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AND TECHNOLOGICAL
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COMMISSION OF EXPERTS
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The Commission of Experts wishes to emphasise that the positions expressed in the report do not necessarily represent the opinions of the aforementioned persons.

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Challenges

Germany can look back on important successes in its research and innovation policy (R&I policy). For example, since 2005 there have been considerable improvements in the areas of public and private R&D expenditure, in the positioning of German tertiary education and research institutions in terms of attractiveness and excellence, and in the modernisation of the German economy.

These developments are also due to the fact that R&I policy has enjoyed a high level of attention over the last ten years and that considerable resources have been directed into the fields of science, research and innovation. Germany is now significantly closer to its aim of playing a leading role as an innovation location.

At the same time, Roman Herzog's statement still applies: „The world is moving fast; it won't wait for Germany."[1] The challenges have further increased over the past few years. German R&I policy must be further developed consistently if it is to make a contribution to addressing these challenges. The Commission of Experts considers the following developments to be especially important:

Climate change and sustainability

An international convention on climate protection has been reached with the Paris Agreement. Now, top priority must be given to implementing the agreement. Research and innovation can make an essential contribution to reaching the climate targets. The policy goal of decarbonising the economy must therefore also play an important role in the deliberations of the R&I policy-makers and form an integral part of the new Federal Government's science and innovation strategy.

Demographic development

The ageing of society is creating considerable problems for social security systems. It is also aggravating the lack of skilled labour. Research and innovation can provide solutions for an increasingly ageing population in order to secure quality of life into old age and make longer participation in working life possible.

Equitable participation

R&I policy, too, is confronted with the question of whether innovation processes increasingly generate inequality. Especially in the course of the digital revolution, profound changes are to be expected which, from the citizens' point of view, involve the risk of losing jobs or prosperity. Unless the population is suitably incorporated in decision-making and able to participate equitably, science and innovation might also face growing scepticism.

Energy supply

R&I policy will play an important role in designing the future energy supply. For example, dependence on non-renewable energies must be further reduced. The aim must be to find an economically sensible path towards the almost exclusive use of renewable energy.

Mobility

In the mobility sector, a profound change is taking place from a strong focus on automobiles to multimodal systems of mobility services. The automotive sector is particularly important to the economy in Germany. The introduction of electromobility, accelerated digitisation, and the emergence of new competitors has put industry under considerable pressure.

Innovations are necessary to maintain and expand the competitive position of German companies.

Digital change

Germany is not yet properly prepared for digital change. Funding schemes still do not yet sufficiently take information and communication technologies into account. R&I policy must focus more on start-ups as new innovative players. In addition to assisting and supporting established economic sectors with digital change, the development of new strengths must also be promoted. Training in the competent use of digital applications and responsible handling of personal data will play a key role.

European Research Area

R&I policy must continue to attach great importance to the further development of the European Research Area. The continuation of cooperation with the UK must be secured after Brexit, above all in the field of student and academic exchange.

New innovation pathways

Innovation processes are changing. Increasingly, basic research is leading directly to application and translation possibilities. Start-ups have become key economic players in some areas. New forms of organisation, such as crowd concepts, competition formats and real-life laboratories, are growing alongside traditional, hierarchically organised R&I processes. R&I policy in Germany should do more to embrace these new developments.

Agile state

At present, technological and economic opportunities and the political environment are changing at high speed. German R&I policy needs to be highly flexible to be able to respond quickly to these developments. The modification of structures and processes as a result of digitisation and the launch of innovation processes cannot and should not be excluded from ministries or the public administration. An agile government will be needed in the future.

Targets for the year 2025

It will be impossible to adequately meet the above (and further) challenges without a further strengthening of science, research and innovation. The Commission of Experts recommends that German research and innovation policy should formulate clear targets as a basis for measuring and evaluating further progress. In particular, the Commission makes the following proposals to the Federal Government:

Spend 3.5 percent of GDP on R&D

Private and public engagement in the field of research and development should continue to grow up to 2025. It would be a visible sign of such engagement if the Federal Republic of Germany were to reach the 3.5 percent target by 2025. National R&D intensity is currently close to 3.0 percent.

Establish at least three German universities among the world's 30 leaders

Federal and Länder governments should specifically promote German universities and other tertiary education institutions in order to sustainably improve the international image and standing of Germany's science system abroad. A visible expression of such a development would be for three or more German tertiary education institutions to be among the leading 30 universities in the Times Higher Education Ranking by 2025. Only one German university is currently among the world's 30 leading tertiary education institutions.

Double venture capital's share of gross domestic product to 0.06 percent

By 2025, venture capital should make up more than 0.06 percent of GDP – i.e. more than double the present figure (0.027 percent).

