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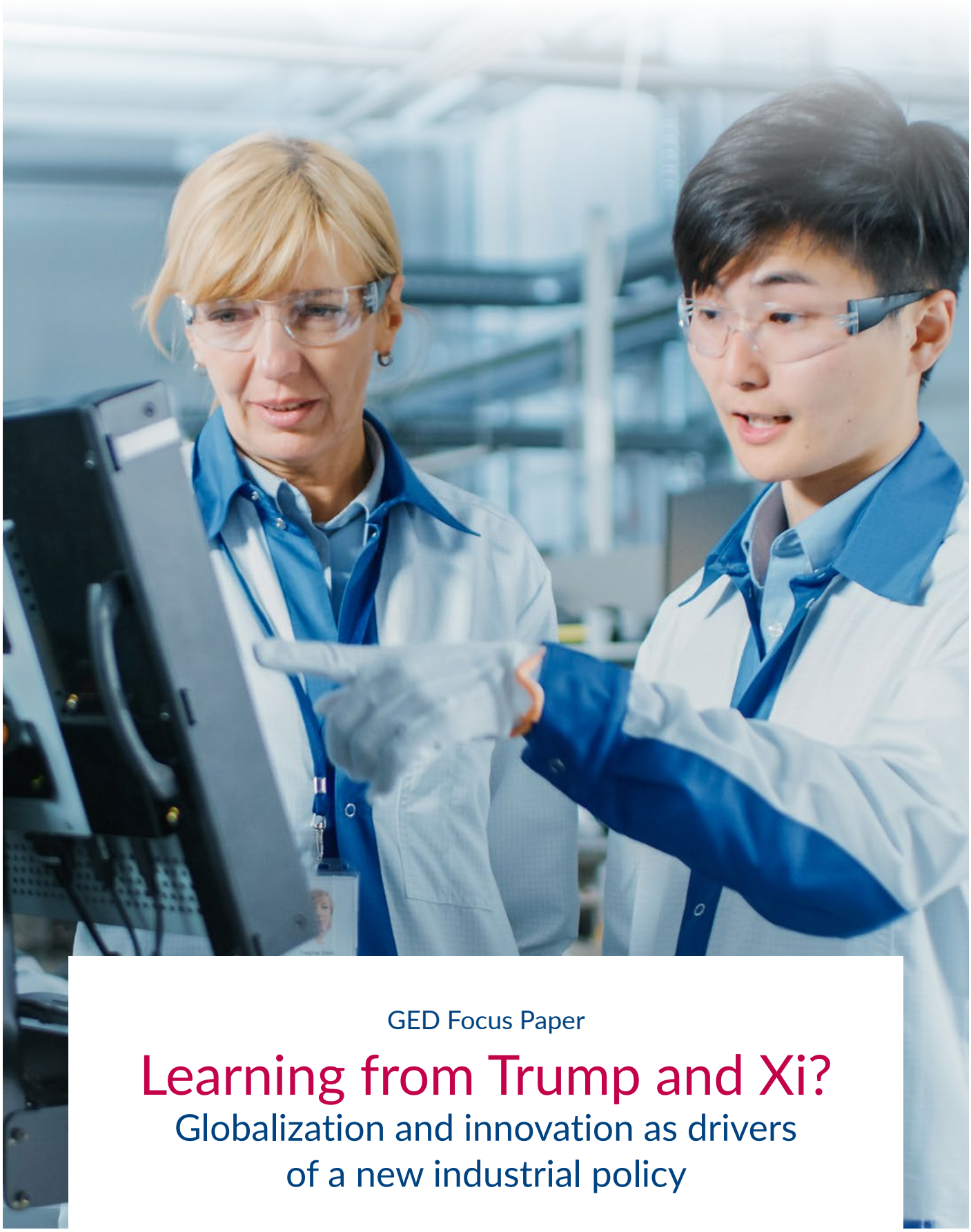

GED Focus Paper

Learning from Trump and Xi?

Globalization and innovation as drivers of a new industrial policy

BertelsmannStiftung

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Globalization and innovation as drivers of a new industrial policy

English translation of the German original text

Content

Key findings

Technological innovations are essential drivers of long-term and sustainable growth. Accordingly, there currently is a debate in Germany and the EU as to whether a new, strategic industrial policy can be an answer to the complex dynamics of digitization. Products of this discussion are, for example, the *Industrial Strategy 2030* published by the Federal Ministry for Economic Affairs and Energy in November 2019 and the *Franco-German Manifesto for a European Industrial Policy for the 21st Century*. The focus here is on the question of how the EU and its member states can maintain their innovative and thus competitive ability in the face of diverse challenges. However, there is no standard recipe for building and expanding the innovative capacity of an economy. Different countries rely on different strategies that can be equally successful. An important distinguishing feature is the role of the state. A clear example of divergent innovation models are China and the USA. Although both countries have completely different approaches to an innovation-promoting industrial policy, both models are characterized by major technological successes. With an analysis of the Chinese and American innovation system, this study highlights the main features and success factors of both innovation models and discusses whether and to what extent these factors are transferable to the European and German case.

Five fields of action for an innovation-promoting industrial policy in the EU and Germany emerge from this analysis

- Implementation of a long-term innovation strategy
- Expansion of venture capital
- Expansion of cluster approaches at EU level
- Thinking and strengthening of cybersecurity at EU level
- Creation of uniform and fair conditions for competition

In addition to these fields of action, which are relevant both for the EU and for individual member states, industrial policy measures in the following three areas could be useful for Germany. In particular:

- Improvement of framework conditions for research and development
- Gearing the education and research system more strongly towards entrepreneurship and innovation
- State as a pioneer and trailblazer in new technologies

In their implementation, however, strategic European and German industrial policies face a trade-off between the protection and promotion of legitimate self-interests on the one hand and the defense against economically damaging protectionism and ill-considered state interventionism on the other. The so-called “mission orientation” can make a significant contribution here: Accordingly, industrial policy should serve to address specific societal challenges (e.g. globalization, digitization, demographic change, climate change) and be coherently targeted towards these objectives. Furthermore, industrial policy is to be driven in parallel by different actors. Above all, it is a joint task of business and politics to enable a competitive business location where the state ensures good competition-promoting framework conditions and the private actors implement concrete actions.

1 Introduction: Industrial policy regains respectability

The sense and usefulness of industrial policy is controversial in business, science and politics. Generally speaking, industrial policy is defined as "all economic policy measures and endeavors by the federal government, the federal states and local authorities and associations which influence the structure and development of industry" (Gabler 1988, p. 2.523). Opponents of such measures generally see industrial policy as a "history of failures" (Handelsblatt 2012). One point of criticism is that the state does not have enough information to make the necessary and meaningful decisions for the development of the economy. Especially when governments try to identify individual "picking the winner" companies or sectors, they run the risk of becoming the plaything of private sector's special interests – to the detriment of the national economy and taxpayers (Donges 2005; Scheel 2005; Rehfeld and Dankbaar 2015). According to this, the state should generally leave it to companies to "discover and implement the industries of the future and cutting-edge technologies of the 21st century in the course of the innovation competition" (Donges 2005, p. 6). A second much-discussed aspect is the question of the relationship between the state and the market: This is because the term "industrial policy" carries the association that the state is attacking the principles of free competition through inappropriate intervention (Wirtschaftswoche 2018; Dohse et al. 2019).

Proponents of an active industrial policy, on the other hand, point out that the economic rise of the Western industrialized countries since the middle of the 19th century would not have been possible without one. In addition, in the 20th century Asian countries such as Japan, South Korea and now China are examples of successful state industrial policy (Aghion et al. 2011; Rodrik 2017; Stiglitz 2017) – although there are also some critical voices regarding these countries (Barwick et al. 2019; Lane 2019; Pons-Benaiges 2017). Mariana Mazzucato (2013) believes that not only has government funded the riskiest research, whether applied or basic, but it has indeed often been the source of the most radical, path-breaking types of innovation. Especially in the case of these basic technologies, which are central to growth and economic dynamics and take 10 to 20 years to reach market maturity, companies are unwilling and unable to carry out the necessary innovations due to the high level of uncertainty regarding potential economic success (Mazzucato 2013; Petersen 2015).

In light of this, there is a strong case for an active state industrial policy aimed at maintaining the technological lead and thus the competitiveness of an economy in the long term. Nevertheless, industrial policy in Germany and the EU did not have a good reputation for a long time (Aghion et al. 2011; Gorning 2012) and still seems to cause great mistrust among economic experts (SVR 2019). This is also related to the fact that economic policy, especially from the 1980s onwards, was primarily market-liberal in orientation, as shaped by the presidencies of Ronald Reagan and Margaret Thatcher. Structural changes in the economy should be driven by market forces and the state should primarily assume a "night watchman" role. This was accompanied by increasing deregulation of the financial markets, which at least proportionately laid the foundations for coming economic crises (Huffschmid 2005). The global financial and economic crisis of 2007/2008 was the main reason why industrial policy in Germany regained (some) respectability. This is because the effects of the crisis were cushioned by state interventions such as "short-time work", the "scrappage premium" or the "bank bailout" (Gorning 2012). By now, there is hence a strong tendency to focus no longer on the question of whether industrial policy should take place at all, but rather on what industrial policy should look like in the 21st century (Rehfeld and Dankbaar 2015; Bardt 2019). This also includes dealing with increasingly complex value chains that go far beyond traditional trade relations and, closely related to this, the question of the future competitiveness of business locations.

This debate is fueled by the policy-making of the acting US President Donald Trump. On the one hand, this consists of aggressive rhetoric and Twitter messages, but on the other hand it also leads to concrete economic policy measures, such as punitive tariffs and tax breaks. True to the motto *America First*, they clearly demonstrate that industrial policy and one-sided lobbying are close to each other – to the potential detriment of international economic relations. Dani Rodrik (2017) even describes Trump's political style as "defective industrial policy". For Rodrik, industrial policy in a democracy requires transparency, reliability and institutionalization, as well as a careful calibration of relations between government and private enterprise. "Industrial policy à la Trump" does not meet these demands, but oscillates between nepotism and intimidation attempts. From a German and European point of view, the USA under Trump thus seems ready to turn its back on the world economic order that it helped to establish after the Second World War. The world economic order aimed to reduce economic barriers and avoid unilateral protectionist measures. At present, however, the USA is breaking away as a reliable partner in international political and economic cooperation. The traditionally good transatlantic relations will thus be put to a severe test (Jungbluth 2017, pp. 6-7). In light of this, the question arises for Germany and Europe as to what measures might be appropriate as a reaction without falling victim to a "defective industrial policy".

On the other hand, Trump's approach is opposed to China's economic rise. This takes place under frequently criticized framework conditions, but is characterized by a thoroughly successful industrial policy – all in all to the benefit of the global economy. Among developing and emerging countries, the Chinese way is now regarded as a model and possible alternative to the Western democratic, but also market-liberal development model (Aghion et al. 2011, p. 2). This resurgent "competition of systems" is a major challenge for the industrialized countries, which has increased significantly since Xi Jinping took office (MERICS 2017; Stahl 2017). For Western scientists like Sebastian Heilmann, the 19th Party Congress of the KPCh, which took place in October 2017, marked a turning point: This had been the "entry into an open systemic competition between China and the market-based democracies of the West" (MERICS 2017). The political dimension of China's rise is thus taking on a new dimension, requiring a readjustment of relations with China. In this process, too, a sense of proportion is needed to maintain the tightrope walk between protectionism and the protection of legitimate national interests.

In the area of tension between this new constellation in the West and the East, Germany and the EU must also deal with the effects and the design of the fourth industrial revolution (digitization). The digitization of almost all areas of life creates new foundations for international competitiveness. Traditional competitive advantages, technologies and business models are becoming obsolete. New ones are emerging at a speed that far exceeds the three previous industrial revolutions (mechanization, automation, informatization) (Schwab 2016). China also wants to take advantage of the opportunities this creates and no longer just act as a supplier for Western companies. In the 21st century, China wants to move to the technological forefront of the world and set standards – and moving from being the "factory of the world" to becoming the "research laboratory of the world" (Jungbluth 2015, p. 85). For Western industrialized countries, which have been leaders in certain technologies up to now, these developments include far-reaching challenges: For them, the risk appears to be particularly high of being overtaken and left behind by the fourth industrial revolution of emerging countries such as China, which are consistently relying on new technologies, flanked by industrial policy (Petersen and Jungbluth 2018, p. 144–145). The transition from the combustion engine to alternative drive technologies could become a warning example of this. This also changes the conditions for an industrial policy: More and more, the question arises how this can be designed in such a way that the innovative capacity of an economy is optimally promoted and thus its international competitiveness in the age of digitization is also guaranteed. Innovation policy should therefore be placed at the heart of industrial policy (Aiginger 2019; see also: BDI 2019, p. 3; SVR 2019, p. 141).

