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Current R&I policy:
The future development of China´s R&I system

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1 Introduction

China's catching up was not only taking place in economic terms, but also in strategic and policy terms. In other words, the systemic change that took place economically was accompanied or even driven by new policy approaches and shifts in focus of the policy activities. While the innovation system emerged, also the system of science and innovation policy was developed in parallel.

This discussion paper addresses policy learning and policy implementation in China since about 2006. In particular, the potential change of research and innovation policy under Xi Jinping is discussed, as well as core policies and strategies to further improve the Chinese innovation system and to shift it from a low-cost to an innovation-driven economy. The Internet Plus strategy and Made in China 2025 (MIC2025) as the most well-known policies that support the overall and most central "Innovation Driven Development Strategy" are briefly introduced. A first section, however, discusses policy-making processes and policy learning processes in China in general. It tries to sketch the current debate in the scientific literature, if the reform era ended and if the new authoritarianism under Xi Jinping is hampering policy implementation and policy learning as well as the future economic development.

In the past years the Chinese government has initiated a number of reforms and changes to the system, stressing the market forces and a liberalisation of several regulations. Criticism, however, arises that these announcements are not sufficiently followed by corresponding actions (ECC 2018). Business surveys like the one by the European Chamber of Commerce (ECC 2017) or also the German Chamber of Commerce[1] emphasise the still existing challenges and obstacles for foreign companies in China. These challenges concern regulations and limitations of market access, insufficient IPR protection, unfair and unequal treatment, as well as quasi monopolies of state-owned enterprises (SOEs) with governmental support, or the discrimination against foreign companies in public procurement procedures. Negative effects for foreign companies are derived from the existing dominance of SOEs in certain sectors, from the forced technology transfer, as well as from regulations with ambiguous rules and discretionary enforcement. Representatives of US government agencies as well as companies raised similar concerns. Different institutions in the USA continuously ac-

1 https://www.dihk.de/themenfelder/international/laender-und-maerkte/asien-pazifik/umfragen-und-prognosen/konjunktur-china-2017

cuse China of following a mercantilist strategy and of breaching WTO rules on subsidising companies as well as discrimination against foreign companies in China.[2]

BOX: Examples of obstacles for (foreign) companies

One of the most intensively debated alterations is the Cyber Security Law that took effect in June 2017. It regulates data collection, use, storage and especially data export. Data that is collected in China needs to be stored in China and can only be exported after a so called 'security review'. This also holds for data traffic between a Chinese branch and headquarters of a foreign company abroad, for example. The existing internet censoring is an obstacle that is a challenge as well, but on top and as a further aggravation, the Chinese government considerably restricted the use of VPN clients for secure data transfer in and out of China in early 2018. These restrictions of internet and data use lead to considerable (potential) problems in the business processes of companies. Furthermore, and even more severe, it leaves a back-door for the Chinese government to access otherwise confidential and secure data, including business secrets, strategies and business models, as well as valuable process data.

The reform of the Chinese patent law in 2010 integrated a similar back-door. While that reform brought the Chinese patent system closer to Western systems, especially in Europe – at least on paper – it also entailed a few negative aspects. Since 2010, compulsory licensing is possible in cases of national interest. Furthermore, it is mandatory for inventions made in China first to file them in China. Based on this, filing a patent for a China-made invention abroad requires application and approval to do so. SIPO (now called National Intellectual Property Administration, NIPA) checks, if national security or vital interests are violated, and gives approval if not.

High hopes arose, by not only foreign company representatives in China, but by economists around the globe after Xi Jinping's speech at the World Economic Forum in Davos in 2017, where he made a pledge for further opening China and where he defended free trade and global market principles. The public announcement at the World

2 See for example: http://www2.itif.org/2018-testimony-atkinson-countering-china.pdf?_ga=2.230946006.833322852.1538460790-1166197201.1538460790; https://ustr.gov/sites/default/files/2016-China-Report-to-Congress.pdf; https://www.amchamchina.org/policy-advocacy/business-climate-survey/

Economic Forum was then also followed by concrete plans[3] and even roadmaps to put forward the opening of the Chinese economy. The criticism, however, is that these reforms are not sufficient, too slow and too half-hearted (ECC 2018). For example, the reduction of the prohibited investment list and the accompanying announced liberalisations of investment rules in certain sectors like transport, finance, infrastructure, or agriculture are criticised as being just cosmetics (Schaff and Schetelig, 2018). In addition, some of them are just aggregations of similar sectors of the previous list or are liberalisations of otherwise restricted (like weapons) or settled markets with oligopolistic structures (like rail transport, shipbuilding or fuel/petrol production). In consequence, the formerly longer list is now shortened, but with limited effect.