Catch up with the five leading nations in the field of digital infrastructure

The Federal Republic of Germany should strive to have one of the world's leading broadband infrastructures by 2025. R&I policy should begin by abandoning the pursuit of a static goal and agreeing on a flexible, dynamically adjusting target. It would be a visible sign of a positive development if Germany became one of the five OECD nations with a leading digital infrastructure by 2025. Compared to other countries, Germany is currently lagging behind according to almost all indicators of high-performance broadband development faster than 50 Mbit/s.

Double the share of funding in the field of digitisation

The Federal Government must also respond to the challenge of digitisation with a sustainable increase in research funding and technology transfer in this area. Its aim should be to sustainably develop new scientific, technical and economic strengths in order to be among the world's leading economies in this field by 2025. The Federal Government's share of funding in the field of digitisation flow should be rapidly doubled.

Take on a pioneering role in e-government

In e-government, Germany should be recognised in Europe as a successful model of digital government and administration by 2025. Hesitant positioning on the part of German R&I policy is no longer the way forward – the challenges are too big for that. The successes achieved up to now should encourage German R&I policy to believe it can achieve major changes if it sets itself ambitious targets.

Area for action: The science system

A raft of policy measures over the last ten years in the tertiary education sector, and in the field of publicly funded research in general, has led to a significant improvement in research conditions, to more third-party-funded research and research collaborations, as well as to an increase in the number of up-and-coming young academics. Germany has become significantly more attractive as a location for science. The Federal Government has substantially increased resources for publicly funded research and has thus made a significant contribution towards achieving the three-percent target for R&D spending and making the German research landscape more competitive.

The Commission of Experts now considers it necessary to set a more ambitious goal. In its 2015 Report it already called for an increase in the target for R&D spending to 3.5 percent of GDP.

The Excellence Initiative has strengthened Germany as a location for science. The Commission of Experts welcomes the agreement on the Excellence Strategy between the Federal and Länder governments adopted in 2016. Since the Higher Education Pact and the Pact for Research and Innovation will expire in 2020, decisions will also have to be taken in the next few years on whether, or in what form, these two pacts are to be continued. While the non-university research organisations achieved the budget increases of the last few years via institutional promotion with the Pact for Research and Innovation, the problem in the case of tertiary education institutions (universities and universities of applied sciences) is that a high proportion of the increase in funding was realised via temporary and earmarked funds. This creates many problems for tertiary education institutions; it also opens up a gap between financing conditions in tertiary education institutions and those at non-university research organisations.

Increase basic financing of tertiary education institutions and continue the Higher Education Pact

A key challenge in the coming years will be to substantially improve the basic financing of Germany's tertiary education institutions, to overcome their structural underfunding, and to further boost their international competitiveness. In this context, it is initially the Länder that have an obligation to invest in basic financing.

At the same time, the Commission of Experts recommends that Federal and Länder governments should initiate a follow-up programme for the Higher Education Pact. The Federal Government should continue to support the Länder in financing teaching and overhead costs. However, this must not lead to the Länder reducing their own contributions to the funding of tertiary education institutions. Assistance from the Federal Government should thus be tied to verifiable conditions.

Increase overhead allowances for third-party-funded projects

The DFG Programme Allowance and the BMBF Project Allowance are usually not sufficient to finance the full indirect costs related to third-party-funded research. To avoid tertiary education institutions being forced to use more and more basic funds to cover overhead costs in view of growing volumes of third-party funding, increases in the DFG Programme Allowance and the BMBF Project Allowance are urgently needed.

Increase the number of permanent professorships

The number of permanent professorships should be increased. At the same time, the student-to-professor ratio should be improved and individual teaching loads reduced. A combination of these measures will make the German academic system more attractive in the international competition for excellent researchers and particularly talented students. It will also improve the quality of teaching for all students.

Improve career opportunities for young academics

An increase in the number of permanent professorships also benefits the greatly increased numbers of up-and-coming young academics, because it improves their career opportunities. Furthermore, it supports greater use of the tenure-track system.

In the context of young people's career planning, more attention must also be paid to their labour-market options outside academia. Young academics' careers outside the higher-education sector represent an essential element of knowledge and technology transfer that sustainably strengthens Germany's research and innovation system.

Refurbish university buildings and create future-proof infrastructures

As regards buildings and technical facilities, many years of investment backlogs must be overcome and expansion investment carried out to improve the increasingly serious state of the general infrastructure and bring tertiary education institutions up to date with state-of-the-art technology. At the same time, the tertiary education institutions must meet the requirements of digitisation. This will require corresponding investment programmes on the part of the Federal and Länder governments.

Differentiate between tertiary education institutions and modernise governance

In addition to improving staffing and the basic provision of premises, the organisation and governance of tertiary education institutions must also be modernised. They must be given more scope for greater differentiation and experimentation with new forms of governance and priority setting; corresponding incentives are needed.

