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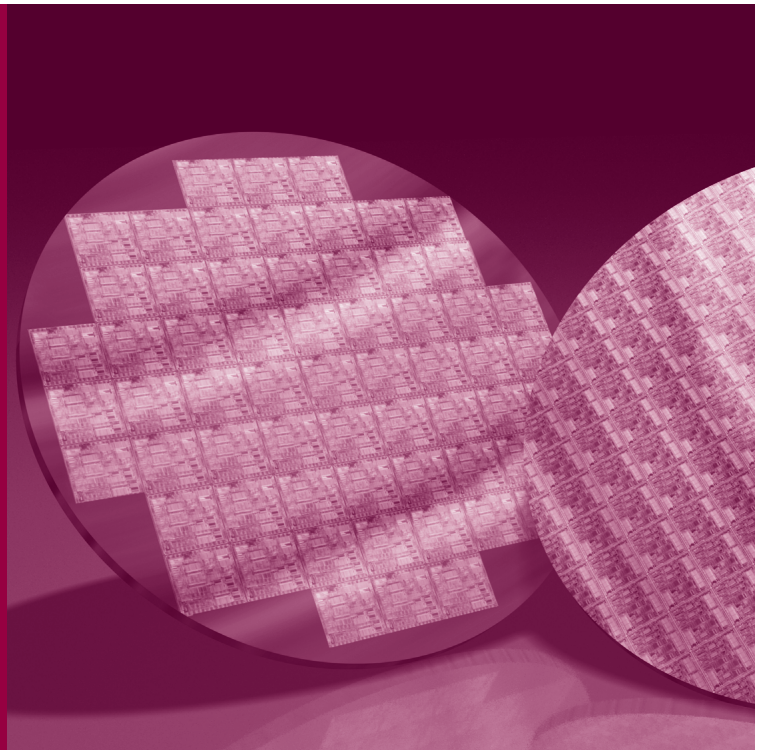
International competitiveness of the european economy with regard to the EU state aid policy: the case of nanoelectronics

Summary



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SUMMARY

STARTINGPOINT, OBJECTIVES AND APPROACH

Many countries see the growth of domestic high-tech branches as vital for their future economic development and therefore engage in fierce international competition. In order to promote growth and employment in these future-oriented sectors or technology fields, companies frequently receive significant government support (e.g. via subsidies or tax breaks).

In the European Union, however, the possibilities of the Member States to grant state aid are regulated by the EU state aid control. The aim is to reduce state aid on the part of Member States in order to drive European integration and free competition within Europe. Only under certain conditions does the European Commission permit the Member States to grant state aid. The impacts of EU state aid control on national policymaking are being discussed with particular intensity in the area of nano-electronics. Nano-electronics is an important cross-cutting technology with a multiplicity of application fields (e.g. consumer, automobile, and industrial electronics) and high economic potentials. In international competition, several non-European countries are massively supporting the construction of new production facilities as well as developing appropriate infrastructure, and manufacturing plants are increasingly being built in these countries.

The present Innovation Report compiled by TAB on behalf of the Committee for Education, Research and Technology Assessment is therefore devoted to the question of how to assess the impacts of EU state aid control on the international competitiveness in the nano-electronics sector, and which options emerge for the appropriate promotion of nano-electronics. The effects of EU state aid control on the competitiveness of the EU Member States are however, primarily of an indirect nature and depend on the interaction of several factors in the innovation system (e.g. demand, domestic locations of user branches), the use of complementary policy instruments and the extent of public support in non-European states.

In order to take these relationships into account, a multi-step approach is selected in this Innovation Report. First, based on a literature review and expert interviews, an innovation systems analysis is undertaken to identify the important

location factors and the challenges for Germany and Europe. Possible policy support needs can be derived from this process. Thereafter, the current policy measures in Germany will be presented, in a global comparison with the USA and several Asian countries in greater depth. The main focus addresses the questions, which public measures have already been implemented in Germany and Europe and whether non-European countries more strongly promote the development of nano-electronics. Finally, possible reasons for and against state interventions, as well as the impacts of the present EU state aid control on nano-electronics are discussed. On this basis, options for action for politics, industry and science will be derived.