However, even against the background of obstacles and challenges for foreign companies, the majority of them still makes good business in present times and expects this to be the case in the near future. The business survey of the European Chamber of Commerce (ECC 2018), of the German Chamber of Commerce (AHK 2017) and of the American Chamber of Commerce (AmChamChina 2018) report rather positive expectations of companies for the development of the Chinese economy in 2018. In addition, the vast majority of surveyed companies in all three studies expects their business to improve or at least to be as good as it was in past years. Only few companies believe that they will not meet their business targets for their China business in 2018. In consequence, compared to previous years (2015 and especially 2016) the confidence of a positive development is much higher. However, several companies are still reluctant to release new investments or to increase their investments in the near future, due to uncertainties about future developments.

The EU-China Summit in 2018, where political leaders from both sides meet and representatives of the economic and scientific communities are present as well, also sends positive signals for future developments. It was even possible to formulate a joint statement for the first time since 2015, which stresses the intention to intensify the collaboration in a number of areas between China and Europe. "The two sides are strongly committed to fostering an open world economy, improving trade and investment liberalisation and facilitation, resisting protectionism and unilateralism, and making globalisation more open, balanced, inclusive, and beneficial to all." (Joint statement

[3] GuoFa No. 5/2017: http://www.gov.cn/zhengce/content/2017-01/17/content_5160624.htm; GuoFa No. 39/2017: http://www.gov.cn/zhengce/content/2017-08/16/content_5218057.htm; an English translation of both documents can be found in ECC 2018, pp.63-72.

No. 8, p.3).[4] The EU acknowledges the efforts that the Chinese side made to achieve a level-playing field, for example, to improve market access or to strengthen intellectual property rights. The European Union and the People's Republic of China intend to set up an investment agreement, which would facilitate an open and more transparent business environment for both sides. The EU-China Annual Action Program[5] foresees a number of projects with a considerable budget of 35 million Euro in the context of societal challenges like environmental issues, digitalisation, or also migration.

For a very long time, foreign countries have made good business in China based on technological superiority and their innovative competitiveness, while the competition by Chinese companies was limited and mostly restricted to low-end market segments or low-tech sectors (Prud'Homm and von Zedwitz 2018; Liu et al. 2017). This, however, has changed in the recent years and the competitiveness and innovativeness of Chinese companies resembles that of foreign companies in many areas and sectors, according to business surveys (ECC 2018; AmChamChina 2018). At the same time, Chinese companies in low-end or labour-based production markets are getting under pressure by lower production cost countries like Bangladesh in the case of textiles or by automation, for example, in the case of the assembly of micro-electronics. In addition, labour costs for R&D personnel - this not only includes wages[6], but also additional direct and indirect costs - almost increased to a similar level like in (Western) countries in most sectors/disciplines so that cost-advantages are not among the main motivations for foreign companies to conduct or even transfer R&D activities to China (Tagscherer 2015; Kinkel 2014). Knowledge-seeking and knowledge-sourcing are rather the motives for many foreign companies to conduct (parts of their) R&D in China (Tagscherer 2015), while it was mostly market access in the past decade (Schwaag Serger 2006; Boutellier et al. 2013; Thomson and de Rassenfosse 2013).