Further strengthen non-university research organisations – continue the Pact for Research and Innovation

The Commission of Experts recommends continuing the Pact for Research and Innovation for financing non-university research organisations beyond 2020. A further improvement in the performance of non-university research organisations can only be achieved if funding can be increased not only in nominal, but also in real terms.

Area for action: Transfer

Innovation is the result of the transfer and recombination of knowledge from numerous actors in academia, business and society. Tertiary education institutions and other research organisations can make major contributions here. Up to now, however, a culture of knowledge transfer has not developed to a sufficient extent in these organisations. Germany admittedly cannot afford to forgo excellent research results that are beneficial to society and the economy. Hence, both in research organisations and in R&I policy, greater importance should be attached to the objective of knowledge and technology transfer. By contrast, the promotion of clusters – in which cooperation and knowledge transfer between business and academia is often organised very effectively – is well developed. There, no further expansion of funding is required.

Intensify transfer, raise transparency

The Commission of Experts welcomes close cooperation between actors from academia, business and society. However, the actors involved act on the basis of different incentives. Nevertheless, the transfer of knowledge and technology can and should be designed in such a way that it does not conflict with freedom of research. To ensure this, such collaborations need to be based on transparency-creating regulations and self-commitment. In addition, a change in culture needs to be enforced in tertiary education and other research institutions that facilitates the use of new knowledge. A fundamental condition for this is to design organisational and incentive structures that are sufficiently flexible. Furthermore, the governance of knowledge and technology transfer in tertiary education and other research institutions should be improved.

The Commission of Experts endorses the recommendations of the German Council of Science and Humanities (Wissenschaftsrat)[2], according to which research institutions should develop and consistently implement a strategy for an improved knowledge and technology transfer.

Improve the legal framework of transfer

The framework conditions governing access to and the exchange of research findings have been improved in the last few years. The Commission of Experts expressly welcomes the recent establishment of open access as a fundamental principle in research funding. It also welcomes efforts to introduce a general exemption to copyright for academic and educational purposes, which limits copyright restrictions on the use of digital sources in academia. This will improve freedom of research and teaching. However, the Federal Government should not rest on its laurels in the coming legislative period. The Commission of Experts renews its call for the introduction of a grace period in patent law, which for researchers would mitigate conflicting goals relating to the academic and commercial exploitation of research findings.

Develop start-up and transfer skills

New ideas and know-how are often not used because researchers lack the necessary skills for communicating findings outside the academic context. Spin-offs from tertiary education institutions and other research organisations represent an important transfer channel, making it possible to exploit and apply the new knowledge generated. Currently, the potential for academic spin-offs is not being used sufficiently. Tertiary education institutions should therefore take action to introduce – or further develop – curricula at the graduate and postgraduate level that address entrepreneurship and company founding as well as the marketing of innovations.

Besides the option of pursuing an academic career, there are also attractive employment opportunities in

business and society, where talented academics can also apply new methods and research findings. Up to now, such career options have often been neglected in structured graduate training. In future, they should be given more backing as an additional transfer channel.

Support market access

In addition, the transfer offices of tertiary education and other research institutions should extend and professionalise their support to cover the preparatory phase to market access. They should specifically provide platforms on which research institutions can present their findings and discuss their respective needs with companies. However, it does not make sense to encourage academics in general to market their scientific findings themselves. Rather, technology transfer should be organised according to the principle of the division of labour to ensure that specialisation benefits can be reaped.

Reorientate cluster policy

Cooperation and knowledge transfer between business and science are often organised particularly effectively in clusters. Cluster-policy measures at both the federal and Länder level have become an integral part of R&I policy – although there is rarely sufficient economic justification for political market interventions beyond the formative and initial growth phases. At the same time, it is currently difficult to reliably estimate the long-term innovation effects of cluster policy. Against this background, the Commission of Experts has already warned against attaching too much importance to this instrument in the past. Although agglomeration effects are important for innovative activities, and R&I-policy measures sustain them – they cannot be forced. Up to now, cluster funding has reached a large number of clusters. The promotional effects can be expected to gradually weaken if support is increasingly given only to clusters that are already developed. The Commission of Experts therefore recommends critically reconsidering a continuation of cluster promotion at the federal level. In particular, the Leading-Edge Cluster Competition should not be continued for the time being, despite the fact that it has shown initial positive promotional effects. Furthermore, cluster policy has hitherto run the risk of concentrating excessively on regional networks, thus leading to regional isolation. The Commission of Experts advocates measures that prevent isolation and aim to achieve a so-called delock-in. The Commission therefore expressly welcomes the BMBF's funding programme for the internationalisation of clusters. In the same way, measures should be developed aimed at preventing lock-in for established technologies and encouraging an orientation towards new technologies; this could also contribute to a reorientation of cluster policies.

