in that it means they are facing world markets dominated by oligopolistic structures, and therefore suggests a strategy of allowing cooperation by European enterprises to form a counterbalance to Japanese and US-American competitors.⁴⁴ Within the European trade policy the Commission suggests a "controlled interdependence" towards their trade partners. Although the Commission is willing to open up the Single Market for foreign trade more widely than in the past, this offer is tied to the demand for the simultaneous opening up of closed foreign markets to European enterprises. Furthermore, the Commission proposes an improved tuning of export support strategies and other measures to increase export chances especially in the major fields of technological progress. Finally, the Commission demands more responsibilities in trade policy to take action against unfair competition.⁴⁵

Table 1

The Most Important R&D-Programmes in Microelectronics within the Triad since 1976

Programme	Country	Period	Budget in US \$ million ^a	Government Share
VOLS	Japan	1976-80	350	40
OMCS	Japan	1979-85	90	100
VHSIC	USA	1980-89	900	100
Supercomputer	Japan	1981-89	130	100
FED	Japan	1981-90	40	100
SG	Japan	1982-91	426	100
Alvey	GB	1983-88	500	50
ESPRIT I	Europe	1984-89	1800	50
ESPRIT II	Europe	1988-93	3800	50
Eureka	Europe	1985-96	7700	50
RACE	Europe	1985-96	3000	50
JESSI	Europe	1989-96	4000	50
MCC	USA	1983-	80 ^b	0
NOMS	USA	1996-	150 ^b	50
SEMATECH I	USA	1987-92	1000	50
SEMATECH II	USA	1993-98	200 ^c	50
ASET ^d	Japan	1996-2001	100 ^b	100
SELETE	Japan	1996	350	50
STARC	Japan	1996-2000	10	n.e.
SiSi ^e	Japan	1996	70	50
13001 ^f	International	1996-?	40 ^g	0

^a Total amounts (government plus industry).

^b Per annum.

^c The 1995 government contribution was \$ 85 million. At the request of its board, SEMATECH will no longer receive government funding after 1996.

^d Japanese subsidiaries of 3 US firms are among 21 corporate participants.

^e Super Silicon Crystal Research Institute to develop 400 mm wafers.

^f Current participants in this 300 mm wafer project include companies from Korea, Taiwan, Europe, and the USA. SELETE is the parallel Japanese national 300 mm wafer programme.

^g Estimated.

⁴¹ Cf. *ibid.*, pp. 9f.

⁴² Cf. *ibid.*, pp. 25ff.

⁴³ Cf. *ibid.*, p. 16.

⁴⁴ Cf. *ibid.*, p. 68.

⁴⁵ Cf. *ibid.*, also pp.13 and 120-21.

Differences and Similarities

As has been briefly shown above, there have been several differences between the orientations and initiatives formulated in the industrial policies of the United States and the European Union in the past but similarities are also observable. Starting with the main differences, the European Union has not only had a longer tradition in industrial policy matters, but has also used the bunch of industrial policy opportunities more specifically and in a higher concentration within the past 15 years in comparison to the United States, especially when considering the complementary industrial policy of the European Commission and the member countries for so-called "sunset industries". This becomes even clearer when taking a look at the past national programmes for the support of the microelectronics industries. In comparison to the USA and Japan, the EU spent a substantially higher amount of financial resources for the catching up of European enterprises in this technological field (Table 1).

Nevertheless, the industrial policy initiatives of the United States as well as the positive attitudes towards industrial targeting increased significantly at the end of the 1980s and the beginning of the 1990s, though not reaching the European Union's level. While the EU was partly driven towards industrial policy action by traditionally interventionist member states and implemented its fast expanding initiatives widely invisibly from European citizens, the US efforts of the past could best be described as a "sowing the seeds of industrial policy" strategy, based on the

transparency of federal action and wide resistance towards the one-sided preferences of specific industries. Furthermore, the US attempts were guided by the necessity to reduce defence expenses in R&D and catch up with competitors' R&D spendings structures (Table 2).

Regarding the main similarities, both the United States and Europe concentrated on the support of mainly the same high technologies that were promising high future growth potentials and therefore were also classified as "strategic" and "generic" industries. While the classification of an industry as strategic refers to the danger of restricted access to a technology, the term generic is used for those technologies whose products are thought to be important components of a wide range of industrial products and that are able to build the ground for technological spillovers to other technological fields. Because most of the new high technologies are excellent examples for these characteristics, the actions of both the EU and the USA concentrated on the promotion of competitive national industries in information and communication technologies and related areas like microelectronics, HDTV or flat panel displays, biotechnology, new materials and robotics.