In contrast, a proposal by the Federal Ministry for Economic Affairs and Energy (BMWi) for a *National Industrial Strategy 2030,* which called for the development of national and European champions (BMWi 2019a), was criticized from several sides (Manager Magazin 2019). Instead, a horizontal approach or a balanced company size structure should be advocated (BDI 2019, SVR 2019). The revised version, *Industrial Strategy 2030,* accordingly departed noticeably from the very concrete plans of national and European champions (BMWi 2019b).

In light of this, the present GED Focus Paper gives in Chapter 2 a short overview of industrial policy approaches in the USA, China, the EU and Germany. Chapter 3 classifies the topic of "innovation as a field of action for industrial policy", which plays an important role in view of the next industrial revolution. In Chapter 4, we examine whether

and what Germany or Europe can learn from China and the USA with regard to an innovation-promoting industrial policy. We then make proposals as to which areas of action and policies could be addressed in the EU and Germany. Chapter 4 incorporates the results of a Bertelsmann Stiftung workshop on industrial policy held in Berlin on July 4, 2019.[1]

1 At this point we would like to thank them by name for their valuable and helpful contributions: Sarah Blanck and Dr Han Wei Chung (Federal Ministry of Economics and Energy); Niklas Garnadt (German Council of Economic Experts); Dr Lea Shih (University of Trier).

2 General guidelines for industrial policy

Industrial policy plays a role in all economies, regardless of their economic system. Depending on the stage of development and the political environment, the focus is more on an active (shaping the economic structure) or a passive industrial policy (maintaining the economic structure). In recent years, strategic industrial policy has developed into another field of industrial policy action: This involves the targeted promotion and expansion of promising sectors, e.g. in the high technology sector (Oberender et al. 2013; Klodt 2018). This topic has become increasingly important in Western industrialized countries, especially against the background of China's economic rise and the increasing internationalization of Chinese companies. The main focus is on maintaining the competitiveness of these economies and their companies in the face of growing Chinese competition, which stems from a strongly industrial policy-driven economic environment and targeted state support.

Moreover, the inauguration of US President Donald Trump led to a remarkable change in the design of international economic policy away from multilaterally influenced approaches towards protectionism and the overemphasis on national interests. The trade disputes between the USA and China and between the USA and the EU have already shown that protectionist industrial policy instruments such as customs duties are increasingly being used in trade policy, making international cooperation much more difficult.

The current industrial policy discussion also revolves around the question of whether strategic industrial policy is necessary and appropriate to balance out unfair competition conditions and to establish a *level playing field* internationally, where the same rules apply to all companies involved and cooperation between countries on an equal footing is possible.

In the following, we will first of all look at the general principles of industrial policy that can be identified in the USA, China, the EU and Germany as well as the role strategic industrial policy already plays.

2.1 USA

The progressive transition from an industrial to a service and knowledge society can also be seen in the USA. The share of the economic output of the industrial sector in 1970 was still 32 percent of total economic output, in 2016 it was only 19 per cent (UNCTAD 2019a). However, American industry plays a fundamental role in the country's exports of goods and employment. Its share of economic output at 3.62 trillion US dollars was generated by 20 million American employees or 13 percent of the working population and corresponds to 63.5 percent of American merchandise exports (USBLS 2017; World Bank 2018).

Although the trend towards a decline in industrial production has by no means affected all sectors equally (Ramaswamy et al. 2017) and even recorded a slight upswing overall in recent years (West and Lansang 2018), the share of industrial production in the USA in total world industrial production is overall declining. While it was still at 28 percent in 2002, by 2016 it accounted for only 18 percent. In 2010, the USA therefore had to relinquish the "title" as the world's largest industrial nation – understood as the economy with the largest industrial production – to China (Levinson 2018).

History, aims and means

Economic or industrial policy conducted in a liberal market economy plays generally a reserved role (Hall and Soskice 2001). Even if this image is readily maintained in official political communication, it is not consistent with the importance of industrial policy for the success of the American economy (Wade 2014). Although the USA as a federal system is characterized more by an unfocussed and decentralized approach to industrial policy (Schrank and Whitford 2009), it has benefited greatly from an active role of the state, especially in the development of new and strategic technologies (Block and Keller 2011; Mazzucato 2013). This strong influence can be traced back to the early

years of the USA and has been prominent throughout its history (Stensrud 2016).

With the government of Ronald Reagan, the latest phase of American industrial policy begins, which is characterized by the targeted promotion of strategically important industries (Stensrud 2016). Here are some recent examples:

- **Provision of capital:** Business start-ups as well as small and medium-sized enterprises benefit from the fact that various federal authorities maintain programs for the provision of risk capital. You can also apply for loans from the *Small Business Administration*.
- **Tax advantage:** Larger companies or multinational corporations are supported by the American government, primarily through tax breaks. At the state level, there has been competition for the most favorable business environment.
- **Preferential treatment in public procurement:** Although the USA is a member of the WTO Agreement on Government Procurement, it is largely free to define the extent of opening up to foreign suppliers. The American defense industry in particular is benefiting from this.
- **Export promotion:** The Export-Import Bank of the United States primarily supports small and medium-sized companies in their economic expansion abroad. Almost half of the loans, guarantees and insurance services it provides, go to the American aviation industry (Export-Import Bank of the United States 2018).
- **Industry and corporate rescue:** In the wake of the economic and financial crisis, Barack Obama signed the *American Recovery and Reinvestment Act* briefly after his inauguration in 2009. In addition, the American government became a major shareholder in the automobile groups Chrysler and General Motors.

Industrial policy under the Trump government

Whereas the previous administration of Barack Obama was primarily concerned with promoting the innovative capacity of the American economy with its industrial policy (Sperling 2013), the Trump administration officially focuses on national defense capabilities (Navarro 2018). Accordingly, the President commissioned a comprehensive report from an inter-ministerial working group to identify the industrial sectors and capacities that are essential for national security. Among other things, the report recommends the development of a *National Advanced Manufacturing Strategy* and higher targeted government investment or subsidies in critical sectors (United States Interagency Task Force 2018). Thereby, President Trump will be able to make a name for himself among his core electorate in the industrialized and electorally very important "Rust Belt" states in the north-east of the country.

In regard to funding the government has mainly focused on tax concessions. The *Tax Cuts and Jobs Act* of 2017, which it played a key role in driving forward, is intended to make the American industry more competitive again internationally. However, in accordance with his strongly transactional basic understanding, the President does not hesitate to give the stick if the carrot approach does not bear fruit. For example, he loudly criticized General Motors for wanting to cut several thousand jobs in the USA despite massive tax breaks. As a consequence, he threatened to cut all subsidies to the company (Horsley 2018) – but to this day he has not followed up these words with action.

In addition, the Trump administration also revived measures that its predecessors had largely shied away from. Quite openly, the President has personally committed himself to using not only non-tariff but also tariff measures to protect American industry (Twitter quote: "I am a Tariff Man."). The extensive measures taken against over 800 Chinese goods provoked a trade war between the two great powers (Lawder and Blanchard 2018). In the view of the Trump government, these tariffs are urgently needed to put a stop to unfair trade practices, as these challenge the competitiveness of the US in the long term (The White House 2018; Slobodian 2018).

The U.S. government is emphatically proactive in its *America First Policy*, including in international trade agreements. In their opinion, the USA is too often on the losing side of poorly negotiated trade agreements. The government is therefore exerting massive pressure to adapt existing agreements (e. g. the *North American Free Trade Agreement*, which has already been renegotiated), or is very skeptical and hostile to new agreements or to agreements still in the negotiation process (Partington 2018). Predecessor governments, on the other hand, emphasized the increasing sales opportunities for American industry and the profits for all countries involved through further liberalization of markets.

Even before or early in the Trump administration, some experts anticipated a corresponding change and tightening of American industrial policy with negative consequences for the United States and the world economy. As mentioned above, the economist Dani Rodrik (2017) spoke quite openly of a "defective industrial policy". Three years after Trump's inauguration, a long-term assessment of the possible con-

sequences of the government's industrial policy is not yet possible, but the undermining of the regional or global trade order and the erratic and aggressive behavior of the government significantly increase the already high level of political uncertainty worldwide (Petersen 2019).

2.2 China

China has undergone a unique development in recent history: from a relatively poor country in the late 1970s to the second largest economy in the world. Between 1978 and 2017, China's gross domestic product (GDP) grew by a factor of 225 from 367.9 billion RMB to 82.7 trillion RMB (NBS 2018). Today China is the "factory of the world" in terms of industrial production and a serious new competitor for the industrial countries.

Although China is also on the way to becoming a service society, industry continues to play a decisive role in economic performance: In 2017, it contributed about 40 percent to GDP and 28 percent to employment (NBS 2018). Moreover, 40.5 percent of the gross value added of the Chinese economy is linked to industry (World Bank 2019a). The role of industry in foreign trade is even more important: 94 percent of Chinese exports in 2017 came from the manufacturing sector (UNCTAD 2018). This means that China is still heavily dependent on industrial exports, even though the Chinese government has been pursuing the goal of reducing these dependencies at least since the financial crisis.

History, aims and means

Industrial policy played a decisive role in China's development from an imperative planned economy to a "market economy with Chinese characteristics". In the 7th Five-Year Plan (1986-1990), it was already named as an official reform instrument (Heilmann and Shih 2013, p. 10). The "East Asian economic miracle", i.e. the rise of Japan and South Korea in the 1960s and 1970s, had a considerable influence on the development of Chinese industrial policy. In particular Japan[2] played a major role in this respect (Jiang and Li 2018). Japan's catching-up process vis-à-vis the industrialized countries was regarded by China's reform politicians as a possible model for their own development process.

2 The orientation towards Japan was so great that even the Chinese term for industrial policy, chanye zhengce, was borrowed from Japanese (Heilmann and Shih 2013, p. 7).

It was not until the Hu Wen government and its administrative reforms of 2003 that industrial policy in China achieved a breakthrough (Heilmann and Shih 2013, pp. 12-14). Since then, the main responsibility has been with the *National Development and Reform Commission*, which took over important powers from its predecessor, the *State Planning Commission* (e.g. on pricing in many sectors) and has considerable formative power. Other actors are the *Ministry of Industry and Information Technology*, which was established in 2008, and sector-specific ministries. The Chinese government subsequently published a large number of industrial policy sectoral and cross-sectoral programs and measures (Heilmann and Shih 2013, p. 13; Meissner 2016, p. 348).

China's industrial policy was refocused after the financial crisis: The development and promotion of new sectors and technologies came to the foreground. This was combined with an increasing promotion of expenditure on research and development (R&D) and a clear focus on "independent innovation" (*zizhu chuangxin*). As early as 2010, the State Council defined seven of these new sectors, which are also reflected in the industrial policy strategy *Made in China 2025* (MIC2025), which was announced in 2015 and is the subject of controversial discussion abroad, including renewable energies, cars with alternative drive systems and mechanical engineering in the premium segment. The state therefore plays a key role in selecting and guiding technological development. The following instruments are at its disposal for this purpose (Meissner 2016, p. 346; Jiang and Li 2018):

- Approval of investments
- Regulation of market access
- Catalogs for controlling investments
- Taxes and subsidies
- Lending
- Allocation of land use rights
- Public procurement (influencing demand)

Until Xi Jinping took office in 2013, China developed a comprehensive system of selective industrial policy on this basis, with some special features: Not only are certain sectors promoted or restricted, but also certain technological road maps (*jishu luxian*), certain products and certain companies (Jiang and Li 2018). A further characteristic of Chinese industrial policy, which is often critized by foreign actors, is the systematic discrimination of foreign companies in China. Examples of this are access to public procurement or the obligation to set up joint ventures in certain sectors (Jungbluth 2015, p. 81; Meissner 2016, p. 350).

Industrial policy under the Xi government

China is now increasingly reaching the limits of its export-oriented development model: The costs of production factors are constantly rising, so that investors are migrating to cheaper locations such as Vietnam. The role of supplier for international corporations leads to an unfavorable position in the global value chains. The dependence on technology from the industrialized countries is still high. At the same time, China is increasingly in direct competition with these countries. This is a politically sensitive aspect for the Chinese government (Jungbluth 2015, pp. 77-85.).