Area for action: Innovation in established companies

As part of the so-called Lisbon Strategy, in March 2000 the European Council formulated the European Union's strategic goal „to become the most competitive and dynamic knowledge-based economy in the world".[3] Against this background, two years later in Barcelona the European Council decided to increase the R&D spending in the EU to 3 percent of gross domestic product by 2010.[4] Another stated objective was that two-thirds of the investment was to be financed by the private sector. By 2005, Germany was a long way from this target with a figure of 2.48 percent,[5] which makes the increase over the last ten years all the more remarkable. In 2015, internal R&D as a proportion of GDP was 2.99 percent,[6] – indeed over 3 percent according to the calculation method used in 2005.[7] The strong increase over the last ten years is a great success for R&I policy, and it has led to a marked growth in publicly financed R&D. Almost two thirds of internal R&D expenditure is financed by private companies.[8] Growth in this field is also large, albeit relatively lower. Strengthening R&D in German companies therefore remains a key challenge.

Promote the diversification of R&D activities in Germany

The R&D activities of German companies are concentrated in a few core industries. Vehicle construction alone accounted for more than a third of Germany's internal R&D expenditure in 2015.[9] The R&D activities of foreign companies in Germany reinforce this concentration. The extensive and still rising R&D activities in vehicle construction are to be welcomed. However, Germany risks being highly dependent on a core industry at a time when competitive positions are being re-defined. Germany should therefore look at ways of achieving greater diversification of its R&D activities.

Use opportunities to internationalise R&D

In the last ten years, R&D spending by German companies has increased in almost all branches of industry, both in Germany and abroad. The Commission of Experts is concerned that German corporate R&D activities are increasingly being carried out abroad in certain sectors, e.g. pharmaceuticals.[10] The aim must be to strengthen Germany as a centre of international R&D activities with an efficient research infrastructure and research-friendly regulation.

Strengthen the innovation activities of SMEs

Up to now, state funding for innovation has not reached enough SMEs – despite well established project funding. The wide range of specific federal and state programmes makes the funding options complex for companies applying for subsidies; the amount of work associated with applications is harder to shoulder for small businesses than for larger corporations. R&D funding through tax credits, as proposed by the Commission of Experts in Chapter B 7, would therefore be an important measure that would reach many more SMEs than the current application-based project funding.

Shortage of skilled labour: incorporate hidden reserves better to boost innovation

Demographic developments represent a major challenge for companies' innovative capacity. A whole package of strategies is required to overcome it. One measure is to use hidden reserves, which are plentiful particularly in Germany. For example, the participation of women in vocational training has increased enormously, yet the percentage of women in employ-

ment is still relatively small. The aim here must be to create conditions that are conducive to higher labour-force participation by women and to remove obstacles, for example tax obstacles. It is also essential in this context to keep productive older workers at work for longer. In coming pension reforms, any further decoupling of the retirement age from life expectancy must therefore be avoided. In addition, an immigration law should be introduced to reduce by means of immigration the lack of skilled labour resulting from demographic developments. Finally, the refugees who have already entered the country must be quickly trained and integrated into the German labour market.

Shortage of skilled labour: develop the education system, increase permeability

Another element is education policy. The education system should be further developed in a way that guarantees a high level of vertical and horizontal permeability – while clearly underlining the distinct profiles of the German education system's two pillars: vocational training and the tertiary education institutions. The developments in the vocational training system should be complemented by greater efforts to encourage life-long learning and corresponding incentives in the employment system.

Gear project funding flexibly to new challenges

Private innovation activities are supported by a whole range of funding instruments. Up to now, the focus has been exclusively on direct project funding, and in most cases this has also proved successful as a funding instrument. However, the question arises as to whether the allocation of funds to the individual funding areas has adapted quickly enough to new challenges, especially digitalisation.

Introduce R&D funding for SMEs through tax credits

Up to now, R&I policy in Germany has not made use of R&D funding through tax credits. The Commission of Experts advises the introduction of such an instrument, focusing on the SME sector, and makes a detailed proposal for implementation in the current annual report (cf. Chapter B 7). The effectiveness of R&D funding through tax credits has been demonstrated in numerous international studies. The promotional effects are particularly marked in the case of SMEs. The variant preferred by the Commission of Experts grants a tax credit on wage tax. The level of the credit should be proportional to the level of R&D personnel costs. Even businesses with no income-tax liability– e.g. start-ups and SMEs in a restructuring phase – could benefit regularly from the cash-flow effects of this form of tax relief. The Commission of Experts believes this would lead to a considerable intensification of R&D activities among SMEs.