The new nationalistic industrial policies have been implemented just at a time when business and technology have become more and more transnational, mainly driven by multinational enterprises that are highly interconnected by foreign partnerships and cross holdings, and it has become more and more unclear which high-tech company is an American,

Table 2
Scientific Input Data of Technological Competitiveness for the Triad
and Selected countries, 1971 to 1993

		Japan	USA	EU-15	Sweden	Germany ^a	France
R&D as a percentage of GDP	1971	1.71	2.47	–	1.49	2.20	1.88
	1981	2.45	2.45	1.70	2.30	2.43	1.97
	1991	3.05	2.84	1.96	2.86	2.61	2.41
	1993	2.94	2.66	1.97	3.26	2.48	2.45
Business enterprise financing of expenditure on R&D in per cent	1971	64.8	39.3	–	54.4	52.0	36.7
	1981	67.7	48.8	48.7	54.9	57.9	40.9
	1991	77.4	57.5	52.4	61.5	61.7	42.5
	1993	76.0 ^b	58.7	53.2 ^b	–	60.2	46.2
Total R&D personnel per thousand labour force	1981	11.4	–	–	9.8	13.3	10.6
	1997	13.2	–	9.2	11.7	14.3	11.5
	1993	14.3	–	9.3 ^b	12.9	12.5 ^b	12.5
Total researchers per thousand labour force	1981	6.9	6.2	3.3	3.5	4.6	3.6
	1997	8.4	7.2	4.0	5.1	5.6	4.5
	1991	9.7	7.4	4.4	5.9	6.1	5.2

^a Figures for Germany from 1991 onwards refer to the reunified Germany; ^b 1992.

Source: OECD.

European or Japanese one. But although the globalization of business, competition and technology implies a lower efficiency for every nationalistic governmental policy, especially when there is no guarantee that the benefits of governmental investment support accrue in the domestic economy,⁴⁶ the EU and now the United States have increased their efforts and therefore "may have bought into a myth of having their 'own' high-technology industries".⁴⁷ Several economic problems are connected to the new governmental attempts to foster national high-technology "champions".

First, following von Hayek, it is questionable whether bureaucrats have more or even better information about the potential success of future technologies than actors on private markets;⁴⁸ therefore it is highly doubtful that bureaucrats or politicians are better than profit-maximizing actors at picking future technologies in the sense of making the "right" investment decision. Since the selection of a special technology requires a high level of technical competence from bureaucrats it is most likely that government's agents receive most of their information from representatives of those industries with the greatest political skills, but not necessarily from those whose technologies offer the highest future payoffs. It is most likely, therefore, that governments would fail to pick the right winners, but as Sylvia Ostry puts it, "winners are very good at picking governments".⁴⁹ Second, a very critical point is the question whether the financial support of a high technology is able not only to establish an industry and make it profitable, but also to establish an industry that is able to generate enough extra national income to compensate for at least the initial cost and therefore proves that it was worth the opportunity cost.⁵⁰ This point cannot be overemphasized especially when considering the fact that high-technology support often concentrates on those fields that have already been recognized and chosen by other countries as possible future engines of growth. R&D activities of companies therefore may be directed to fields that are already overcrowded and where profit margins rapidly

decrease, forcing international parallel R&D, and preventing activities in other fields of innovation. Third, the sectoral targeted initiatives are discriminating not only against branches and business enterprises without the favour of being supported, but especially against small and medium sized business enterprises with less information on market for financial R&D support. Fourth, direct financial support may reduce the readiness of business firms to take risks themselves, when rent-seeking activities promise at least the same, or even higher, profits as entrepreneurship; and finally, the subsidization of technology-creating activities may flow into the establishment of durable subsidies, if monetary support is not temporarily restricted from the beginning as the AIRBUS example has clearly demonstrated. All in all, selective industrial policy restricts the width and the depth of the competition principle as a decentralized method of market search and discovery, and bears high potential risks of failures in picking the right winners.