All these positive developments have been made possible by changes, adaptations and reforms of the Chinese science, technology and innovation system over the past years. While the foundations for all these reforms and policies were laid out in the MLP (Mid-to-Longterm Plan for Science and Technology) already in 2006, more recently three big policies were widely recognised and some of them broadly discussed also at a global level. However, some spectators see challenges and even obstacles for the

4 http://eueuropaeeas.fpfis.slb.ec.europa.eu:8084/delegations/china/48424/joint-statement-20th-eu-china-summit_en

5 http://ec.europa.eu/dgs/fpi/announcements/news/20180716_en.htm

6 https://www.kellyservices.cn/cn/siteassets/china---kelly-services/uploadedfiles/china_-_kelly_services/4-resource_centre/salary_guide/kelly20services20201720salary20guide_f2.pdf

further development arising from current policy and governance changes in China. This paper addresses some of these critiques and perspectives and describes the most relevant innovation policies in China against this background.

2 Policy diffusion and implementation

China is about twice the size of the EU-28 countries and has almost three times more inhabitants than the European Union. The economic development of the past years was unevenly distributed not only between different parts of society and between rural and urban population, but also between different regions/provinces within the country (Kroll and Frietsch 2014). Most of the Chinese provinces are larger than European countries in terms of inhabitants, and even some cities are larger than most European countries. In consequence, the need for and the reach of science and innovation policy is rather disperse. The three agglomerations of Beijing/Bohai Bay Area, Yangtze River Delta (Shanghai), and Pearl River Delta (Guangzhou) were the main drivers of the economic development of the last decade.

Beijing/Bohai Bay Areas mainly is the political and scientific hub of China (Kroll and Frietsch 2014). More recently, Beijing was developed further as a financial hot-spot in China as well as the service industry. At the same time production facilities and industry was re-located out of the greater Beijing area to the surrounding provinces/cities to speed-up the restructuring process. The Yangtze-River Delta developed very quickly due to considerable foreign direct investment - most of the large multinational companies set up their first production facilities here. Meanwhile they spread out to the surrounding cities and provinces (e.g. Jiangsu, Zhejiang). In addition, a number of Chinese created and benefitted from a dynamic economic/innovation environment. At the same time scientific excellence developed at a number of universities and research institutes that provides the intellectual foundation of this dynamic environment. In the Pearl-River Delta, on the other hand, the academic institutions are still of limited quality and reach. The competitive edge of Guangdong province is mainly the large production facilities, mainly with manual labour in electronic industries or low-tech sectors. In addition, the region benefitted from its geo-strategic location close to Hong-Kong, Macau and the maritime transport routes to East-Asia, North-America, but also Europe and Africa. The Pearl-River Delta was and still is China's gate to the world in terms of exports. Beyond these larger areas, a number of dynamics cities of regions came up especially in the recent years, fuelled by an increasing role of IT-services and internet-based companies, serving the fast growing Chinese market, but also reaching out to the world, e.g. in Shenzhen or Hangzhou.

Since the beginning of this decade other provinces like Jiangsu, Zhejiang, Chongqing, or Shandong are on the rise, either by extensions of the existing hubs/clusters or by own efforts with means of science, innovation or investment policies. Besides, cities like Shanghai or Beijing, with 10 to 20 million inhabitants, formulated their own priorities and strategies, based on own reporting/monitoring and policy processes. Also smaller cities like Qingdao at the East coast, Chengdu in central China or Shenzhen in the South set up their own research and innovation priorities and try to achieve their aims with own strategies and policies. All of them are, however, not independent from the central government's policy goals and policy activities.

2.1 Policy learning and policy experimentation

Chinese policy-making, among others in the context of science and innovation, always followed a top-down approach, but with flexibility on the provincial or municipal level when it comes to implementation and adaptation (Breznitz, and Murphree 2010; Teets et al. 2017). This left enough room for variation and it was a way to ensure policy learning and policy experimentation that is necessary, even mandatory in a developing and dynamic system. Policy learning in this context means that provincial or municipal governments/bureaucracies adapt central policy ideas to local needs and derive best practices. These best practices were then communicated and exchanged with other provincial or municipal policymakers and in some cases rolled out nationally and became part of a revised policy.[7] This was and is a common procedure, even used by the central government at the national level, for example with the special development or demonstration zones. In some cases the policies are piloted in some regions, and the lessons are learned and best solutions/policy formula are identified before they are diffused and implemented nationally through a formal policy document. But in some cases, especially in the event of urgency, they might not have the time to go through the process. They are mostly the responsive policies, and called crossing the river by touching the stones. One of the most well-known cases is the '10 cities, 1000 cars' program launched in 2009 to get electro-mobility kick-started and support the capacity and competence building of national electric car manufacturers (Tagscherer and Frietsch 2014). The free trade zone in Shanghai is another example, or even the one country-two-systems-approach concerning the special status of Hong Kong falls into this category.