This is also reflected in China's current approach to industrial policy, which is becoming evident since the 18th Party Congress 2013: A central goal is to end China's role as "factory of the world". Instead, the country is to move up into the lucrative segments of global value chains and become the "research laboratory of the world". The emphasis is placed even more strongly on an industrial innovation policy (*chanye chuangxin zhengce*) than before (Jiang and Li 2018). More innovation should also create more dynamism in China's economic development.

Moreover, China's innovative capacity will be crucial for its future competitiveness, especially in direct competition with the industrialized countries. Large-scale support programs for R&D in China should contribute to this, as should targeted investments by Chinese companies abroad that acquire and develop important know-how. An important measure in this respect is the establishment of an efficient *National Innovation System*. To this end, intellectual property rights are to be better protected, better conditions for basic research and technological innovation are to be created and talent promotion is to be expanded (Jiang and Li 2018).

A general feature of politics under Xi Jinping is the strong centralization of political power in his person, a departure from the collective leadership style established and cultivated under the Jiang Zemin and Hu Jintao governments, and a stronger top-down approach to important decisions (Stephan and Alsabah 2017, pp. 4-5; Naughton 2018). This also applies to perhaps the most important industrial policy program adopted so far under Xi Jinping: *MIC2025*. With this paper, the Chinese government emphasizes state control of the economy and lays the foundations for all authorities to take the necessary measures to implement the strategy. It defines a clear objective: "By the 100th anniversary of the founding of the New China, we want to build our country into an industrial power that will lead the development of the global industrial sector" (State Council of the People's Republic of China 2015a). *MIC2025* specifically states ten key industries in which China aims to become a global technology and innovation leader by 2049:

- New generation of information technologies[3]
- Machines with computer-aided numerical control (CNC) in the premium segment[3] and robots
- Aerospace systems
- Marine technology systems and high-tech ships
- Advanced rail transport systems
- Energy-saving cars and cars with alternative drive technology[3]
- Energy systems[3]
- Agricultural machinery
- New materials[3]
- Biomedicine[3] and medical devices in the premium segment

In the core areas that are central to these industries, China is to "expand its market share of its own intellectual property rights [...] on a large scale, significantly reduce its dependence on foreign countries [...] and [...] reach a leading international level by 2025" (State Council of the People's Republic of China 2015a). However, this goal is not to be achieved by independent innovations alone. The targeted acquisition of know-how abroad is explicitly provided for in *MIC2025*. This is also the reason why reservations about Chinese company investments have increased considerably in Germany since the takeover of the robot manufacturer Kuka by the Chinese household appliance manufacturer Midea in 2016 (Jungbluth 2018, p. 8). In response, the Federal Government has already twice amended the Foreign Trade and Payments Ordinance. The aforementioned industrial policy papers at German and EU level also show a clear reference to the future relation to China (Jungbluth 2019, pp. 38-39).

2.3 European Union

Industry plays an essential role in the European single market. It produces about 80 percent of EU exports and provides over 30 million jobs (BMWi 2019c). As the future development of industry could be a decisive factor for long-term growth and sustainable employment, the European Commission considers that "the main role of industrial policy at EU level is to proactively provide the right frame-

3 Already defined as a strategic sector by the State Council in 2010 (Jiang and Li 2018).

work conditions for enterprise development and innovation in order to make the EU an attractive place for industrial investment and job creation" (COM 2007: 374).

It is therefore the responsibility of the EU to ensure that the necessary conditions for the competitiveness of European industry are in place. For this reason, European industrial policy is primarily geared to this in accordance with Article 173 TFEU (TFEU 2012),

- speeding up the adjustment of industry to structural changes,
- encouraging an environment favourable to initiative and to the development of undertakings throughout the Union, particularly small and medium-sized undertakings,
- encouraging an environment favourable to cooperation between undertakings,
- fostering better exploitation of the industrial potential of policies of innovation, research and technological development.

Principles, history and goals

Although industrial policy has not always played a leading role, it has always been an important component of European economic policy (SVR 2019, p. 143). In the run-up to the founding of the EU, economic policy focused on the creation of a single market (European Parliament 2019). Industrial policy played a minor role and its implementation was limited to national ownership. However, the Maastricht Treaty of 1992 opened the way to an integrated industrial policy in the EU.

In particular, Article 3. 1. (m) of the *Treaty establishing the European Community* (EC Treaty 1997) sets the objective of "strengthening of the competitiveness of Community industry". For this reason, European industrial policy began in the early 1990s to identify sectors with potential for competitiveness.

Against the background of a high unemployment rate in most member states and increasing international competitive pressure on the EU, the EU Council adopted "the objective [...] aim[ed] at accelerating the uptake of digital technologies across Europe and ensuring that all Europeans have the necessary skills to use them" (European Parliament 2000). This area should not only be able to achieve sustainable economic growth with more and better jobs, but also have greater social cohesion.

In the context of the *Lisbon Strategy*, the European Commission also called in 2005 for a more integrated approach to industrial policy (COM 2005: 474). This approach proposes an action program with the following objectives:

- Making Europe more attractive to investors and workers
- Placing knowledge and innovation at the heart of European growth
- Developing strategies to enable businesses to create more and better jobs

Sustainability has also played an important role in the development of European industrial policy, which, according to the Commission, "aims at the continuous improvement of the quality of life and well-being for present and future generations" (COM 2008a: 397). Therefore, since 2008, the European Commission has been integrating the dimension of sustainability and resource efficiency into industrial policy. This decision focuses on improving the energy and environmental performance of products, promoting their acceptance by consumers and securing the supply of raw materials (COM 2008a: 397; COM 2008b: 699). In addition, European industrial policy has over time turned towards strategic sectors that should contribute to the development of key technologies (COM 2009: 512).

The *Lisbon Strategy* was in turn replaced in March 2010 by the *Europe 2020 Strategy – A strategy for smart, sustainable and inclusive growth*. The following four of the seven flagship initiatives of this strategy are particularly important for a competitive EU industry: *Innovation Union* (COM 2010a: 546); *A Digital Agenda for Europe* (COM 2010b: 245); *An Integrated Industrial Policy for the Globalization Era* (COM 2010c: 614) and *An agenda for new skills and job opportunities* (COM 2010d: 682).

In addition, the European Commission publishes communications with priority action lines and work programs at irregular intervals. These focus, in particular, on far-reaching structural reforms and better coordinated policy measures in the member states (COM 2011: 642), sectors with high innovation potential (COM 2012: 582) and the promotion of the manufacturing sector (COM 2014: 14). In addition, a focus on a coherent internal market policy and effective European infrastructure (energy, transport and information networks) for goods and services attempts to attract new investments and create better economic framework conditions (COM 2014: 14).

Current industrial policy in the EU

Nowadays, European industrial policy has a clear strategic component. The focus on maintaining competitiveness and promoting future technologies is much stronger than in the past. This is also shown by the current *New Strategy for European Industrial Policy,* which the Commission published in September 2017 (European Commission 2017).

The aim is to bring together all existing and new horizontal and sectoral initiatives and thus, according to former President of the European Commission Jean-Claude Juncker, help European companies "to stay or become the world's number one in terms of innovation, digitization and decarbonisation" (European Commission 2017). Key elements of the new EU industrial policy strategy include:

- Strengthening cybersecurity
- Free cross-border data traffic ("common European data space")
- New measures for recycling management
- Security of supply with regard to critical raw materials
- New proposals for clean, competitive and connected mobility
- Modernization of the legal framework for intellectual property
- Improving public procurement in the EU
- Extending the skills agenda to new key sectors (e.g. green technologies and renewable energy, manufacturing)
- Initiatives for a balanced and progressive trade policy
- European framework for the verification of security-related foreign direct investment

Urgent topics such as improved internet security and the explicit further development of key technologies (e.g. autonomous driving) are thus comprehensively covered. However, the implementation of these measures in practice depends largely on the EU member states. For this reason, the *Friends of Industry Conference* has been an annual meeting of the responsible EU ministers since 2013 "for better coordination in central industrial policy issues" (BMWi 2019c).

In addition, for some years now, the growing tension between the USA and China has led to calls for a more targeted EU industrial policy in some member states, including France and Germany. The question increasingly arises as to what extent the EU has to counter an erratic US policy in the West and a stronger China with a clear industrial policy agenda in the East.

Germany and France gave an initial response in February 2019 with the *Franco-German Manifesto for a European Industrial Policy for the 21st Century* – a first proposal for the future of an integrated European industrial policy. "Massive" investments in innovation, the readjustment of the European legal framework and the protection of European technologies and markets are at the forefront of this manifesto (BMWi 2019d). In concrete terms, both countries propose to pool financial resources to enable technology investment, promote breakthrough innovation and, above all, to enable Europe to take a leading role in the field of artificial intelligence. In terms of regulation, the manifesto focuses mainly on amending and updating the control of mergers. Although France and Germany stress the importance of free trade and multilateralism, their *Manifesto* calls for the protection of the internal market through stricter control of foreign direct investment, the creation of an effective reciprocity mechanism for public procurement with third countries, and the modernization of the WTO rulebook to improve transparency and to combat more effectively trade-distorting practices, including excessive subsidies to industry.

2.4 Germany

As the largest economy with one of the highest industrial shares in GDP, Germany plays a decisive role for European industry. The manufacturing industry provides around 6.3 million jobs, a turnover of almost 1,900 billion euros and thus 27.6 percent of Germany's gross value added (Statistisches Bundesamt 2018a, 2018b). In 2017, the automotive industry with 425 billion euros, mechanical engineering with 252 billion euros, the metal industry with 223 billion euros and the chemical/pharmaceutical industry with 196 billion euros were the top-selling industrial sectors in Germany (Statistisches Bundesamt 2018a). These industries not only occupy a leading position in Germany, but also convince customers all over the world with their high quality standards *Made in Germany*.

In comparison to other EU countries, industry in Germany is far more responsible for growth, prosperity and jobs. With a share of 86 percent, it is also the core of Germany's export (World Bank 2018). The role of industry and industrial policy is therefore of particular interest to Germany, not only at national but also at EU level.

History, aims and means

Historically, Germany has tended to be reluctant to actively pursue industrial policy and has exercised restraint in this respect. In the time of the economic miracle, the view had established itself that "the 'free market order' and functioning competition should be the basis of all economic policy measures and instruments", because "economic policy should essentially be 'regulatory policy' (Ordnungspolitik)" (Gerlach and Ziegler 2015, p. 527). In practice, however, this guideline has not been consistently applied. Thus, time and again, individual sectors (e.g. hard coal mining) or even companies (e.g. BMW rescue at the beginning of the 1960s) have been given special support (Gerlach and Ziegler 2015, p. 527). In the 1970s, with the end of the economic miracle and the emergence of new global competitors such as Japan and later South Korea, the promotion of high-tech sectors (e.g. IT and biotechnology) moved more into the foreground of industrial policy. Disruptions such as German reunification at the beginning of the 1990s and the financial and economic crisis of 2008/2009 clearly required industrial policy concepts that were not in line with "pure market theory", e.g. the rescue of "industrial cores" in Eastern Germany or the "scrappage premium" to support the automotive industry in the wake of the financial crisis (Gerlach and Ziegler 2015, p. 527–528).

A broader interest in industrial policy can be observed with the start of the grand coalition from 2013. An important indication of this is the *Alliance for the Future of Industry,* which was launched in 2014 by the BMWi, IG Metall and the BDI and to which 17 other partners have now joined (BMWi, n.d.). In this way, the Alliance brings together industrial and employer associations and trade unions. The aim is to strengthen Germany's industrial competitiveness and to develop cross-industry and cross-interest approaches to this end. According to the Alliance's understanding, industrial policy will only be successful if it is not limited to individual sub-sectors and sectors (BMWi 2015). In order to develop concrete recommendations for action, there are a total of five working groups (WGs) that deal with the following questions (BMWi 2016; BMWi n.d.):

- **WG 1:** Acceptance – attractive industry: How do you reduce the existing prejudices against industry among the population and how do you communicate its importance for Germany's prosperity?
- **WG 2:** Investment-strong industry: How can the German framework conditions for private and public investment be improved?
- **WG 3:** Future of work in industry and industry-related services: How can the skilled workforce be secured in times of digitalization and demographic change and how must technological change be shaped so that opportunities can be exploited, and risks minimized in the working world of the future?
- **WG 4:** Value creation structures of the future: What are the risks and opportunities of digitization for Germany?
- **WG 5:** International competitiveness of German industry: How can the German and European framework conditions be improved to strengthen the international competitiveness of German industry?