Increasing Techno-Nationalism

While these arguments mainly concentrate on the dangers of domestic market distortions and misallocation and are therefore limited to national inefficiencies, the more dangerous development lies in the consequences of increasing techno-nationalism for the future efficiency of the world economy. Techno-nationalism in this context means the focusing of governments on having their "own" high-tech industries, be they created in the domestic country or attracted from foreign countries. While the creation of domestic high-tech companies was the main goal of governmental action in past decades, the attraction of foreign firms is the modern variant of high-tech nationalism. Both forms are based on the idea that a significant amount of the high-tech products consumed in the domestic economy should also be produced locally.⁵¹

Some of the industrial policy actions described

⁴⁶ D. Archibugi and J. Michie: The globalisation of technology: A new taxonomy, in: *Cambridge Journal of Economics*, Vol. 19, 1995, pp. 121-40, p. 122; and S. M. Irwin: *Technology Policy and America's Future*, New York 1993, p. 78.

⁴⁷ S. Ostry and R. R. Nelson, *op.cit.*, p. 60.

⁴⁸ Von Hayek: *Die Anmaßung von Wissen*, in: *ORDO*, Vol. 26, 1975, pp. 13-21; and T.C. Casey, *op.cit.*, p. 29.

⁴⁹ S. Ostry: *Governments and Corporations in a Shrinking World*, New York (Council on Foreign Relations) 1990.

⁵⁰ T. C. Casey, *op.cit.*, p. 59. Although the AIRBUS subsidization seems to be an impressive example of a successful European industrial policy based on the strategic trade theory, Krugman, p. 112, points out that "airbus has cost its sponsors more than it is worth". See P. R. Krugman: *Pop Internationalism*, Cambridge, Mass. and London 1996. The Congress' Office of Technology Assessment argues in the same direction, when formulating that the government's claims about the importance of a domestic flat-panel display industry "are exaggerated" and that forcing US manufacturing in the flat-panel display sector would "require massive investments ... and by no means ensure the United States a significant presence in this industry". Cited in C. E. Barfield, *op.cit.*, p. 69.

⁵¹ L. d'Andrea Tyson: *Who's Bashing Whom? Trade Conflict in High-Technology Industries*, Washington, D.C. 1992, p. 5.

above are good examples of the old form of technonationalism. Especially direct financial targeting is able to induce an international subsidy race with the danger of over-investments in special technologies and welfare losses for all participating countries. The complimentary build up of trade policy measures like Voluntary Export Restraints (VERs), VIEs, and antidumping duties that accompanied technology policy not only leads to distortions in the international division of labour, but also means a renunciation of the imported specialization advantages of foreign enterprises. Additionally domestic consumers are worse off when the domestic price level rises above the world price level for those products protected by trade policy measures.

But the greatest danger of welfare losses results from potential retaliation by foreign countries using similar trade policy measures. While on the one hand the profit prospects of domestic firms will be drastically reduced when foreign competitors react with aggressive price competition to the rent-shifting activities of the domestic government, on the other hand foreign governments can respond with counterblows. Protectionism and subsidization on both sides can induce a trade war and leave all countries worse off than before. This danger is shown in Figure 2. After the domestic government increases the market shares of its firms by subsidization of R&D (point b), the foreign government reacts with retaliation measures. With that the response function is shifted outwards to R_a^{SUB} . The new equilibrium is given at point (c), where altogether more goods are produced than at point (a). But the additional production can only be sold at lower prices, so that the producer

rents for all participating companies decrease after subtracting the subsidies. That is why point (c) shows welfare losses for both countries.

Additionally, foreign retaliation can lead to the loss of access to important sources of foreign technologies.⁵²

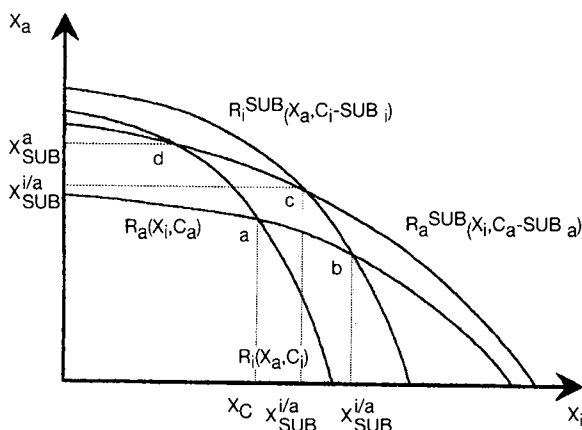
Since trade policy became a strong set of instruments for protecting domestic industries from foreign competition while the unilateral GATT was by-passed by bilateral or multilateral grey area measures and the United States started – contrary to its former attitudes – to react to “unfair” foreign competition by using trade policy measures in the 1980s as an answer, the high-tech dispute among the triad was initialized.⁵³ But although these measures were originally created to protect domestic infant or lagging high-tech industries and therefore should hamper the diffusion of foreign high-tech industries, they spurred the globalization of technology. By nationalistically motivated closings of their markets through “buy national” initiatives and nationalistic procurement policies as well as import restrictions nations fostered foreign direct investment by MNEs.