Area for action: Entrepreneurship

Start-ups make an important contribution to economic growth and to maintaining a country's competitiveness. Successful start-ups create jobs through local value creation. However, the number of business start-ups in Germany is small by international comparison, especially in the knowledge-based economy. Funding is a key challenge for young companies during both the start-up and growth phases. They need a flexible financing environment that also allows exits by going public. The venture-capital market is less well developed in Germany than in many other European countries. To remedy this situation, policy-makers have launched a wide range of funding programmes and announced further measures in the meantime. Furthermore, as repeatedly proposed by the Commission of Experts, the restrictive treatment of loss carryforwards has been newly regulated. Despite the progress made particularly in recent times, there is still a need for action to expand start-up activities in Germany on a permanent basis. To achieve this, it is essential to reduce bureaucratic obstacles and establish planning security on financing – for both founders and investors. The framework conditions for start-ups and company growth must be designed in such a way that potential founders and their ideas do not move abroad and their potential can be used to maximum effect. Also at tertiary education institutions and non-university research organisations there is underused start-up potential which should be better deployed.

Lower administrative costs for start-ups

The administrative obstacles for start-ups are large by international comparison and must be reduced. A starting point could be the project known as Einheitlicher Ansprechpartner 2.0 (Point of Single Contact). However, this project still needs to be efficiently implemented in order to give start-ups access to all necessary information and procedural rules of the public administration. Furthermore, it is vital to take the specific interests of young companies into account in the design and implementation of funding programmes. Possible scope for discretion should be used generously in favour of young companies.

Begin early with start-up training

A greater awareness of the option of launching start-ups can now be found in study courses relating to economics, but hardly in other courses of study such as engineering, natural sciences, humanities or other social sciences. As a result, the start-up potential that exists in Germany is not being sufficiently exploited. In addition to the technical skills that are needed, start-up awareness must also be created across all disciplines, so that launching a business is perceived as a realistic option. To achieve this, it is helpful to begin start-up training early in a person's education, ideally already at school. Initial positive examples can now be found throughout Germany.

Improve start-up funding – expand incentives for private investors

Compared to other countries, too little support is provided by private funding sources in Germany for start-up funding in the early phase, and particularly during the growth phase. The Commission of Experts calls for more commitment from private players, especially from large enterprises. For example, in the context of the High-Tech Gründerfonds III, private players could contribute a much larger share of funding than in the case of its predecessor funds. Potential anchor investors – e.g. life insurers – are often hesitant because of restrictive regulations in this segment. For this reason, the framework conditions for institutional investors in Germany should be designed in such a way that investments in venture-capital funds that finance innovative growth businesses are supported, and recognised anchor investors can emerge.

KfW's return to the market as a fund investor in 2015 should be seen as an initial positive signal, as it can make a contribution to winning over other domestic and foreign institutional investors. Policy-makers' focus should not be so much on providing additional public funding but on creating the kind of incentives that make it attractive for private investors to invest in venture-capital funds and start-ups. The INVEST programme has already been impressively successful in this.

End the restrictive treatment of loss carryforwards

Germany's 2008 corporate tax reform introduced a particularly restrictive regulation by international comparison on the use of loss carryforwards. The Act on the Further Development of Tax Loss Carryforwards for Corporations (Gesetz zur Weiterentwicklung der steuerlichen Verlustverrechnung bei Körperschaften), which was passed in December 2016, can now effect a considerable improvement in overall conditions and financing incentives. The newly introduced section 8d of the Corporation Tax Act (Körperschaftsteuergesetz) aims to ensure that unused losses (loss carryforwards) can still be used despite a change in shareholders. The precondition is that the entity's business operations are maintained after the change of shareholders, and any other use of the losses is excluded. The Expert Commission welcomes this law. However, when it is implemented, the continuation of the business must be interpreted flexibly enough, since start-ups often change their business model, customer target group or technology.

Secure attractive overall tax conditions for start-ups

In the past, the Commission of Experts has already welcomed the fact that the Federal Government does not tax capital gains on sales of free-float shares in corporations. No such tax should be introduced in the future. Furthermore, there should be no increase in the existing taxation of fund-initiators' remuneration (carried interest). To prevent distortions in cross-border tax competition, the conditions governing the establishment and management of venture-capital funds should be made internationally competitive.

Area for action: Governance

In the new legislative period, Germany must increasingly face up to the major societal challenges of our time – including climate change, demographic development, health and food security, resource scarcity and energy supply, access to information and mobility. In order to rise to these challenges, it is decisive that the state promotes the development and use of knowledge. Different areas and levels of policy are increasingly being affected by the breadth and complexity of societal challenges. This means that the coordination of R&I policy has an important role to play in order to avoid any negative overlapping of regulations and to tap positive synergies. Alongside developing an effective inter-departmental innovation strategy and making overall conditions innovation-friendly, however, the state is also active as an engine for innovation in innovation-oriented public procurement.

Continue High-Tech Strategy, implement measures quickly

The Commission of Experts lauds the concept of an inter-departmental coordination of policies pursued since 2006 with the so-called High-Tech Strategy (HTS). This was the first time a reliable framework was created for a higher-level innovation strategy. In the meantime, innovation is understood as an important cross-policy task. The HTS's inter-departmental approach has fundamentally proved its worth and should be continued. However, the implementation of the new HTS has been considerably delayed in the 2013-2017 legislative period, so only a limited number of new measures requiring inter-departmental coordination have been implemented to date.