In addition, six concrete guidelines and demands are the Alliance's first results:

- Strengthening global competitiveness through innovation and investment
- Creating an energy union and exploiting potential for energy efficiency
- Achieving global commitment in climate policy
- Setting sustainable framework conditions for a successful European automotive industry
- Fostering a digital European single market
- Shaping EU-China trade relations

Precisely because the German economy is dependent on the international competitiveness of German industry and thus in particular on its innovative capacity, the government has in recent years bundled all research, technology and innovation policy measures in a high-tech strategy. The focus here is on key technologies, "which are of particular importance due to their economic leverage effect", and five lead markets "with particularly great future potential": Health, mobility, climate and resource protection, energy and environment, production technology and industry 4.0 and new materials (BMBF 2018).

Current industrial policy in Germany

Currently, there seems to be a fundamental consensus of government, trade union and associations in Germany that a strategic overarching industrial policy can be a useful instrument for strengthening Germany's international competitiveness. This is all the more true in view of the situation already mentioned that important competitors, such as the USA or China, do not (any longer) play according to internationally recognized rules, but try to establish special rules for themselves. For this reason, the current Minister for Economic Affairs and Energy, Peter Altmaier, explicitly advocates an active German and European indus-

trial policy. Under his mandate, the Federal Ministry for Economic Affairs and Energy published the first draft of a *National Industrial Strategy 2030* (BMWi 2019a) in February 2019. This led to a discussion process lasting several months, particularly between politicians, business, trade unions and academics. The results were incorporated into the revised version of the report published at the end of November 2019 *Industrial Strategy 2030*. This now provides for three central industrial policy fields of action (BMWi 2019c):

- Improve national and international framework conditions for the industry
- Activate innovation potential and strengthen key technologies
- Protect Germany's technological sovereignty

Compared to the previous version, a more sophisticated concept has now been published with the new BMWi industrial strategy paper. There is no longer any direct reference to the targeted promotion of national and European champions. Instead – in addition to the usual support measures for technologies considered important and the strategic orientation in response to a globally tense trade situation – the importance of small and medium-sized enterprises is now also emphasized as a further core competence of the BMWi. Moreover, industrial policy is to become a priority of the German EU Council Presidency. In the further process it will be decisive how the implementation of the measures proposed for this purpose is designed in practice and to what extent these measures are sufficient to strengthen Germany's international competitiveness vis-à-vis the USA and China. Considering the relevance of an economy's ability to innovate, an "active innovation potential" seems central to us.

3 Innovation as a field of action for industrial policy

Chapter 2 has shown that the innovative capacity is central for industrial policy in the 21st century. The main reason for this is that in times of demographic change and digitization, technological innovations are becoming increasingly important for growth and prosperity. This is particularly true for Europe. Alternative levers for growth, such as the number of people in the labor force, will become less important in future due to demographic factors. At the same time, digitization and the disruption caused by new business models requires a constant process of innovation in order to survive in international competition in constantly changing markets. States and intergovernmental organizations have an important role to play here. They can intelligently set the framework for innovation processes and the growth of key technologies and industries so that synergies and market-driven products emerge – and the corresponding industries become self-sustaining in the long-term and generate economic and social returns. That is to say: Public action can stimulate new technologies and markets, which in turn contribute to prosperous economies in Europe.

This is also the origin of the current debate in the EU on whether a new strategic industrial policy can be a response to the complex dynamics of digitization. Products of this political tendency are the new German *Industrial Strategy 2030* and the *Franco-German Manifesto for a European Industrial Policy for the 21st Century,* both of which were presented in 2019. The focus here is on the question of how the EU and its member states can maintain their innovative and thus competitive strength in the face of the challenges posed by digitization.

Certainly, there is no standard recipe for building and expanding the innovative capacity of an economy. Different countries rely on different strategies that can be equally successful. One important difference, however, is the role of the state. Examples of this difference are the innovation models of China and the USA. Although the two countries pursue industrial policy in very different ways to promote innovation (see Chapter 2), both models are characterized by major technological successes, such as the establishment of the technology giants GAFA (Google, Apple, Facebook and Amazon) and BAT (Baidu, Alibaba, Tencent). In contrast, Germany and the EU are in a period of upheaval. Recent contributions to the debate on industrial policy from politics, business and science point out that European and German policymakers face the task of developing and implementing strategies and measures to create their own sustainable and competitive innovation model (BMWi 2019c; BDI 2019; SVR 2019).

In the following we will first address the challenges facing the EU and Germany with regard to their innovative capacity. We then examine the American and Chinese innovation models with the aim of not only gaining a better understanding of the characteristics of both models, but, most importantly, to identify their success factors. With this background, we analyze in Chapter 4 whether and to what extent these success factors are at least partially transferable to Germany and the EU or whether they can contribute to the development of German and European measures and strategies to promote innovation.

3.1 EU and Germany: Declining innovative ability as a challenge

Productivity increases are an important prerequisite for long-term real economic growth (Galor 2005; Solow 1956). The standard measure of productivity, known as total factor productivity (TFP), is also an indicator of the technological progress of economies. It describes which part of economic growth is not attributable to an increase in capital stock and a higher number of employed persons. In short, it is a measure of the efficiency and degree of innovation in the economy.

Figure 1 shows that the EU countries – measured in economic terms – have lost innovative strength: TFP growth in the 1960s was just under three percent; today it is stagnating. Two other findings should be mentioned in this context. First, despite declining TFP growth, many countries are still recording GDP growth. This means that the source of economic growth is shifting more from innovation to labor and capital stock factors. For example, in many countries the labor factor has been achieved by increasing the employment rate among women or by more immigration.

However, these growth effects will only last in the short- and medium-term. In contrast, other economies show higher growth rates of technological progress. For example, TFP growth in China averaged almost three percent between 2011 and 2016, and as much as 3.5 percent in 2017 – even if a catch-up effect is likely to play a role here. Europe's declining and now also stagnating innovative capacity is thus accompanied by still quite robust growth in technological progress elsewhere.

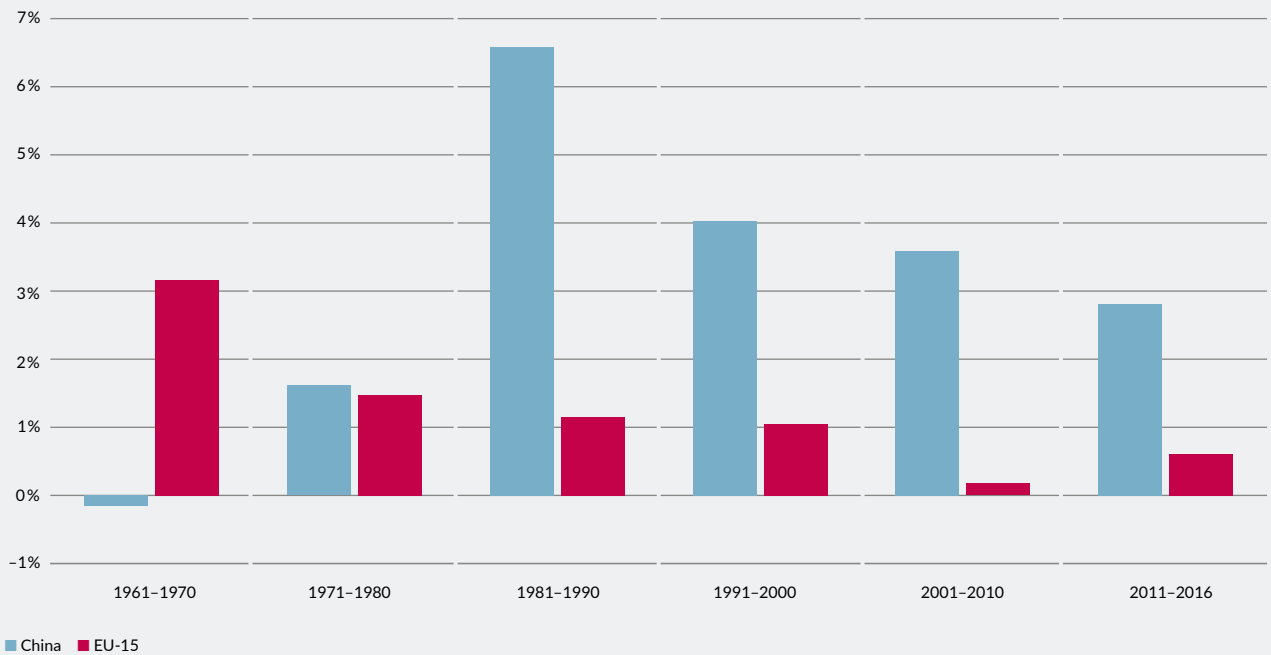
In Germany, the picture of TFP growth has been slightly better than in the EU in recent years, which may be due to a higher average industrial quota, since the propensity to innovate there is on average higher than in the economy as a whole (BDI 2016). Nevertheless, technological progress has not been falling "like manna from heaven" for some time now.

International competition for patents and innovations

Europe's weakness in innovation is also evident outside the economic indicators. For example, patent figures reflect the competitiveness of sectors, industries and ultimately the companies located within them. With information and communication technology (ICT) becoming increasingly important, a large number of new and rapidly growing companies have become active through patent applications. This is also evident from the patent applications filed under the *European Patent Office* (EPO). Among the top ten companies with the most patent applications, the majority are no longer from the European Union – Figure 2 shows this finding. It appears that, particularly in the ICT market and closely related industries (such as smartphones, microprocessors and semiconductors), EU companies are not at the forefront of patent applications.

This observation is further supported by the current level of corporate R&D expenditure. Companies such as Samsung invest about seven percent of their annual turnover in R&D. At least as important are American corporations such

FIGURE 1: **Total factor productivity growth**



Sources: Conference Board 2018; European Commission AMECO database 2019; own calculations.

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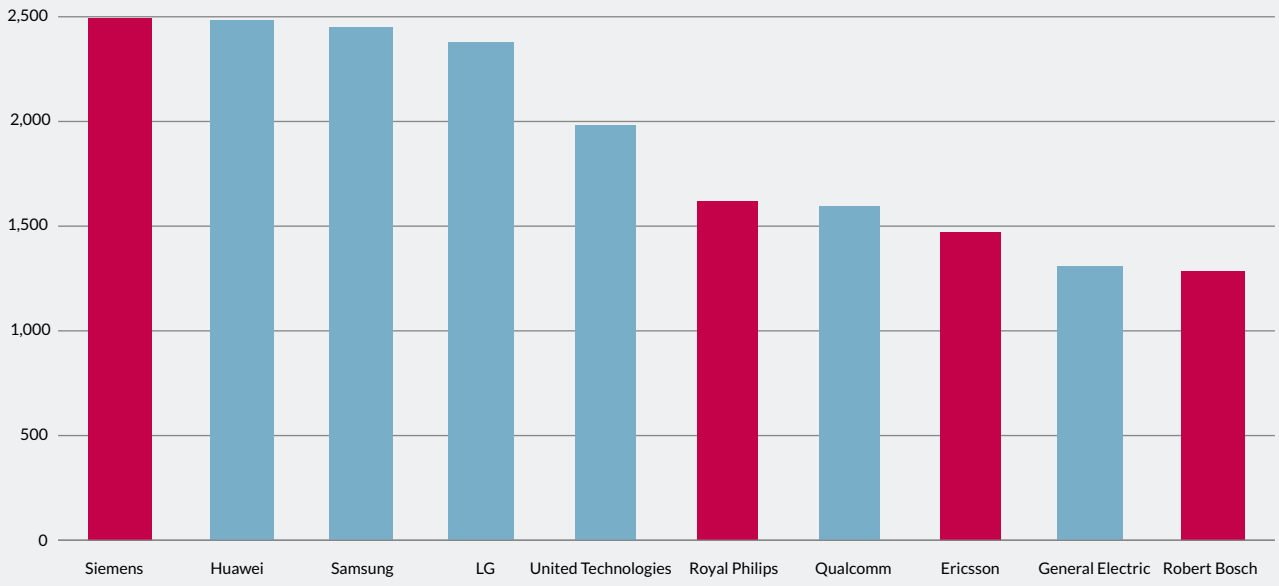
FIGURE 2: **Patent applications in Europe, 2018**



Source: EPO 2019.

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as Google's parent company Alphabet or Amazon, which, thanks to their financial strength, can also open up new business areas and industries that were previously foreign to them.