Since the countries became aware of the fact that the creation of national champions in high-technology industries is very costly and there is no guarantee of long-term success and sufficient payoffs from these support initiatives, but that there is the danger of risking trade wars among the industrial powers, governments may be willing to reduce those efforts in the future as they had started to do in the past, but may at the same time expand their initiatives towards foreign-owned companies with the goal of attracting or forcing high-technology firms to within their geographical borders. With such policies governments urge “firms, by location or alliance, to take on the colors of whatever nation is offering them something”.⁵⁴

When governments attempt to ensure that a significant part of the high-technology products that are consumed domestically are also produced locally, they actively distort the competition among countries

Figure 2

Retaliation of Foreign Governments after Strategic Subsidizing of Domestic Industries



⁵² S. M. Irwin, *op.cit.*, p. 102.

⁵³ For the dispute among the major industrial powers see S. Ostry and R. R. Nelson, *op.cit.*, pp. 63-78. The changing role of the United States must be emphasized as a major cut in world economic integration, since the USA took the place of a guard for free and undistorted competition on world markets after World War II, thereby indicating foreign countries for using selective and sectoral targeted industrial policy instruments.

⁵⁴ S. Ostry and R. R. Nelson, *op.cit.*, p. 61.

directed towards the attraction of highly mobile investment capital or, in short, the locational competition. The expansion of governmental support activities to settle foreign high-technology companies locally involves the danger of substantial distortions within the international flow of investment capital and allocates investment to those locations that would not have been chosen without the guarantee of strong governmental support. These "doping activities" may end, in an extreme scenario, in a "race to the top", where countries outbid themselves by continually increasing support activities. World-wide misallocations may be the consequence of these governmental politics, accompanied by over-investments, finally again forcing the diffusion of technology and strengthening the trend towards techno-globalism.

The most important positive outcome of protectionist and interventionist industrial policies in the past therefore was the accelerated diffusion of technology, with important consequences: with the global exploitation of technology, and the rising number of global technological collaborations⁵⁵ fostered by selective industrial policy measures on the one hand, and the need for companies to market their high fix-cost products world-wide on the other, technologies are becoming more rapidly available world-wide, while through the simplification of access the technological know-how of scientists and engineers is continually converging. Therefore techno-globalism leads to a high degree of security against being denied high-technology products.⁵⁶

Resistance to Industrial Policies?

What do the possible results of interventionist industrial policies towards high-technologies suggest for the future? Selective and interventionist policies for the creation of national champions are likely to run high risks of failure, inducing resource misallocations within the domestic economy. The more specialized the targets of the initiatives and the more political prestige connected to them, the more likely they are

to fail. But in most cases there is no additional economic argument for these technologies that could justify the preference of a "strategic" or "critical" technology in contrast to other technologies, except the higher flow of externalities resulting from R&D activities. Or as Branscomb puts it: "Most of the technologies said to be critical are at best important opportunities for the private sector, but it cannot be said of every one of them that the failure of private industry to practice it successfully threatens the survival of the nation".⁵⁷ Because of the danger of negative sum games by competitive counter-biddings common rules of the game are needed in order to preserve the ongoing world integration.⁵⁸ Those new rules of the game must include the strengthening of the WTO in its ability to deal with the establishment of barriers to trade and stronger sanction mechanisms for the punishment of violating governments, as well as the establishment of an international competition policy⁵⁹ and the control of unfair practices in locational competition.

But even if national governments are willing to follow the suggested path of strengthening the role of international institutions, thereby giving up some of their selectively oriented instruments in sensitive areas like competition, technology, and trade policy, the question remains whether there are any new necessities for governmental industrial policy action besides support for basic research, justified by positive externalities, and the maintenance and improvement of intellectual property rights to guarantee temporary monopoly positions for innovators.

Indeed, there are several reasons for a new role by governments to promote a steady flow of knowledge generating and utilizing activities by industry based on the characteristics of new technologies and a new perspective of the innovation process,⁶⁰ but also resulting from the trends and necessities related to techno-globalism.