EUROPES COMPETITIVENESS IN NANO ELECTRONICS

Global competition and the international division of labour are even more advanced in nano-electronics than in other branches. Often the individual activities (chip design, production, »packaging«, further processing) are globally distributed in the nano-electronics value added chain. The following key developments were observed in the recent past:

> The American location is clearly the leader in R&D-intensive chip design up to now, but individual Asian countries (above all Taiwan) are catching up. Design companies in Europe are mainly active in automotive and industrial electronics.
> The shares of geographical locations in production capacity have clearly shifted in the past years. In Europe, the share of worldwide output has sunk between the years 2000 and 2009 from 15 to about 10%. Germany is the most significant manufacturing location in Europe, but is also losing ground. Japan and the USA have also lost considerable production shares to other Asian countries (e.g. Taiwan, China).
> For many years, semiconductor products have been mainly assembled (so-called »packaging«) in Asia. Europe's employment share in this segment is currently under 2%.
> The largest buyers respectively users of semiconductor products are the Asian countries with a joint market share of ca. 70%. In Europe the demand for worldwide output is only 13%.

This evidence shows that the nano-electronics companies located in Europe are under considerable competitive pressure.

RELEVANT LOCATION FACTORS AND POSTITION OF GERMANY AND EUROPE

Significance of individual location factors

The reasons for the developments in nano-electronics described above are multi-faceted. A plethora of supply- and demand-side location factors (e.g. knowledge base, infrastructure, proximity to markets), as well as policy measures are signif-icant for the competitiveness of the nano-electronics companies. A key issue to emerge here is how important domestic production facilities are for the long-term successful development of Germany and Europe as nano-electronic manufacturing sites. Neither the authors consulted in the literature search nor the experts interviewed could agree on this.

For the great significance of spatial proximity between semiconductor production and other value added steps (among others, suppliers, R&D, users) agglomeration advantages must be mentioned (inter alia joint R&D infrastructure, economies of scale) and spatial knowledge spill-over effects. For instance, it is of great advantage for the equipment manufacturers or R&D service providers to have fast and easy access to the clean rooms in the production plants, as well as having the opportunity to exchange information on site, in order to develop adaptable solutions. User industries can find themselves strategically dependent on foreign semiconductor companies (e.g. loss of influence in determining the direction to be taken in R&D, exchange rate risks, market power of other countries). As a result, the outsourcing of production from Europe to third countries would be followed by the increasing outsourcing of domestic suppliers and design firms, or the firms located abroad would grow particularly strongly in these areas.

Several of the experts however have taken up the position that a loss of German or European production plants will not necessarily lead to negative consequences. They emphasize the considerable importance of other location factors (e.g. technological knowledge for chip design) and recommend concentrating on developing innovative products and processes for the world market. In addition, the downstream user companies are not significantly weakened, as they are already globally active in other regions (above all, Asia, the USA) and thus continue to have good access to nano-electronic intermediate goods and related new technological knowledge.

In conclusion, it is difficult to judge how vital preserving domestic production and corresponding state support are.

Strenght and weaknesses of Germany and Europe

Observation of the strengths and weaknesses of Europe in a global comparison presents the following picture: Current strengths of the location Germany (and in part Europe) consist in the technological knowledge base. The broad systems competence of highly qualified workers (e.g. in power electronics), and the research strength in the so-called »more than Moore« area lead to high international competitiveness. Also, collaboration in the respective clusters in Germany and Europe among different actors (from science, industry) is well established. On the demand side, there are advantages in automotive and industrial electronics through the large domestic market.

A weakness of Germany and Europe in the nano-electronics sector is seen, as in other technology fields, in the commercialization: The investments of large firms are low, the pressure to internationalize and diversify is high for SMEs and the business models of companies in Europe have only limited complementarity to each other.

In general, however, it must be noted that with many location factors there are no great differences among the leading nano-electronics locations in the world. Therefore, government policy measures, above all in building production plants, are regarded as being of decisive importance in making location decisions.

Current policy measures in nano electronics

The current policy measures in Germany illustrate diverse approaches to promoting the knowledge base, as well as knowledge application and networking. Among these are in particular institutional R&D promotion, the construction of public-private partnership models (e.g. Namlab) plus regional and national promotional programmes (e.g. IKT 2020 of the BMBF). While the interviewed experts assessed the diversity and execution of the promotion on the part of the institutions as positive, on the whole, some criticisms remain. These are

> the rather stagnating state R&D expenditures in nano-electronics, which cannot keep pace with the rising R&D costs (inter alia due to the more expensive equipment required for the more complex R&D challenges);
> the restriction of important promotional programmes to support for projects in which processes respectively products are developed which are nationally utilized, produced or processed. Projects which are intended for purely international commercialization are scarcely funded;
> coordination problems with the European research promotion programmes.