Throughout Germany, private sector's R&D expenditure accounted for 69 billion euros in 2017, for which the vehicle construction industry is primarily responsible with a share of almost two thirds (Stifterverband n.d.) – an industry in which company representatives see a risk of disruption of almost 90 percent (Staufen AG and Staufen Digital Neonex GmbH 2019).

Weakness in growth industries

The patent applications within the EU shown above and the industry-specific concentration of R&D spending in Germany suggest that companies are not leaders in high-tech markets such as 3D printing, artificial intelligence (AI) and semiconductors. This in turn could indicate that Europe has considerable growth potential in high-tech markets.

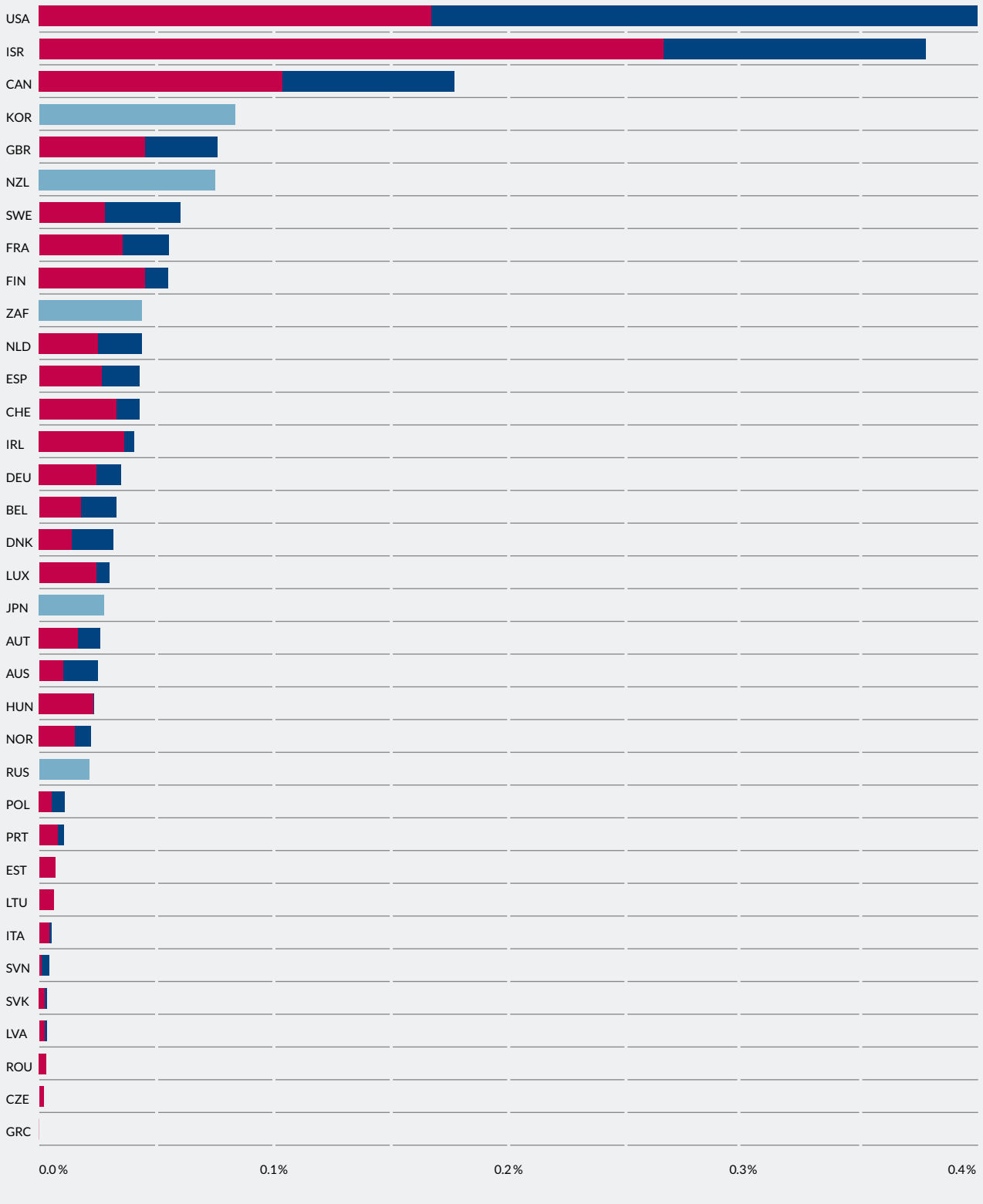
Europe's market growth in the industries of the future has been weaker in recent years than in other parts of the world (A.T. Kearney 2016). This finding is interesting for two reasons. On the one hand, these industries are far from saturated in Europe, so that the low growth rates are not a consequence of high growth rates in the past. On the other hand, both developed economies (e.g. the USA and Canada) and emerging markets (e.g. in the Asia-Pacific and African regions) have growth rates almost twice as high.

These markets are becoming increasingly important in the context of the "networked industry". However, as cross-sectional technologies, it is those future industries that have considerable potential for higher labor productivity of employees. More generally, productivity is a prerequisite for wage growth, notwithstanding the discussions on decoupling productivity and wage growth in some countries. The higher productivity gains in the past, the stronger the rise in wages (Kügler et al. 2018). Hence, in future industries like those mentioned above, companies do not only have potential to catch up, but stronger market growth can also have a positive effect on the labor market.

Lack of risk capital and start-up support

Despite intensive efforts to improve the start-up culture and to promote growth companies more strongly, the EU countries still lag far behind the activities in the USA, Canada, Israel or South Korea. Figure 3 illustrates this fact. Israel, the US and Canada have the highest level of risk capital expenditure as a share of GDP. In the first two countries, the share of expenditure in GDP is about 15 times

FIGURE 3: **Venture capital by enterprise type as a share of GDP, 2017**



Source: OECD 2019.

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higher than in Germany. Also noteworthy is the still very high proportion of venture capital invested in start-ups (in Israel, about two thirds of total venture capital). Germany ranks only in the midfield; with the exception of Spain, the southern European countries hardly invest at all. Overall, it becomes clear that the EU countries still have enormous catch-up potential in this area.

Skill shortages due to demographics and inefficient allocation of talent

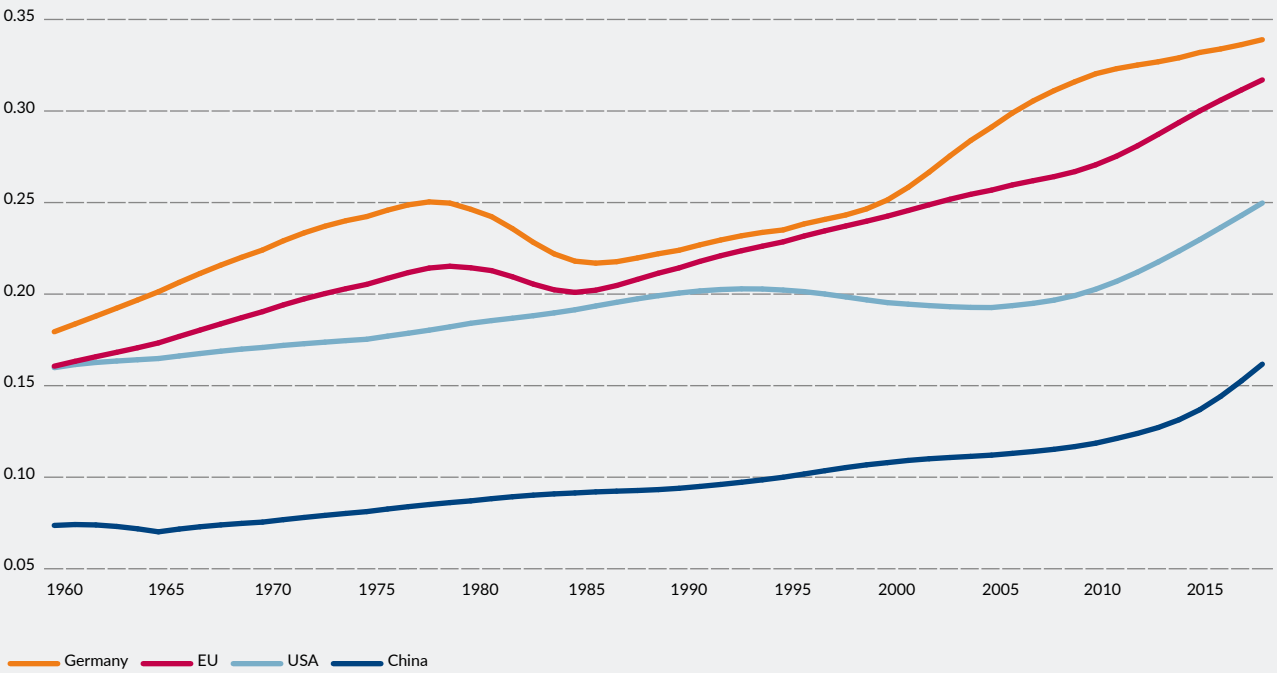
Human capital is an important driver of innovation (Mariz-Pérez et al. 2012). Companies worldwide are faced with the challenge of finding suitable personnel for increasingly complex tasks. The shortage of skilled workers is not only a predominant topic in the media in Germany, but a global phenomenon with a number of country-specific causes. Specific challenges for the EU and Germany arise in particular from demographic change and less successful talent matching (Hays 2018).

Figure 4 shows the age dependency ratio, measured as the population aged 65 and over as a share of the working age population between 15 and 64 years. The demographic development expressed in this figure primarily poses a challenge for Germany and the EU, since the age dependency ratio is significantly higher there than in the USA and China. Many workers, especially in the old EU member states, will soon retire. This leads to increasing pressure on the social system, for which more resources must then be made available. At the same time, the average age of the working population is increasing, and aging workforces are increasingly losing the capacity for innovation (Liang 2018; Kaniovski and Url 2019; Petersen and Steiner 2019).

In the EU as well as in Germany, the efficient allocation of talent is a further difficulty. People who are able to work often lack the skills required for a particular job in order to be able to fulfill them appropriately. The main reasons for this are the lack of attractive job opportunities and a lack of talent management. This in turn has a negative impact on the innovative capacity of companies. The shortage of skilled workers in the EU is thus a major obstacle to innovation (Cedefop 2015).

Empirical evidence shows that Europe has a considerable amount of catching up to do in order to ensure future economic growth driven by innovation and productivity. In order to keep up with global competition in future markets, it will be crucial for EU countries to set the right course today.

FIGURE 4: **Age dependency ratio**



Source: World Bank 2019b.

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In view of the innovation-driven rise of the GAFA and BAT companies in the USA and China, it is worth taking a look at the innovation models of these two countries in order to find suggestions for the future industrial policy design of German and European innovation capability.

3.2 USA: Silicon Valley as the epitome of innovation

> *"Despite the perception of the US as the epitome of private sector-led wealth creation, in reality it is the State that has been engaged on a massive scale in entrepreneurial risk taking to spur innovation."* (Mazzucato 2013)

Although the high-tech boom, especially in Silicon Valley, is often perceived as a product of American market liberalism, the innovative capacity of the USA is largely ensured by decentralized state support.

The modern innovation landscape of the USA is a product of the Second World War (Block 2008). The technological progress of this period led the Allies to victory (e.g. the work of the *Radio Research Laboratory*) and showed that it was also the responsibility of the state to ensure the financing of R&D. In the post-war period, government support for scientific activities increased significantly. The war also strengthened cooperation between the universities and the government and gave the military a broader role as a major and permanent supporter of basic and applied research (NSF 1994). The interest in science and innovation was institutionalized in American politics in 1945 with the proposal of Vannevar Bush, one of the most prominent engineers of the war. With his report "Science, The Endless Frontier" Bush presented the plan for future cooperation between research institutions and the state (Bush 1945). Five years after this plan was presented, the *National Science Foundation* (NSF) was established. The NSF was regarded as a continuation of military research in peacetime and was run as a civil organization (NSF 1994). Almost 70 years after its founding, the NSF continues to promote science and engineering in the United States, particularly in the fields of computer science, biology, mathematics and physics. In 2018, the agency had a budget of 7.8 billion dollars, financed 1,800 colleges, universities and other research institutions and thus supported an estimated 386,000 people (NSF 2019). Major innovations, some of which have been funded by NSF, include QUALCOMM, Google, the iPhone and 3D printing (NSF 2019).