□ While world-wide technological competition intensified rapidly during the past decade, risks and

⁵⁵ D. Archibugi and J. Michie, *op.cit.*

⁵⁶ S. Ostry and R. R. Nelson, *op.cit.*, p. 79-80. As G. Bletschacher and H. Klodt showed for the semiconductor industries, there has been a high degree of potential competition among semiconductor producers within the 1980s indicated through a continual shift in market positions. See G. Bletschacher and H. Klodt: Braucht Europa eine neue Industriepolitik? Discussion Papers of the Kiel Institute for World Economics, No. 177, Kiel 1991, here pp. 22ff. C. E. Barfield, *op.cit.*, convincingly pointed out that there is absolutely no danger to be seen that the United States will be excluded from access to flat-panel displays by Japanese enterprises within the next decade, because of several emerging sources in South-Korea, Europe, and Taiwan.

⁵⁷ L. M. Branscomb, *op.cit.*, p. 48.

⁵⁸ M. Sharp and K. Pavitt, *op.cit.*, p. 146.

⁵⁹ For these suggestions see S. Ostry, *op.cit.*; see also S. Ostry and R. R. Nelson, *op.cit.*

⁶⁰ The linear model of innovation is not adequate for the description of the innovation process. Innovation rarely proceeds sequentially from one stage to the next. Rather, it is a process of continuing interactions between the actors and between the different phases of innovation. Therefore the new perspective must abstract from the linear model and rely on the network model of innovation.

insecurities regarding the technical realizability and the potential economic success of innovations rose once more, the latter strongly reinforced by the shortening of average product life cycles. Therefore innovators have to fulfil the task of designing their innovation processes faster, more flexibly, and more efficiently in order to deal with the new challenges.

□ Within the forced international competition for technological innovations, innovators have to rely on a steady stream of new technological knowledge and its evaluation as well as its integration. The width and the depth of the research areas and technological fields require not only cooperation with other companies to reduce knowledge deficits through the adaption of special research results, to reduce development times and to share cost, but it also becomes more important for companies to cooperate increasingly with public research institutions as external sources of knowledge.⁶¹ Moreover, consumer feedback on desired and useful products will become more important in the future under increasing insecurities about technical realizability and economic success.

□ Within the new environment of more specialized and more differentiated technological fields the sighting and use of new technologies, of external knowledge resources and potential application fields becomes relatively more important in contrast with the development of own innovations. Within this process of "learning by interacting" it is less important for governments to increase financial support than to establish innovation networks between innovators, governmental research institutions and the demand side.

□ With the development and utilization of new "key technologies" and the changes in production processes connected with them, new possibilities for decentralization arose enabling the regional independence of production processes. Especially the new and strongly improved possibilities of information exchange can be held responsible for this development, thereby not only increasing world-wide locational competition and technology transfer, but also the importance of small and medium-sized enterprises as well as of regional and local institutions within the process of innovation.

Innovation Policy

Industrial policy, understood as policy for the industry, must therefore concentrate on guaranteeing entrepreneurial time advantages and innovation premiums⁶² on the one hand, and on the diffusion of new technological knowledge and technologies on the other hand, while re-thinking the centeredness of current industrial policies on central governments. In this perspective, industrial policy is not selective or sectorally oriented, rather it is a non-discriminating innovation policy completing the macro policies. Hence, the demand on governments' abilities as moderators and catalyzers in the innovation process will increase in order to release boosters and make synergetic effects realizable. Therefore there are several new tasks for governments, sharing in common the priority of reducing governmental technological activism.

□ First of all, the pace of technological progress and the reduction of product life cycles within the competition for technological innovations as well as the deep world-wide recession at the beginning of the 1990s seem to have induced a sharp decrease in companies' basic research activities, while more of their R&D budget is being spent on product development in order to cope with the new challenges.⁶³ Furthermore, governments have also reduced their general knowledge-creating activities while trying to help industry in the commercialization of new technological knowledge and therefore have been shifting their support to shorter oriented activities of firms and laboratories.⁶⁴ One of the major goals of governmental industrial policy for the future must therefore be the compensation of these reductions in long-horizon research activities. The accompanying indirect R&D support should be related to the extent of positive externalities connected to entrepreneurial R&D activities. The more these entrepreneurial activities are directed towards the generation of general technological basics, the higher externalities will occur, while externalities will decrease as industrial R&D moves towards specific applications. Therefore the additional indirect support of companies' projects must decrease the more activities are directed towards market relevance, and vice versa.⁶⁵

⁶¹ Ch. Freeman: Networks of innovators: A synthesis of research issues, in: *Research Policy*, Vol. 20, 1991, pp. 499-514, here p. 500.