High-Tech Strategy: clarify target hierarchies, avoid silo formation

The Federal Government must clarify target hierarchies and set milestones right at the beginning of the next legislative period. The promotion of internet-based technologies and business models should be a top priority in the new HTS's target hierarchy. In this context, the approaches to managing digital change should not be related to individual industries or technological areas, but geared to a wide variety of topics. The formation of thematic silos must be avoided. The field of information and communication technology, which plays a key role in the management of digital change, should be given a significantly higher priority in the distribution of research funds.

High-Tech Strategy: institutionalise inter-departmental cooperation

To ensure effective communication, networking and cooperation between ministries, as well as a coherent external image, a Federal Committee of State Secretaries for the HTS should be made a fixture. Internal incentives for different ministries to participate in the HTS could be strengthened by a separate, additional HTS research budget.

Shape innovation policy at the European level

In the coming years – also in view of Brexit – German research and innovation policy must become more engaged in the European Research Area and contribute at an early stage to shaping a successor programme for Horizon 2020.

Pay more attention to social innovations

Not only technological, but also social innovations – i.e. changes in social practices – can help resolve societal challenges. Technological and social innovations can be both substitutive and complementary – and a broad understanding of innovation is becoming ever more important for the knowledge markets of the

future. Although the definition of innovation has been extended in this sense in the new High-Tech Strategy, it is now also important to treat social innovations on an equal footing with technological innovations in the implementation of funding policy. Promotion should focus on the development, research and testing of new ideas for changing social practices that seem important for dealing with major societal challenges.

Permanently integrate transparency and participation in innovation policy

When identifying major societal challenges and defining target hierarchies, intensive consideration should be given to how societal groups can be included in shaping research and innovation processes. More transparency and participation can contribute to increasing long-term support for innovation policy in society. This has been implemented within the framework of the HTS, for example, with the establishment of the High-Tech Forum. When developing their ideas on research policy, the responsible ministries could experiment more with internet-based methods such as online platforms for gathering ideas or forming opinions. Ultimately, however, public innovation policy remains a task for democratically legitimate representatives of the people in a permanent and constructive discourse with knowledge bearers in both the academic and business worlds.

Gear public procurement to innovations

State innovation policy has an important role to play on the demand side in the emergence and further development of innovation-oriented markets. In view of the fact that the volume of public procurement is approximately €450 billion per annum, the Commission of Experts calls for part of these funds to be used to promote innovation more intensively and in a more coordinated way than in the past. To achieve this, it would in particular also be necessary to adjust both the legal framework and the practical operations of public procurement to give ‚priority to the more innovative offer'. However, the Commission of Experts warns against assigning the state the key role as an investor and initiator of innovations. Such an understanding of roles would risk causing considerable misallocations by weakening market-economic innovation dynamics. Furthermore, the Commission of Experts remains sceptical about direct programmes for promoting private demand for innovative products (e.g. buyer's premiums for electric cars).

Develop innovation policy in an evidence-based way

Evaluations form the basis for an informed political decision, and they can only accomplish this if they are carried out in a way that is free of preconceived expectations, if the medium and long-term effects of a measure are also considered, and if they meet methodological standards that make it possible to identify causal effects. The best guarantor of quality assurance is transparency, i.e. the disclosure of methods used and results, as well as competitive access to data to verify the results. The institutional integration of evaluation practices in the ministries should be continued and special attention paid to further training and methodological competence. It is also expedient to legally codify the research mandate of the statistical offices to ensure that data collected by the administration can be used for evaluation purposes. The Commission of Experts recommends incorporating evaluations based on randomised experiments into the evaluation portfolio of state R&I funding as one of its standard instruments.

Continuously improve governance of R&I policy

Good governance in public research policy includes and requires innovation in the sense of experimenting with new funding strategies. This requires sufficient freedom and strategic flexibility. At the working level in the ministries, there should also be positive incentives (e.g. integrative process teams, competitive salary, career options, research budgets) to encourage involvement in key R&I initiatives. Like innovation itself, innovation policy takes place in the context of change and uncertainty. Here, the aim should be to create framework conditions and incentives for an agile form of governance, enabling it to react flexibly and actively to any short-term need to adapt R&I policy.

Area for action: Digital change

Digital change is an extremely rapid process. Its key technologies and business models are not among the core strengths of the German (R&I) system. For Germany in particular, digital change represents a radical innovation that calls into question competitive and specialisation advantages attained over many years.

Up to now, German R&I policy has paid too little attention to the technical and economic dynamics underlying this transformation. This is also reflected in a lack of funding for the promotion of R&D in information and communication technologies. In the next few years, Germany must develop new technical and economic strengths. This will require consistent and prompt policy measures, and these should be implemented right at the beginning of the new legislative period.