These programmes are on the whole of great significance for application-oriented, international cooperative research in nano-electronics. However, in the programmes co-determined by Member States (e.g. ENIAC, CATRENE) not only do considerable substantive overlapping and a lack of critical mass for promotional topics emerge, but also significant problems of coordination between the nation states (e.g. in the grant sums allocated or in reaching agreement on content);

> the low promotion of investment. While Germany utilized the regional funding possibilities above all to strongly support the development of the semiconductor industry during German re-unification, it appears that promotion of investment continues to shrink, not least because of the present regulations of EU state aid control.

A comparison of the German and French promotional policies reveals significant differences. Although France is also subject to EU state aid control, its nano-electronic policy has a clearly higher industrial policy character. Various measures (e.g. high national support within European R&D programmes, R&D programme Nano 2012) lead to clear promotion of the scientists located in Grenoble.

In a global comparison, several countries (e.g. Taiwan, China, the USA) provide even greater state support for nano-electronics. Although the information about public measures is incomplete, comprehensive state interventions are indicated. The states and regions have developed a large number of different support measures and incentives. These include

> intensive R&D promotion (e.g. Taiwan, Japan, the USA),
> at least in single cases very high grants to construct production plants (e.g. China, the USA),
> various tax breaks, among others, tax exemptions for new investments or property tax reductions (e.g. China, Taiwan, South Korea, Japan),
> government interventions to rescue memory chip manufacturers in the wake of the current economic crisis (e.g. Taiwan, Japan).

In a global comparison, the trend is towards similarities in the R&D promotion. Promoting manufacturing in nano-electronics, however, appears to be significantly higher in some countries (e.g. China, the USA, Taiwan) than in Germany or France.

JUSTIFICATION AND IMPACTS OF EU STATE AND AID CONROL

The European state aid control is named by many interviewed experts as the main obstacle to a more generous state support for the industry in European countries.

Reasons pro and contra state aid

In principle, state aid is often regarded critically. In the opinion of many economists, coordinating economic decisions through private markets leads to an efficient utilization of scarce resources. State interventions like tax breaks or subsidies are only justified from this perspective for important reasons, e.g. for market failure reasons (including externalities, information asymmetries, misallocation in global competition), for distributional policy reasons or from the viewpoint of evolutionary economics in the case of innovation system failure (e.g. problems with coordination).

An in-depth analysis of different types of market failure with regard to nano-electronics shows that several of these reasons apply to this technology field. There are, for instance, indications of considerable externalities (including knowledge spill-over effects to other industries, cost reductions for users) and misallocations in global competition because of high state subsidies in non-European countries. Whether these market failures are severe enough to justify considerable state investment aid for manufacturing facilities cannot be generally decided. Moreover, even the presence of these reasons does not necessarily always justify state interventions, as unwanted effects can occur. These include distortions of competition, failures on the part of the state (e.g. the problem of »picking winners«) tax or subsidies competition between countries.

Structure and impacts of EU aid control

There are therefore several reasons which justify European state aid control. The current EU state aid law forbids state aid in principle, but foresees various exceptions to this rule (e.g. for SMEs, R&D). In recent years, the EU state aid law was tightened up in the »State Aid Action Plan« (»less and more targeted« state aid). It has become more difficult for the Member States to grant aid, especially regional and sectoral aid, and as a result it has been cut. Thus the restrictions of the EU state aid law are even more severe than global subsidy regulations like the WTO guidelines, which can hardly prevent subsidised bidding competitions for large investment projects.

Approval of exceptions in the various EU aid programmes are based on the above mentioned reasons for state interventions (e.g. externalities). They include them as positive criteria in individual state aid cases for large promotions. According to disputes up to now, they were judged to be correct for nano-electronics, as a rule. However, these approval criteria are not connected to the maximum aid levels. For the »Multi-sectoral Aid Programme for Investments« which includes nano-electronics, no higher rates of aid are possible, even in the case of intensive location competition with countries outside Europe.