⁶² H. Albach: Technische Entwicklung und Wettbewerb. Discussion papers of the Wissenschaftszentrum Berlin FS IV 94-12, Berlin 1994, p. 16.

⁶³ For a recent description of this shift in U.S. industry's R&D spending see: Task force on Strategic Energy Research and Development: *Energy R&D: Shaping our Nation's Future in a Competitive World*, Washington, D.C. 1995, pp. 3-5.

⁶⁴ S. Ostry and R. R. Nelson, *op.cit.*, p. 111.

□ Second, governments can try to enhance the collection and diffusion of new technological knowledge by providing an "info-structure", thereby taking into consideration the importance of a continuing flow of technological knowledge for the innovative enterprises. The provision of an "info-structure" can be divided into two parts: while forcing the build-up of an adequate information infrastructure on the one hand, governments can implement institutions related to the collection and distribution of world-wide accessible new technological knowledge via nation-wide data bases on the other. This would give enterprises the chance to fall back on the production factor information without restrictions and to produce and transport it, thereby increasing the entrepreneurial transparency with regard to new technological developments, as well as simplifying cross-border cooperation between private and governmental actors.

□ Third, the past has shown that regions not only have endogeneous potentials for innovations, but that they also have opportunities to formulate an independent innovation policy and to build up regional or local innovation clusters. While considering the special comparative advantages of local factors, their abilities and skills, local institutions are able to initialize an environment of local or regional positive externalities and to contribute to the simplification of access to ideas, goods and services between enterprises, thereby demanding and forcing their innovative potentials.⁶⁶ The main advantage of local institutions therefore is their decentrality and nearness to economic actors. Given that, the main task of local actors is to promote the local science and technology infrastructure such as education and training facilities, science base support, R&D, the support of small business innovators, and university-industry linkages.⁶⁷ Therefore it will be necessary to strengthen the

roles of local and regional governments within the innovation process in the future.⁶⁸

□ Fourth, governments have to remove unnecessary hindrances within the process of converting inventions into innovations in order to secure time advantages for companies. Since time becomes more and more a strategic variable for enterprises facing the international competition for technological innovations, every loss of time means a potential reduction of returns under the conditions of shortened product life cycles. The later companies are able to enter markets due to governmental time delays, the less time they have to gain the necessary returns, and the greater is the danger they will have to enter overcrowded markets and be forced to sell at lower prices in comparison to competitors. Moreover, the faster technological progress proceeds, the greater is the danger of entering the market with out-of-date products. But not only government induced time delays for commercialization via innovation have to be checked. All other unnecessary hindrances of the innovation process must also be the subject of a general check-up in order to secure optimal conditions for utilizing new technological knowledge.

□ And finally, governments must try to flank the generation of new technologies by competition policy. While precompetitive collaboration in R&D is an important source of learning and an instrument to reduce the cost of searching for new technological knowledge and therefore economically desirable, governments have to control competition on product markets even more intensely when allowing these forms of R&D cooperation in order to avoid tendencies towards oligopolistic or monopolistic power on domestic markets.

Based on the characteristics of the new technologies themselves and the new quality of international competition for technological innovations, there are several new fields for government activities. All of them have in common that they do not try to pick specific industries bearing the dangers of competitive distortions and misallocations, but to promote the generation of new technological knowledge and its utilization over all industries. General innovation policies bear not only greater chances of success,⁶⁹ but they also provide fewer risks of massive failures and connected distortions, and they are less likely to be politically instrumentalized. But, most of all, this kind of policy for the industry leaves the direction and the quantity of technical change to the economic actors in private markets.

⁶⁶ H. Klodt: Grundlagen der Forschungs- und Technologiepolitik. Working Papers of the Kiel Institute for World Economics, No. 664, Kiel 1994.

⁶⁷ M. E. Porter: The Competitive Advantage of Nations, New York 1990, p. 622; and G. Grabher: Rediscovering the Social in the Economics of Interfirm Relations, in: G. Grabher (ed.): The Embedded Firm, London and New York, pp. 1-31, here p. 21.

⁶⁸ M. Sharp and K. Pavitt, op.cit., p. 147.

⁶⁹ The recent suggestions made by the State-Federal Technology Partnership Task Force: Final Report, Cleveiano 1995, to tighten the cooperation of the Federal government and the States and to strengthen the States' responsibilities for their own science and technology goals as well as to improve their science and technology infrastructure are important steps towards a more decentralized, but also integrated system of R&D policy.

⁷⁰ S. Charnovitz, op.cit., p. 88.