In addition, the *Defense Advanced Research Projects Agency* (DARPA) has made a significant contribution to the development of the USA's innovative capacity. This agency was founded in the middle of the Cold War, when the Soviet Union and the USA competed to be the first to place a satellite in space (DARPA 2019). In 1957, the Soviet Union won this competition with the launch of the *Sputnik* satellite, which not only caused panic among politicians, but also called into question the entire innovation model of the USA. DARPA was the direct result of this shock in 1958.

Mariana Mazzucato (2013) describes that DARPA was founded "[...] to give the USA technological superiority in different sectors, mainly (but not only) those related to technology". Compared to the NSF, the role of the state in the DARPA authority goes beyond the funding of basic research: It also directs resources in strategic sectors and facilitates cooperation between public and private actors. DARPA currently has a budget of 3.1 billion dollars (DARPA 2019). This budget is invested flexibly and locally in four core areas: Defense technology, big data, biotechnology and the expansion of technological capability (groundbreaking technology) (DARPA 2019). The authority distributes its resources between small projects of high-ranking engineers and scientists as well as start-up companies, established firms and industrial consortia (Block 2008). The DARPA model has led to major discoveries and technological advances since its foundation: Thanks to the agency, we now have the internet as well as GPS and voice recognition systems (DARPA 2019).

The support of the state has always been important in the USA. State agencies have the power to decide independently on resources, cooperation possibilities, investments and projects. This type of innovation support enabled the development of a wide range of new technologies that were cross-sectoral. Companies such as Apple and Google have benefited from this diversity and achieved their success by, among other things, integrating and transforming different technologies to meet consumer demand.

The relationship between the state and the venture capital market has also been of particular importance for the development process of the GAFA economy (Klingler-Vidra 2018). Silicon Valley would not have come about without the generous but deliberate regulation of the state. As early as the 1970s, the state facilitated access to venture

capital by introducing the *Employee Retirement Income Security Act*, which enabled pension funds to invest in venture capital. In addition, capital gains tax was also reduced in the early 1970s and the *Small Business Investment Act* created new incentives for investing in high-growth start-ups. Therefore, in the success story of its innovation model and especially of the GAFA companies, the American government not only played the role of the demand side, but also, according to Klingler-Vidra (2018), the roles of the financier, the regulator and the profit maker.

Strengths and weaknesses of the decentralized US innovation landscape

Various innovation rankings and indices show: The USA is one of the most innovative countries in the world. In the *Global Innovation Index* of the World Intellectual Property Organization, INSEAD and Cornell University (WIPO 2019), the USA will rank third in 2019 behind Switzerland and Sweden. The *Bloomberg Innovation Index* puts the USA in 6th place – behind South Korea, Japan, Germany, Finland and Israel (Bloomberg 2019). The USA is particularly strong in research expenditure. Public and private research spending in 2017 totaled 511 billion US dollars – more than in any other country in the world (WIPO 2019).

According to Robert Atkinson (2014), the success of a national innovation system is understood as the interplay of all important political, economic and social factors that initiate innovation, transfer it to other contexts, develop it further or disseminate it. Those states, which manage to make all three sides of a "triangle of success" work well together, are the leaders:

- on the **corporate side**, the skills, activities and cultural attitudes of the private sector
- on the **regulatory side**, commercial, fiscal or any other legislation that sets the framework for innovation
- on the **innovation policy side**, strong political institutions that provide the necessary infrastructure and investment

How does the USA manage this interaction? Which strengths, but also weaknesses are evident?

On the **corporate side**, the USA is characterized by a strong combination in the corporate structure: On the one hand, they have many small start-ups with the ability to bring new ideas to market quickly. In the past, the start-up sector has benefited greatly from its openness and attractiveness to immigrants: Of the 91 American start-ups valued at more than one billion dollars in October 2018 (*unicorns*), more than half were founded by immigrants (Anderson 2018). On the other hand, the USA is home to many large global companies in the high-tech sector with the potential to scale new products quickly and globally. Nine of the ten largest high-tech companies in the world (measured by market capitalization) come from the USA (Bloomberg 2019). In the ranking of the *Boston Consulting Group*, eight American companies are among the top ten most innovative companies worldwide (Ringel et al. 2019). However, due to the outsourcing of many manufacturing processes abroad, these are showing increasing weakness in applied and process innovations in an international comparison (Adler 2018).

Key features of the American innovation model

The state as a consumer: A considerable part of the research demand in the USA comes from the state, which has contributed to the steady growth of the American technology market.

The state as mediator: The US authorities have managed to promote cooperation and collaboration between the private sector and research institutions. They facilitate the exchange of information, resources and funding.

Diversified investments in research and science: US investment is spread across many different sectors and levels of research. In this way, the state promotes innovation activities on a broad basis, not sector- or technology-specific.

The state as provider of basic technologies: The US authorities have a particular interest in promoting basic research whose products are used for applied research or the development of advanced technologies by the private sector.

Facilitating the framework conditions for new technological developments: The innovation market is a capital-intensive sector. By facilitating the framework conditions of the venture capital market, the State provided access to a larger pool of financial resources.

Furthermore, companies in the United States have a very large and well-organized capital market. In particular, they are founders and still international "market leaders" in the field of venture capital, which is important for financing investments. This is especially true given the large number of venture capital companies. However, the increasing tendency not to focus on the long-term success of companies, but rather on the short-term dividend policy (*shareholder value*), is more of a weakness. Here, surveys show that American managers themselves estimate that this prioritization is at the expense of R&D spending – and thus also at the expense of innovation (Atkinson 2014).

Finally, cultural factors are decisive for a successful corporate landscape in the field of "innovation" (Mihet 2013). On the supply side, the United States is characterized by a greater willingness to take risks and innovate (*yankee ingenuity*) and a more pronounced entrepreneur culture than many other countries. This also includes the willingness not to stigmatize failures but to recognize them as an important learning experience, or to introduce new information technologies quickly and successfully into the organization (Atkinson 2014). On the demand side, the US benefits from consumers with low saving rates, high product demand and access to a large amount of information on new products. In addition, American consumers often aim to be *early adopters* of new products (Bhidé 2009).

On the **regulatory side**, the US basically offers a stable and transparent legal framework (in particular independent courts and democratic legislation), which creates the necessary expectation certainty in the area of "innovation". This applies in particular to the regulations in the area of "intellectual property". However, regulations in the innovation landscape in the USA are relatively restrained, so that they offer a lot of leeway (Atkinson 2014). This is how the USA makes it relatively easy for entrepreneurs to set up new companies compared to other countries. In the World Bank's *Ease of Doing Business Ranking*, the USA occupies eighth place behind a number of much smaller economies (World Bank 2019c). Conversely, it is also comparatively easy to close down companies or lay off employees – both factors that make it easier for entrepreneurs to take the risk of starting up again and to react flexibly to changes in demand.

The regulatory framework, which is not too tight, also has a positive impact on the higher education landscape. The state requirements – whether from the federal capital Washington, D.C., or from the individual states – are less pronounced here than in other developed countries (Wessner 2013). This opens up a wide range of opportunities for universities to enter into cooperation with local companies and thus form regional clusters with research parks and business incubators (not only in Silicon Valley, but also, for example, in the Research Triangle in North Carolina). This is one of the reasons why the first six places in Reuters' ranking of the most innovative universities, i.e. the universities that are particularly strong in research and use their technologies to drive new markets and growth sectors, are all US universities; a total of 46 universities from the USA make it into the top hundred (Ewalt 2019).

However, government support through tax incentives to finance innovation (e.g. deductibility of R&D expenditures) is rather low in the US (Stewart et al. 2012). In an OECD comparison, the United States is only in midfield here (OECD 2019). The expansion of trade barriers and the rather negative climate towards immigration under the government of President Donald Trump are among the negative developments in the regulatory area. The cross-border flow of innovation is inhibited, and the talent pool in R&D is reduced (Flournoy and Chefitz 2019).

On the **innovation policy side**, the main issue is the active role of the state in promoting innovation. The important role in promoting key and promising basic technologies has already been discussed in the previous chapter. There are also a number of government programs to support the dissemination and adoption of new technologies. Just one example: For more than a century, the Ministry of Agriculture has been supporting farmers with numerous measures to adopt new production technologies. In addition, since the 1980s, Congress has introduced a number of bills to make it easier for research to be commercially exploited. For example, the *Stevenson-Wydler Technology Innovation Act* ensures that federal research institutions can more easily transfer innovations to other institutions or companies (Atkinson 2014).

Compared to the private sector, public spending on R&D as a share of gross national product has fallen sharply in recent decades. While research expenditure in the 1950s was almost two percent, it has now fallen to around 0.7 percent (NSB 2018). Moreover, the United States lacks a strong central actor to coordinate the various governmental innovation initiatives. Formally, this task is best placed with the *Office of Science and Technology Policy*, which is located directly in the White House. However, the agency is equipped with insufficient powers and a budget that is too small for this task and has suffered a severe loss of importance under President Donald Trump, after leadership

positions remained vacant for months and the number of employees fell from 135 (under President Barack Obama) to 45 (Alemany 2017).

3.3 China's "long march" from piracy to independent innovation

Since the beginning of the reform and opening policy at the end of the 1970s, the Chinese economic system has been undergoing a transformation from a communist planned economy to a socialist market economy. One focus is the development of indigenous technologies and "independent innovation" (*zizhu chuangxin*).

The Chinese government has taken and continues to take an offensive role in the development process of the Chinese innovation landscape: To this end, the central government issues economic and political guidelines, which are implemented by local governments with a certain degree of leeway. At the same time, they experiment with pilot projects to test new approaches (*trial and error*). If these are successful, they are incorporated into national policies (Heilmann 2008).

As early as the 1980s, there were a number of programs ranging from financial support for R&D and cooperation between business and science to the creation of autonomous research institutions (Huang et al. 2004) (Table 1, p. 26). Since the 1990s, investment in R&D and the number of Chinese students and researchers abroad have also increased steadily. Both are examples of indirect channels of knowledge acquisition and transfer and are important foundations for the emergence of a *National Innovation System* (OECD 1997).

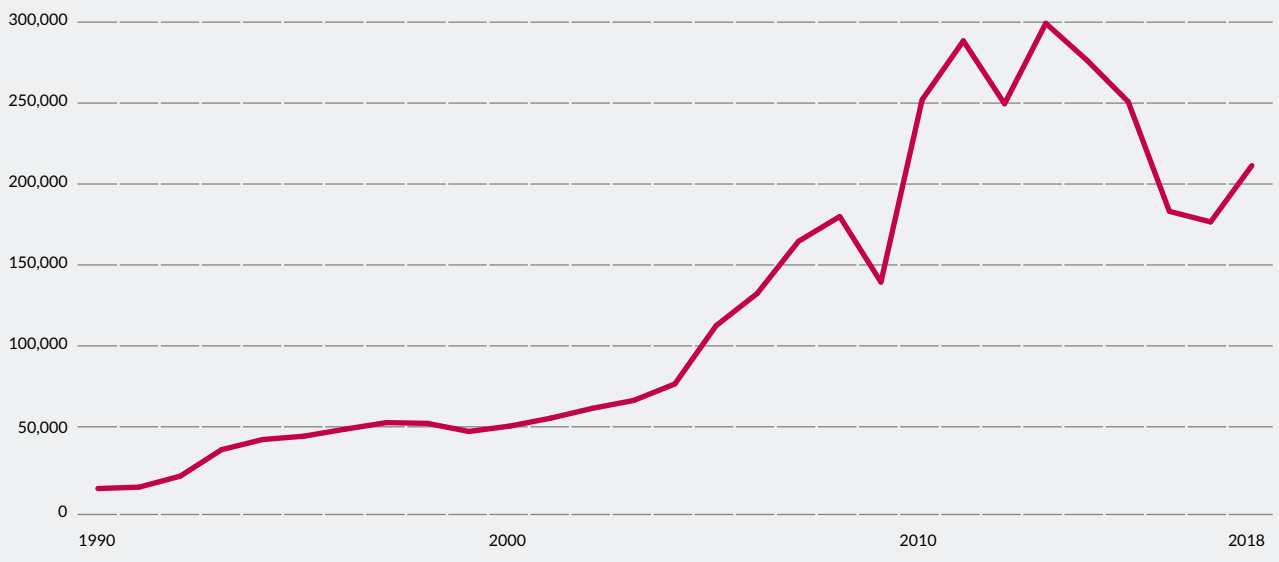
The Chinese innovation landscape has also benefited from the, in some cases forced, transfer of technology from abroad. For example, cooperation between foreign and

TABLE 1: **Development of policy adjustments in the Chinese innovation system, 1978 – 2004**

Period	Policy actions target	Policy actions
Reformation of Planning Practice (1978 – 1984)	Recover and develop the R&D system and integrate it into the planned economic practices	Rehabilitation and improvement of R&D institutions after the damage during Culture Revolution (1966 – 1976).
		Integration of R&D activities into the 6th National Five-Year Plan (1980 – 1985).
Performing the S&T activities in the "Market" (1985 – 1991)	Establish the horizontal and regular connection between S&T sector and enterprises	Replace the former S&T funding method that is mainly through planned appropriation by the program projects competition mechanism.
		Diminish the government grants to force the R&D institution to establish cooperation with industry.
		Create a "Technology Market" to legitimize paid transactions for technology and set up the agencies to support the transactions.
		Promote the autonomy of R&D institutions and mobility of the S&T Personnel.
		Attempt merging the R&D institutions into enterprises.
		Support the spin-off enterprises.
Bridging S&T activities closely to "Socialist Market Economy" (1992 – 1998)	Run non-basic research R&D institutions as run enterprises.	Endow the R&D institutions the comprehensive economic autonomy as the same hold by normal enterprises.
		Encourage spin-off activities through promoting science park and incubators.
		Continue the merging strategy.
Large Scale Transformation of R&D institutions (1999 – 2004)	Transform nearly all of the government owned R&D institutions.	Transform the R&D institutions into enterprises, non-profit organizations, intermediary organizations or merged them into universities.