This means that the current regulation on maximum aid amounts are clearly more restrictive, not only compared with earlier European regulation prior to the year 2002, but also compared with currently available investment aid in non-European countries. However, the necessity to change European state aid law cannot be directly deduced from this situation, e.g. due to risks of an increased competition for subsidies (subsidy race), rising state debt etc. At the same time, it appears that the nano-electronics example can only be transferred to other sectors to a limited extent and that nano-electronics occupy a special position. Especially because of the very high capital intensity in nano-electronics and the very critical situation with competing latecomer countries, the restrictive impacts of the EU state aid regulations must be evaluated as clearly higher than in other sectors.

OPTIONS FOR ACTION

With regard to the starting points for improvements, several general options for action can be deduced which have been unanimously approved, both in the literature and also by the experts interviewed. In addition, further options exist, about which however there are clear differences of opinion both between the interviewed experts and in the pertinent literature. Some experts regard financial aid for production plants as essential for the long-term successful development of Germany as a location for nano-electronics. Such measures would however mean a very specific intervention in the nano-electronic innovation system. Other experts, on the other hand, consider the proximity of manufacturing plants to be less relevant and advise against this, above all because of the possible risks (e.g. subsidy race). They recommend instead that state support be more strongly focussed on R&D and on the suppliers to the nano-electronic sector.

Both the analysis of aid control conducted by TAB and the analysis of Europe's competitiveness in nano-electronics have shown that there are plausible arguments for both sides of the issue. Therefore, based on these different viewpoints,

a distinction is made between two different action scenarios for the secondary options for action:

> Firstly, the scenario »Framework-setting Policy« which concentrates on the needs of actors from the early value creation steps (R&D, design, equipment manufacturers). A market failure is very probable in this context (e.g. externalities of R&D) and political actions should follow. Primarily horizontal measures will be utilized (e.g. promotion of SMEs).
> Secondly, the scenario »Active Sectoral Technology/ Industrial Policy« which attempts to strengthen the entire nano-electronic value added chain. This includes also specific, sectoral policy instruments (e.g. investment subsidies) to promote production plants.

The options require direct changes of the EU state aid control only to a limited extent. Rather, they result mainly indirectly through the limits of the control or as support measures complementing state aid control. In the following, first of all the general options for action and subsequently the options in the action scenarios are briefly summarized.

GENERAL OPTIONS FOR ACTION

The general options for action present primarily an optimization of Germany's action strategies up to now and include the following design possibilities:

Increase R&D expenditures: The rising R&D costs over time for the design and production of semiconductors, as well as increasing R&D activities of Asian countries raise the pressure on the research location Germany, respectively Europe. Against this background, a growth in private and public R&D expenditures should be targeted. Parts of the public funding could be more specifically allocated to certain thematic issues (e.g. to the »more than Moore« area) than before.

Promotion of education and training: To date, the knowledge base in Germany has been positively evaluated because of the broad systems know-how of the highly skilled work force. The interviewed experts however expressed the fear that in future sufficient high skilled workers may not be available. An important starting point is therefore to improve the education and further training of qualified workers. The previous combination of teaching broad, basic knowledge (among others, in electrical engineering) and practical, nano-electronic-specific application orientation appears appropriate also for the future, as relevant

know-how in future-oriented fields (above all in the »more than Moore« area) is of great significance.

Improving agreement and coordination processes at the European level: The European promotional programmes CATRENE and ENIAC strongly overlap and have complex promotion procedures due to the problems of coordinating the directly participating Member States. A more intensive coordination between the states or a greater delegation of decision-making competences to the funding institutions themselves could increasingly direct the programmes towards addressing current issues and avoid duplicated funding. In addition, it would be more easily possible to build stronger profiles for research programmes with a critical mass of projects for certain promotional topics (including organic electronics, 3-D chip integration).

Efforts to achieve a global regulation of state aid: As a result of the observed subsidy race, many states benefit only to a limited degree from the economic development in nano-electronics (misallocation of resources, high expenditures for funding, etc.). Therefore the efforts to arrive at a standardised regulation of state interventions should be continued. Conceivable preparatory steps are measures to increase the transparency of state aids (e.g. an observatory to review state aid, WTO studies).