Build a future-proof infrastructure

The existing measures for developing the digital infrastructure have not been designed sustainably. Germany needs an ambitious expansion of its infrastructure that is not geared towards average OECD figures, but aims to lead the way in terms of performance and upgradability. The expansion targets must be adapted dynamically to the respective technical standards.

Give SMEs support with digital change

There is currently a risk of a ‚digital divide' in the corporate sector. Not all SMEs seem to be fully aware of the importance of the imminent changes. Furthermore, a lack of financing makes it difficult for companies to tackle the necessary changes systematically. For this reason, SMEs in particular should be the main target of measures aimed at explaining digital technologies and business models and facilitating their implementation. The Commission of Experts calls for the creation of an ‚SME Digital' programme, in which – as in the case of the Central Innovation Programme for the Mittelstand (ZIM) for R&D support – SMEs are eligible for state support in the planning and implementation of digitisation projects.

Expand digital education

The population in Germany has less experience than people in other countries in dealing with digital technologies and data. In this context, emphasis should be placed on a broad-based promotion of skills in the use of digital technologies and models – in all training and further-education segments.

In Germany, the PISA studies have supplied transparent information on the level of education of German school students and revealed deficits. A corresponding data pool is also needed in the field of digital education. Länder governments should not – as in the case of the PISA studies – be able to block comparative surveys or their analyses.

Digital education in particular should be strengthened in all elementary and secondary schools in Germany. The education offensive for the digital knowledge-based society proposed by the BMBF is a step in the right direction. The concept must be backed up by budgets and specific, ambitious time schedules.

Students in tertiary institutions should be offered instruction in computer science – whatever they are studying. Computer science should be understood as a new key discipline and incorporated more into the curricula of other training courses. The new possibilities offered by Article 91b of the Basic Law should be used in a joint effort on the part of the Federal and Länder governments to implement appropriate best-practice approaches in tertiary education institutions.

Introduce targeted research funding for start-ups

Start-ups contribute in a special way to managing digital change. Up to now, the concerns of start-ups have not been sufficiently taken into account in R&D funding. The Commission of Experts proposes extending the EXIST programme by adding a further research component. This should be based on the established EXIST start-up grants and give those supported an opportunity to finance staff that might be required for short-term research needs that crop up in the course of building their company. In the funding programmes of the BMBF, the BMWi and other ministries, greater efforts should also be made to extend support to young companies that are already established on the market.

Use e-government and open data as innovation drivers

Germany still has a lot of catching up to do when it comes to digital governmental and administrative processes – so-called e-government. This is reflected in a limited and not-very-user-friendly range of digitised public services. Furthermore, data in the public sector are not yet automatically made available as open government data via well-structured access systems. The Commission of Experts welcomes the fact that important legislative framework conditions have been created in the last few months for the establishment and operation of efficient central portals for e-government and public data stocks. In the new legislative period, the Federal Government should make active use of its extended regulatory powers to significantly improve the quality of services provided for the citizens by the authorities and to open up significant value-added potential.

Create a future-oriented legal framework for the digital economy

Internet and internet-based technologies require new or adapted legal frameworks, e.g. in the fields of copyright, data protection and consumer protection. The legal framework should, wherever possible, be adopted at the European level in order to strengthen the internal market. In this context, legislation must not be geared towards building protective fences around established sectors of the economy.[11] Rather, the framework must be designed in such a way that new models of the digital economy can be introduced rationally and quickly in Germany and Europe.[12] In the long term, grandfathering and perks for established business models – e.g. the introduction of new intellectual property rights – jeopardise Europe's competitiveness as a centre of the digital economy.

Provide more effective governance for digital policies

Up to now, the activities of the government departments in charge of the Digital Agenda have been fragmented and in some cases contradictory; the Commission of Experts advocates a greater concentration of these activities. Above all, the next legislative period must see the rapid implementation of further measures to strengthen the digital infrastructure, research and innovation (especially among SMEs). Possible solutions could be an innovation agency, which has already been discussed in the Bundestag, a coordination office at the Federal Chancellery, or the creation of a digital ministry with far-reaching responsibility for the infrastructure, innovation funding, e-government, and public-sector digital procurement. The Commission of Experts believes that a political decision needs to be made in favour of an effective pooling of competencies – without again creating a high level of complexity.

Options for funding R&D through tax credits

The Commission of Experts submits two proposals for funding R&D through tax credits in Germany with the aim of complementing existing R&D funding instruments. As shown by an analysis of R&D tax incentives in important countries, when designed appropriately R&D tax incentives are effective and lead to an increase in corporate R&D spending, particularly by small and medium-sized enterprises (SMEs). The Commission of Experts therefore recommends the introduction of such a funding instrument in Germany. It also recommends initially limiting the introduction of an R&D tax-credit scheme to SMEs. The possibility of a subsequent gradual extension of the scheme to include larger companies can then be examined in the light of initial experience.