Abbreviations: R&D: Research and development; S&T: Science and technology
Source: Huang et al. 2004.

FIGURE 5: **Foreign direct investment flows to China, 1990 – 2018, in million US dollars**



Source: UNCTAD 2019b.

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domestic companies in the form of joint ventures was an important strategy for promoting technology and innovation. These partnerships were intended to make it easier for foreign companies to access the Chinese market and to provide Chinese companies with new know-how (*yi shichang huan jishu*) (Jungbluth 2015). However, the legal framework for joint ventures favored Chinese companies with the aim of promoting the development of local technologies. In addition, the state protected certain sectors from foreign competitors by either restricting or even prohibiting market access for foreign companies (e.g. *Great Firewall*). The conscious protection of domestic companies therefore played an important role in the creation of innovations *Made in China* (Sohm et al. 2009). It also promoted the development of the Chinese tech companies Baidu, Alibaba and Tencent (BAT), as they did not have to stand up to the overwhelming competition of the GAFAs (Shen 2019).

A second important factor in the emergence of BAT companies was – as in the USA – the evolution of the venture capital market since the early 1990s (Ahlstrom et al. 2007). The transformation of the Chinese economic system has produced a rapidly growing private sector and increasing private investment. Foreign direct investment also increased rapidly (Figure 5). However, regulatory and infrastructural adjustments were necessary to ensure that capital flows reached Chinese companies more easily. Therefore, in 2002 the Chinese government established the *China Venture Capital and Private Equity Association* (CVCA), which is intended to support the development of venture capital and private equity in China (CVCA n.d.).

China's rapid economic development since the early 1990s has directly and indirectly driven the development of the Chinese innovation landscape. In this way, over the last 30 years, China has developed from a country where simple cheap products *Made in China* (e.g. flip-flops, T-shirts, jeans and sneakers) were produced to a production location where more technology-intensive consumer goods (e.g. dishwashers, air conditioners and PCs) can be manufactured cost-effectively with acceptable quality. Some product categories, e.g. smartphones and tablets, are now even mainly produced in China. Nevertheless, China is still highly dependent on foreign technology, especially in the high-tech sector. For example, Apple products are not developed in China. The iPhone therefore says: "Designed by Apple in California. Assembled in China." This also shows that not even all of the components, some of them technology-intensive, are manufactured in China, but that the iPhone is merely assembled there. This also applies to other high-tech products (Levinson 2018). In other words: China does not yet play a leading role in global value chains, but a subordinate one. However, the Chinese government is already in the process of changing this: The next step is for China to develop into a world-leading location for innovation and technology, especially in a number of key sectors such

as aviation, robotics, environmental protection, transport and medicine (Jungbluth 2018).

In addition to *MIC2025*, there are other industrial policy measures that are intended to contribute to this, such as the national *Internet Plus* initiative, also launched in 2015. This should pave the way for the digitalization of the Chinese economy, e. g. with regard to intelligent production *(Smart Factory)* or the Internet of Things (IoT). The initiative covers a wide range of sectors, from the financial sector to health care, industrial production and agriculture (State Council of the People's Republic of China 2015b). Similar to *MIC2025*, the aim behind this is to strengthen the innovative capacity of Chinese companies so that they can build up technological competitive advantages and thus sustainably strengthen their international competitiveness.

Such large-scale national projects are flanked by a large number of local initiatives: government-funded start-up incubators, for example, extensive financial support for key industries such as robotics (Taplin 2016), science parks even in smaller cities and a whole range of support programs for young entrepreneurs and scientists, which are also helping to ensure that more and more Chinese engineers, programmers and researchers return to their home country from the West (Weinland 2018).

The Chinese innovation model contains both centralized and decentralized elements and is characterized by a complex interplay between central and local government, state and private companies as well as research institutions. Similar to the USA, the state plays a prominent role as regulator and consumer. It also guarantees, where appropriate, protection for domestic companies against foreign competition so that they can develop internationally competitive innovation activities.

Strengths and weaknesses in China's state-controlled innovation model

China's economic and now also technological success continues to amaze European observers: Whether it is industrial policy or the environment, major infrastructure projects or innovation initiatives – the government and authorities in China have little or no need to consider electoral cycles, lengthy legal proceedings to clarify state powers, and objections from the opposition or affected citizens.

From this, some strengths can initially be deduced which also apply to the Chinese innovation model: The Chinese government is able and has the political will not only to

Key features of the Chinese innovation model

Innovative ability as a core objective of the Chinese economic order: There is a fundamental interest of the state in supporting public and private institutions in the technology sector, as the promotion of science and research is a central component of Chinese economic policy.

Protection of Infant Industries: The limited access of foreign competitors to the Chinese market has played a special role in the development of Chinese technologies. The state allows and supports the growth and establishment of national companies before they are ready to position themselves on the international market.

Technology transfer: The regulatory framework for cooperation between foreign and Chinese companies as well as certain laws and bureaucratic processes facilitate access to foreign know-how.

Facilitating the framework conditions for capital inflows from abroad: To achieve innovation and bring it to market, a considerable amount of capital is required. By facilitating the framework conditions for foreign direct investment, the Chinese state provided access to a larger pool of financial resources.

The state as a consumer: As in the USA, the Chinese state plays a decisive role in the demand for products and technologies. For example, it uses its market power to favor domestic brands and products in public procurement.

Pilot projects: From the outside, China often appears as a centrally governed state. However, in the past, local governments have had both some influence on the development of central guidelines and scope for their implementation. This was done through local pilot projects, which were transferred to the national level if successful.

formulate long-term strategies but also to implement them. These include industrial policy strategies such as *MIC2025,* which set targets over a period of more than 30 years on how certain industries and technologies should develop and where the acquisition of foreign technology may be necessary. In addition, the Chinese government also has the financial means to do so. Both play an important role in the development of new infrastructures, which is necessary for the implementation of innovations. These include a stable 5G network for intelligent production facilities, area-wide fuel pumps for e-cars or urban planning compatible with autonomous driving.

The role of the state as a regulator, financier and consumer is also strengthened by combining the possibility of long-term governance with sufficient financial resources. In this way, the Chinese government can promote innovative technologies in a targeted manner and encourage companies to push these more strongly. The most recent example of this is the introduction of a sales quota for e-cars in the automotive industry (Frankfurter Allgemeine Zeitung 2017). The Chinese government has also made targeted use of its strengths in long-term planning, implementation and financing in the development of high-speed trains and the infrastructure required for them. The *Medium and Long-Term Railway Plan*, which was adopted in 2004 (with revisions in 2008 and 2016) and covers a period of up to 15 years (Lawrence et al. 2019), played a central role in this.

Moreover, such long-term support programs often favor domestic companies over foreign competitors. Many industries in China initially need this protection to be able to hold their own against more advanced competition until, in the best case, they have accumulated enough know-how to stand on their own two feet. In this way, the government is trying to ensure that independent innovation activities actually develop.

Another strength of the Chinese innovation model are the pilot projects which have proven their worth in many areas since the beginning of the reform and opening up process in China. On the one hand, there is a certain central organization of processes that coordinate, for example, mutual learning among the political, economic and scientific actors involved in innovation and its application. On the other hand, the local levels are decisive for the implementation of innovation policy and can take local needs and specifics into account (Huang et al. 2004).

Finally, market size combined with high competitive pressure is an important factor in the development of the Chinese innovation model. It can have a positive impact on the market introduction, adaptation and distribution of technology, since economies of scale can be achieved more quickly, and thus the incentive to bring innovations quickly to market maturity and to concrete application in practice can be higher than in small economies (Business Model Innovation Lab 2018; Duesterberg 2018).

The strengths of the Chinese innovation model go in part hand in hand with China's autocratic political system. This in turn results in significant weaknesses. These include the education system, which in large parts is still not designed to promote independent creativity and critical questioning, and the restrictions on the free flow of information – both essential factors for an innovative economy. This makes it more difficult to reduce China's dependence on foreign technologies. In addition, there are ethical questions which have so far played a much smaller role in the Chinese research and innovation landscape than in the EU and Germany, and which harbor considerable potential for social conflict (e.g. genetic research).

A serious economic problem is the misallocation of capital and resources (Barwick et al. 2019). It is a systematic weakness of the Chinese economy and also affects the innovation initiatives of the Chinese government. The robotics plan is a good example of this: Because China has identified automation as a key industry for a boost to innovation in the country, President Xi Jinping called for a "robot revolution" in 2014 (Bland 2016). Shortly afterwards, several ministries agreed to increase the sale of domestically produced robots to 100,000 units by 2020. According to this plan, Chinese robot manufacturers and their customers will receive subsidies, cheap loans, tax exemptions and free building land. In addition, local governments have been authorized in some cases to finance these and similar measures, e.g. the construction of robotics research centers, through risky off-balance-sheet financing vehicles (Tobe 2017). As a result, the politically driven "robot revolution" led to overcapacity in production, waste of resources (e.g. unused robots) and a focus on quantity rather than quality. In addition, the "blind expansion" in the robotics industry has meant that Chinese companies have copied machines with low technology content instead of driving forward independent innovations (Taplin 2016).

In addition to the misallocation of resources described above, China's industrial policy programs to promote technology and innovation can also cause discrimination and

distortion of competition – both between domestic and as well as between domestic and foreign companies. On the one hand, the question arises as to whether the support always reaches the most innovative domestic companies or whether it is not rather the politically best networked, i.e. often state-owned companies. On the other hand, discrimination against foreign companies often emerges: In a survey conducted by the EU Chamber of Commerce in China in 2018, 46 percent of all foreign companies surveyed said that regulatory hurdles and restrictions on market access hindered their business in China. Smaller companies are hit particularly hard. Fifty percent of them said that these obstacles would have taken them more than ten percent of their annual sales in 2017 (European Union Chamber of Commerce in China 2018).

However, the deliberate protection of certain sectors against foreign competition or their restrictions on market access, which have played an important role in the development of the Chinese innovation model, is now increasingly reaching its limits. Foreign companies and governments are less and less willing to accept such distortions of competition. They are increasingly taking action to defend themselves (European Commission 2019). The most extreme example of this is currently the USA, which could cause considerable damage to China through the ongoing trade conflict. Of all things, one of the most important goals of the Chinese government – to make China a leading location for technology and innovation by 2049 – is being severely disrupted by this.

4 Outlook: Strengthening innovation capacity through strategic industrial policy

Globally, industrial policy is changing. This process takes place in an international context that is determined by two narratives: Protectionism and innovation. On the one hand, Trump's protectionist rhetoric has brought a clear reorientation of structural policy towards the protection of national industries into the debate. This is evident not only in domestic American policy, but also in China's reactive policies in the course of the trade war with the USA as well as in the intentions of the new industrial strategies of Germany and the EU. On the other hand, China's ambitious future plans to become a leader in the fourth industrial revolution have set off alarm bells in the West. With its economic growth in recent years, China has proven its future potential and is becoming increasingly important as a global competitor in the field of digitization and innovation. Countries such as Germany, France and the USA feel threatened and are trying to maintain their position as technology and innovation leaders through new national strategies.