Support for knowledge transfer between science and industry: Several of the experts interviewed believe that the existing technology transfer can be improved. A stronger orientation of science to the needs of industry should be aimed for. Corresponding incentives for the scientific actors to cooperate with the companies, e.g. by increasingly anchoring technology transfer as a strategic goal of R&D institutions or universities, should however not overly restrict the freedom of research. Also, a more intensive information exchange between the players, like temporary exchange of personnel, would be helpful in nano-electronics, to improve the results of the research work and increase the usability from the perspective of industry.

Support for cooperations between industrial actors: Up till now, the cooperations between the industrial players in nano-electronics in Germany and Europe were considered successful. The rising R&D costs, the growing specialization of firms and the opening up of new application fields (e.g. medical technology, molecular electronics), whose actors are not yet networked, increase the need to cooperate in the future. An expansion of the existing support of networking for industrial actors would thus be appropriate, among other measures, funding for

interdisciplinary projects and assistance in initiating cooperations (e.g. industry days, science councils).

ACTION SCENARIO »FRAMEWORK SETTING POLICY«

In this scenario, primarily horizontal policy measures are proposed, in order to address the problems of market failure and to achieve the goals of state aid control (e.g. reduction of competition distortions). The focus of funding tends to centre on early value creation steps in nano-electronics (e.g. equipment, chip design, services). Selective interventions to promote investments in production plants are mainly avoided in this scenario. Thus problems with targeted steering efforts are also avoided. Due to low specific support, the probability of Germany increasingly losing importance as a production site is however high, and the pressure on a strong international orientation of the remaining companies is growing. The action scenario »Frame-setting Policy« comprises the following options:

Fiscal R&D promotion: A tax break for R&D promotion could increase the R&D activities of the semiconductor firms by its usually broad impacts. Against the background of the significance of SMEs in nano-electronics, a strong orientation towards tax incentives for SMEs would be desirable in this scenario (e.g. through higher promotional rates for SMEs).

Stronger orientation of R&D promotion to SMEs' needs: According to the statements by many experts, the existing research programmes are only oriented towards the needs of SMEs in nano-electronics to a limited extent (especially the support for incremental innovations such as e.g. efficiency, process or quality improvements). Therefore a stronger SME-orientation of R&D promotion should be striven for. This should also contain a stronger integration of external know-how in the R&D strategies of the SMEs. In addition, a supplementary specific direct R&D promotion could be offered for R&D design firms and suppliers, like providing infrastructures for design firms via »open innovation« programmes or programmes to utilize already existing production plants of earlier chip generations (e.g. besides 200-mm also 150-mm production lines) to develop new applications in the »more than Moore« area.

Stronger international orientation of R&D support: Through the – especially in this scenario – increasingly global division of labour in nano-electronics, a conflict emerges because only those R&D activities are presently liable for promotion which develop processes/products, which are used, produced or processed

at a national level. The suppliers or design firms will, through the outsourcing of factories and consequently of their markets abroad, have very little chance to secure promotional funding in future. In order to support the internationalization efforts of these enterprises, it would be worth checking whether the funding regulations should be granted in the case of an international commercialization.

Support for the internationalization of SMEs: In this scenario, it will be increasingly difficult, due to the probable increase in manufacturing outsourcing, to maintain the long-term adaptability of the know-how development of suppliers, on the one hand, and users, on the other hand. This requires constant updating of knowledge about technology trends and customers' need structures in the respective international sales markets. The following measures come into question: export credits, support for internationalization plans by non-profit service providers, or further education measures which strengthen the abilities of SMEs to better absorb information about international technology trends and markets and further process this information in an enterprise-specific manner.

Protection of single production plants in Europe: In order to prevent the risks inherent in a strategic dependency on other countries (e.g. delivery bottlenecks, fluctuations in cost, loss of technological know-how), it would be conceivable to guarantee the existence of at least one or two production locations with a high state-of-the-art technology status within Europe. In a corresponding consultation process, all actors (nation states, industry) if possible should be integrated and a clear ruling of the procedures for key issues, such as the technological direction or upgrading of the plant, be established (e.g. co-determination of individual nation states).