Different forms of R&D funding through tax credits

According to the Commission of Experts two proposals should be on the short list: a tax credit on income tax proportional to the company's R&D spending, and a tax credit on wage tax calculated on the basis of the R&D personnel costs incurred.

Variant 1: Tax credit on all R&D expenditure within the framework of corporate taxation

- This variant is the most widespread internationally; it is also the most closely studied in terms of its expected impact. In this model, the calculation of the tax credit would include all qualifying R&D expenditure, i.e. staff costs, the cost of instruments, equipment and the buildings used for the research project, as well as the costs of feasibility studies, consulting services and certification (of R&D expenditure's eligibility for funding).
- Because all R&D expenditure would be equally included, no systematic preference would be given to certain economic sectors or technologies that use individual forms of R&D expenditure particularly intensively. This can be seen as an advantage of this variant.
- The tax credit would be offset against payable corporate tax; in the event of a loss, or if the tax debt is lower than the tax credit, it would be either carried forward or paid out (pro-rata). Here lies a disadvantage of the model, especially for SMEs: there would be no positive liquidity effects until the financial authorities have issued the tax assessment notice. In certain circumstances, disbursements would not be made until over two years after the original expenditure.

Variant 2: Tax credit for R&D personnel expenses to be offset against wage tax

This variant is used in the Netherlands. The tax credit would be linked to the level of R&D personnel costs and offset against the wage tax payable by the company. The model has the following advantages: the wage tax is subject to smaller fluctuations than the corporate income tax payable by the company as a whole and must be paid irrespective of the company's profit situation. This makes it easier to plan both the promotional effect for companies and the fiscal effect for the public sector. In addition, the wage tax is paid monthly, so that the tax credit would have a positive impact on the same day as the personnel expenses are paid. This immediate liquidity effect would be of particular relevance for companies with major financial restrictions, and especially for start-ups.
Indirectly, in addition to providing an incentive to increase R&D activities, the reduced personnel costs could boost demand for R&D staff covered by social security and thus generate more jobs in regular employment. Limiting the tax credit to R&D personnel expenses would also make the scheme easier to administer than one applying to all R&D expenditure. Both declaration costs for the taxpayer and the monitoring costs for the tax authorities would be lower than if all R&D expenditure were taken into account.

At the same time, if the basis for the computation of the tax credit was limited to R&D personnel expenditures (as a subset of all R&D input factors), there would be less potential for abuse.
One disadvantage of this variant is that companies and industries with different levels of labour intensity in their R&D operations would receive different levels of funding under this variant.

The Commission of Experts regards both models as useful additions to the existing set of R&D funding instruments. However, having weighed up the advantages and disadvantages of the two variants, the Commission of Experts prefers the second. The most important arguments here are better plannability and the stronger liquidity effects. Since these are particularly important for SMEs, the Commission of Experts regards Variant 2 as more effective for this group.

In any case, the introduction of R&D funding through tax credits should be accompanied by a solid scientifically-based evaluation framework.

Endnotes

1 http://www.bundespraesident.de/SharedDocs/Reden/DE/Roman-Herzog/Reden/1997/04/19970426_Rede.html (last accessed on 16 January 2017).
2 Cf. Wissenschaftsrat (2016): Wissens- und Technologietransfer als Gegenstand institutioneller Strategien, http://www.wissenschaftsrat.de/download/archiv/5665-16.pdf (last accessed on 16 January 2017).
3 http://www.europarl.europa.eu/summits/lis1_de.htm#I (last accessed on 16 January 2017).
4 Cf. on this and in the following http://cordis.europa.eu/programme/rcn/805_de.html (last accessed on 16 January 2017).
5 Cf. information provided by SV Gesellschaft für Wissenschaftsstatistik mbH.
6 Cf. information provided by SV Gesellschaft für Wissenschaftsstatistik mbH.
7 The method of calculating GDP was changed in 2014. According to the new calculation method, GDP is higher than before. This in turn influences the level of the R&D ratio – it is slightly lower as a result.
8 In 2013 the private sector financed 65.4 percent of gross domestic expenditure on internal R&D in Germany. The data for 2015 are not yet available.
9 Cf. https://www.stifterverband.org/pressemitteilungen/2016_12_12_forschung_und_entwicklung (last accessed on 16 January 2017).
10 Cf. also EFI (2013: Chapter B 2).
11 Cf. the Commission of Experts' criticism on the introduction of an ancillary copyright law for press publishing houses. Cf. EFI (2015: Chapter B 3).
12 The Commission of Experts made proposals on this in its 2015 and 2016 Reports. Cf. EFI (2016: Chapter B 3-4) and EFI (2015: Chapter B 3).

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