Although both narratives are important for the future of German and European industrial policy, innovation is the main driver of future industrial policy measures and strategies (see Chapter 3). The high degree of digitization and the increasing importance of AI and automation for the economy require that both general economic policy and concrete industrial policy measures focus on innovation and technology. Furthermore, this requires the consideration of strategies in which the state no longer assumes the role of a silent observer.

The desire to maintain its own innovative and competitive capacity is a clear link between the industrial policy ambitions of the USA, China and the EU or Germany. However, our analysis shows that Germany and the EU have some catching up to do in terms of an innovation-promoting industrial policy. In particular, we have identified five key factors that describe the weaknesses of the European and German innovation landscape:

- Stagnating or declining innovative ability
- Loss of competitiveness on technology markets
- Low growth in future markets
- Lack of risk and seed capital
- Lack of qualified specialists

Suggestions for the development of an innovation-promoting industrial policy can be found in the US and China (Table 2). In this context, it is of central importance to avoid falling into the trap of either the trumped-up "defective industrial policy" or Chinese state-control.

In general, a strategic European or German industrial policy must succeed in balancing the protection and promotion of legitimate self-interests on the one hand and economically damaging protectionism and ill-considered state interventionism on the other. The so-called "mission orientation" can make a significant contribution here: Accordingly, industrial policy should serve to meet specific societal challenges (e.g. digitization, demographic change, climate change) and be coherently geared to these objectives (SVR 2019, pp. 152–153). Furthermore, this strategic industrial policy is to be driven in parallel by different actors. It is a joint task of business and politics to facilitate a competitive business location where the state ensures good competition-promoting framework conditions and the private actors take the actions.

Taking these requirements into account, we consider the following five fields of action as particularly important for an innovation-promoting industrial policy in the EU and Germany:

TABLE 2: **Comparison of the deficits of the German and European innovation model with the success factors of American and Chinese industrial policy**

	USA	China
General deficits in the EU and Germany	**Successful measures and strategies**	
Stagnating or declining innovative ability	**The state as a consumer:** A significant part of the research needs in the US are public, which has contributed to the steady growth of the US technology market.	**Innovative ability as a core objective of the economic order:** There is a fundamental interest of the state in supporting public and private institutions in the technology sector, as the promotion of science and research is a central component of Chinese economic policy.
Loss of competitiveness in technology markets	**The state as a mediator:** The US authorities have managed to promote cooperation and collaboration between the private sector and research institutions. They facilitate the exchange of information, resources and funding.	**The state as a consumer:** As in the USA, the Chinese state plays a decisive role in the demand for products and technologies. For example, it uses its market power to favor domestic brands and products in public procurement.
Specific deficits in the EU and Germany	**Successful measures and strategies**	
Low growth in future markets	**Diversified investments in research and science:** US investment is spread across many different sectors and levels of research. In this way, the state promotes innovation activities on a broad basis, not sector- or technology-specific. **The state as provider of basic technologies:** The US authorities have a particular interest in promoting basic research whose products are used for applied research or the development of advanced technologies by the private sector.	**Pilot projects:** From the outside, China often appears as a centrally governed state. However, in the past, local governments have had both some influence on the development of central guidelines and scope for their implementation. This was done through local pilot projects, which were transferred to the national level if successful. **Protection of Infant Industries:** The limited access of foreign competitors to the Chinese market has played a special role in the development of Chinese technologies. The state allows and supports the growth and establishment of national companies before they are ready to position themselves on the international market.
Lack of risk and seed capital	**Facilitating the framework conditions for new technological developments:** The innovation market is a capital-intensive sector. By facilitating the framework conditions of the venture capital market, the State provided access to a larger pool of financial resources.	**Facilitating the framework conditions for capital inflows from abroad:** To achieve innovation and bring it to market, a considerable amount of capital is required. By facilitating the framework conditions for foreign direct investment, the Chinese state provided access to a larger pool of financial resources.
Lack of qualified specialists	**Migratory conditions:** Facilitating migration processes for highly skilled migrants has in the past led to a larger pool of human capital.	**Technology transfer:** The regulatory framework for cooperation between foreign and Chinese companies facilitates access to foreign know-how.

Source: Own representation.

❶ Implementation of a long-term innovation strategy

As a basis for this, strategic European value chains in key technologies could be defined and digitally networked via Internet of Things applications (e.g. smart health, cybersecurity, hydrogen, autonomous driving). A starting point in this respect is provided by the already existing measures to promote six *Key Enabling Technologies* (KETs) (e.g. nanotechnology or advanced production technologies), which lay the foundation for innovation in a large number of traditional and new industries (European Commission, n.d.). These KETs have a particularly high potential to stimulate future growth and innovation and to ensure competitiveness with the USA and China.

For the targeted financing of innovations in key technologies could *Horizon Europe*, the successor program from *Horizon 2020*, as the largest research funding program in the world, set a decisive accent. Member states should increase or adjust their spending on key technologies in line with *Horizon Europe*. Government procurement that is more strongly oriented towards key technologies could also play an important role here (e.g. infrastructure planning).

For the concrete implementation of innovations in practice, it is also important to have a good interlocking of scientific and market perspectives. Here could play the *European Institute of Innovation & Technology* (EIT), which is part of *Horizon 2020/Horizon Europe* an important role. In particular the EIT ICT Labs (now: EIT Digital) are a promising approach. Among other things, the laboratories, which were launched in 2010, are intended to better link education, research and marketability – by means of an "ecosystem" that will stabilize the use of ICT applications in the form of so-called "hotspots" in Europe.

❷ Expansion of venture capital

Effective support for innovation also involves the EU and its member states providing growth funds for venture capital and other vehicles to promote innovation-driven growth companies and new business models. While some progress has already been made in the area of start-up financing, there is still a clear lack of access to capital to bring an innovation to market and thus to practical application *(go to market)*.

❸ Expansion of cluster approaches at EU level

In many EU countries, including Germany, cluster policy has become an important instrument of innovation and regional promotion. This approach could also be thought of on a pan-European basis in order to better exploit the diverse advantages of the individual EU member states. So-called "EU-wide clusters of excellence" are a sensible step here: Groups of companies, small and medium-sized enterprises, start-ups and research institutions from various sectors can be organized in clusters and thus the value chains can be integrated to increase productivity. In addition, clusters could also serve to make more use of pilot projects as an innovation approach and – if successful – to gradually expand them across the board.

❹ Thinking and strengthening cybersecurity at EU level

Efforts to increase innovation in the EU will undoubtedly lead to more digital and data-based business models. These – like the digital internal market – need not only a clear competitive framework but also a modern security architecture. In addition to Internet crime and industrial espionage, international terrorism and espionage by states make cybersecurity and cyberdefense urgently necessary. Both areas can be conceptually described as integrated security of software, hardware and data-based information. However, it is clear that there is still a considerable need in EU countries. Germany, for example, is only in 24th place globally, Austria and Denmark are in 30th and 34th place. In general, a pan-European approach to cybersecurity is needed.

❺ Uniform and fair conditions for competition

In order to meet the current challenges to European innovation capacity, a level playing field is needed – both for competition between EU companies and between EU and non-EU companies. Particular care must be taken to ensure that small and medium-sized enterprises are not disadvantaged in favor of European champions. Furthermore, regulatory scope for pilot projects to test modern, even disruptive business models could be made possible in order to increase the chances of European companies to compete internationally. The need for reform is also evident in European state aid law, which has so far put EU companies at a disadvantage in financing the acquisition of high-tech companies compared with buyers from third countries who have access to state-subsidized funds.

There is also potential for improving competitive conditions by harmonizing and simplifying EU-wide regulation: From a global perspective, Europe has high standards, for example in the areas of occupational safety and data protection, taxes, duties and environmental protection. They make an important contribution to strengthening consumer sovereignty and must therefore be preserved. However, the past also shows that, for example, ICT standards, which are still not harmonized in Europe in every area, put many European companies at a competitive disadvantage compared to those in more integrated markets. The same standards would also make sense for infrastructure projects so that companies can tackle them on a Europe-wide basis.

At the international level, it is recommended that the EU should have a single voice in the relevant organizations (e.g. OECD and WTO) in order to achieve globally applicable and uniform regulatory standards. European companies came under pressure in their home markets, not least because international providers, for example in the telecommunications industry, had to deal with less regulation in their home markets and had more resources at their disposal to enter the European market.

In addition to the above-mentioned fields of action, which are relevant both for the EU and for the individual member states, industrial policy measures in the following three areas could be useful for Germany in particular:

❶ Improvement of framework conditions for research and development

The social market economy and a strong middle class are and remain central pillars of the German economic system. At the same time, it is important to improve the conditions for more private investment in R&D. These include reducing bureaucratic hurdles, strengthening e-governance and promoting greater diversity among professionals.

❷ Gearing the education and research system more strongly towards entrepreneurship and innovation

Public research, especially in basic technologies, can be an important incubator for R&D in private companies. An even stronger networking of public research institutions with the private sector can contribute to this. A general strengthening of the start-up culture would also be desirable, as this is still relatively weak in Germany, especially in comparison to the USA, partly due to the widespread fear of failure. This could be remedied, for example, by extending programs for start-ups in schools and universities and by increasing the number of state scholarships.

Another particularly critical factor for the success of an innovation is its implementation in practice, i.e. market entry. Much depends on the extent to which the start-up culture is shaped by the urge to professionally prepare the start-up. There is also room for improvement here: For example, students of MINT subjects, but also of the humanities and social sciences, could receive supplementary business management training in order to achieve the necessary market orientation. Better training in so-called *design thinking* is also conceivable – a method that promotes problem solving through creative and unconventional thinking. In addition, the patent application process could be simplified. Furthermore, the potential of the working population in the EU and Germany must be better exploited in order to make use of existing talent and adequately counteract a possible shortage of skilled workers. To achieve this, the labor supply side and the labor demand side would have to converge. Investments in talent management, attractive and challenging working conditions as well as more intensive cooperation with educational institutions are approaches to creating innovation-friendly conditions and thus pursuing an appropriate industrial policy.

❸ State as a pioneer and trailblazer in new technologies

The state has the advantage of being able to draw up long-term strategies and plans that go beyond the periods in which companies think. In the case of issues of macroeconomic importance, a consensus across party and departmental boundaries is conceivable, beyond the thinking in legislative periods. This is particularly necessary for the successive implementation of a long-term strategy across different government coalitions. In light of this, state actors could initiate and control a debate within society as a whole, which deals with overarching issues, such as: Which technology could come next? What are its advantages and disadvantages? How does it possibly influence everyday life? Does it help society in the long-term?

It is important to clearly explain the advantages of new technologies and how they work or to have them explained by proven experts. This could help to reduce potential prejudices and fears that may exist, at least in parts of the population.

Such a process and its results could help to define essential elements and objectives of a long-term strategy, e.g. in relation to the management of digitization. In addition, the state could play a pioneering role in application and implementation (e.g. by rapidly expanding the digital infrastructure and – as already mentioned – e-governance or by increasing the promotion of e-business).

The fields of state action mentioned here indicate that a "night watchman state" is insufficient to sustainably promote innovations and key technologies. To this end, a long-term, coherent industrial policy at EU level and in the member states is both sensible and necessary. The findings and possible solutions presented in this paper are intended to make a constructive contribution to the development process of such a policy.

Appendix

Abbreviations

AI	Artificial Intelligence
AMECO	Annual Macro-Economic Database of the European Commission
BAT	Baidu, Alibaba, Tencent
BDI	Federation of German Industries (Bundesverband der Deutschen Industrie)
BMBF	Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung)
BMWi	Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
COM	European Commission
CVCA	China Venture Capital and Private Equity Association
DARPA	Defense Advanced Research Projects Agency
EIT	European Institute of Innovation & Technology
EPO	European Patent Office
GAFA	Google, Apple, Facebook, Amazon
GDP	Gross Domestic Product
GED	Global Economic Dynamics Project
GPS	Global Positioning System
ICT	Information and Communications Technology
IoT	Internet of Things
KET	Key Enabling Technology
MERICS	Mercator Institute for China Studies
MIC2025	Made in China 2025
MINT	Mathematics, Informatics, Natural Sciences and Technology
MLTRP	Medium- and Long-Term Railway Plan
NBS	National Bureau of Statistics of China
NSB	National Science Board
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
RMB	Renminbi
S&T	Science and Technology
SVR	German Council of Economic Experts (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung)
TFP	Total Factor Productivity
UNCTAD	United Nations Conference on Trade and Development
USBLS	United States Bureau of Labor Statistics
WG	Working Group
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Figures

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