ACTION SCENARIO »ACTIVE SECTORAL TECHNOLOGY/INDUSTRIAL POLICY«

In this scenario measures are suggested which are targeted to support the development of the local nano-electronic industry. The focus is on promoting the entire value chain (R&D, production, demand) and includes actively promoting the establishment and securing of the location of production plants. Thus it will be easier in part to react to some potential market failures (including externalities, possible dependency on monopolists) in a more targeted manner than with horizontal measures.

In order to minimize the risks involved with such a policy, such as subsidy races, great attention should be paid to developing a fitting programme design. In addition, it should be noted that the important option in this scenario of raising

the support for investment can only take place if the EU state aid law is simultaneously adapted. The scenario »Active Sectoral Technology/Industrial Policy« contains the following options:

Development of a uniform strategy: So far, a consistent and clear strategy for the German and European nano-electronic location has been lacking, to which the players could orient themselves. In this scenario a common strategy for coordinated action on the part of the actors would be important. In the opinion of the experts, Germany should pledge a stronger »commitment« to nano-electronics as a strategically important cross-cutting technology and should actively support the process through funding aid and long-term involvement at the international level. The actors should receive signals as to which goals in nano-electronics will be pursued and which topics will be supported in the mid to long term, and which not. The entire strategy as well as the substrategies should be developed on the basis of transparent, methodologically supported (e.g. by means of a German or European roadmap for nano-electronics), integrative and participative processes, so that if possible they will accepted by all innovation players in nano-electronics.

Greater priority-setting in R&D funding: In accordance with a clear strategy, in this scenario the research programmes should be bundled and the research funds be more strategically utilized. The national priority-setting of research funding should integrate many actors (including SMEs, large enterprises, R&D institutes) and be embedded more than was till now the case in the context of European research cooperation. The research capacities would address topics and technology areas in which Germany, on the one hand, has comparative strengths (e.g. power electronics) and, on the other hand, large market and growth potentials are seen. The promotion should together with private financing include more R&D infrastructure. Here conflicts with the EU state aid law are possible and must be looked out for, as it limits the support for R&D infrastructure. Where required, adaptations would be necessary, like amendments to the state aid law or common European funding from the EU budget).

Development of strategic business models and strengthening a complementary European network: The increasing focus of many companies in their activities or specialisation on concrete product areas (e.g. automobile electronics) leads towards a growing fragmentation of the European corporate landscape. A stronger European networking of enterprises and R&D players can make it possible to exploit synergy potentials better, share the rising costs for developing the next technology generations, achieve a critical mass in market segments as well as in part to be able to service various user branches. Until now, considerable ob-

stacles stood in the way of such a development. These include the risk of losing strategic knowledge or the loss of social proximity, which the actors must jointly overcome. Politics admittedly has only limited influence on these developments. But it can play a supporting role, e.g. in the form of reaching a more intensive agreement on joint promotional conditions or on increased support for pre-competitive collaborative projects in European promotional programmes.

More investment promotion and contemplation of a change in the EU state aid law: In order to compete in the international competition for the location of semiconductor production plants, increasing investment grants would be an appropriate measure in this scenario. The agreements on grants for large investments therefore should be so designed that the locational pull is increased (including cooperation contracts with local companies, locational guarantees) and to keep the burden on the state budget as low as possible (e.g. by distributing the grants over a longer time period). A significant increase in investment support can only take place if simultaneously the EU state aid law and the risks associated therewith are adapted. However, various alternatives to changing the EU state aid law are basically conceivable. They would increase the possibilities of granting aid, either specifically in nano-electronics (e.g. by introducing a sectoral aid framework, supplementary clauses in the Multi-sectoral Regional Aid Programme) or generally, for various economic branches (e.g. increasing aid levels for large investments; matching clauses for higher aid levels for third country competition). Each intervention should be carefully conducted, in order not to overturn the goals and regulations of the EU state aid control too much.

Strengthening innovation-promoting demand: State support of demand for innovative semiconductors can contribute towards overcoming various barriers for the actors (e.g. high entry costs, market uncertainties, lack of infrastructure). Possible examples could be regulations for the energy efficiency of electronic products or direct government demand, e.g. for electronics in medical technology. It should be examined how the disadvantages associated with such measures (e.g. high burdens for the state, consumers, user branches) can be minimized and what a suitable design (long-term planning vs. flexibility, orientation towards markets with a promising future) can look like. One important measure in this context would be to combine demand promotion with supply-side policy instruments, such as e.g. a high R&D support in the relevant markets.

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