Especially in the second half of the last decade the possibility for variation and flexibility led to strong deviances from the central government's policies, for example in the case of environmental regulations. In addition, policy makers at the provincial or municipal

7 https://www.merics.org/de/blog/xis-china-party-morphs-state

level set-up incentive structures for companies, for example by cheap land, cheap credits and especially tax benefits that aimed building a local/regional economic system. Examples exist where companies engaged in rent-seeking and built branches in different provinces, sometimes close to borders of the provinces, to benefit from subsidies (Conlé and Taube 2010). Local policymakers were judged and assessed by the performance of the local economic system. In consequence, their main interest was not necessarily the implementation of environmental regulations required by the central government, but the development of their local economy.

"Heaven is high and the emperor is far away" is a traditional Chinese saying that kept its validity over centuries and essentially means that the central policies and requirements are selected or adapted and the central government can hardly do anything about it. In consequence, also in terms of the implementation of science and innovation policy at the provincial or municipal level, the central government's approaches are seen as guidelines that come along with sanctions and incentives. The intensity and level of implementation or adaptation were to be decided at the local level. Based on the flexibility and variations not only in policy implementations, but also in terms of fit with the local economic or societal development status, several researchers (e.g. Huang et al. 2016: 6) conclude that there is not one single Chinese Innovation System, but a number of such systems that aggregate to the national innovation system (Liefner and Wei 2014). Breznitz and Murphree (2011: 8) summarise it in the following way: "…China's economy should not be analysed as one homogenous economic entity but rather as a multitude of regional systems. …[C]ollectively, these regional systems combine to form a unique, de facto national innovation system …".

The positive effects of the diversity of the policy implementations were policy learning, adaptability and (potential) orientation at the real or effective needs at the local level. Negative effects range from strong deviations or even ignorance of central policy goals, via inefficiencies, mismanagement, and abuse of public funding, down to cronyism and bribery. Another negative effect is what some analysts (e.g. Teets et al. 2017)[8] have called 'ossification' – the detachment of central policy makers from the public as well as from local officials.

To conclude and put it into perspective of R&I policy: this kind of policy learning is of particular relevance as it allows for a fast and needs-oriented adaptation and implementation of central policies. The catching-up and fast development of the past decade was only possible because local policy makers were using the central policy with flexi-

8 See also: http://www.eastasiaforum.org/2016/12/20/how-xi-jinpings-leadership-discourages-local-innovation/

bility. It also resulted in scientific and technological specialisation as they were able to foster their local strengths. Leaving questions of efficiency aside at this point, the effectiveness of the policies and the infrastructure investments are obvious.

At the same time, flexible policy adaptation ensured the 'trickling down' not only of institutional arrangements, but also of the policy ideas as such. Most of the provinces and even cities have similar structures like the central government level, including local authorities with tasks like the Ministry of Science and Technology or also similar research bodies like local academies of sciences or local governmental research institutes. However, next to this administrative infrastructure also the policy ideas had to diffuse. Local policy makers were assessed based on their economic successes, but innovation as a driving force of this economic success was not part of the mind-sets neither of policy makers nor of managers, be it in state-owned enterprises or private companies a decade ago - and partially still is not today. It took a while for the central policy ideas to arrive at the local level. Directives, incentives, funding and infrastructure investments alone were not sufficient, but simply policy learning over time did the trick. Cities like Hangzhou or Shenzhen were able to go their own way to some extent and then even became role models for others, so the policy learning could spread. This, however, has started to change already in the last decade or so as innovation has become part of the performance evaluation criteria of government officials.

2.2 Reasons for instability and inconsistencies

Essentially, the promise of the early years of Deng Xiaoping's opening-up and especially of the last decade's steep economic development led to inequalities and injustices. As long as the cake was growing and everyone's piece of this cake was growing as well, it was acceptable that for some the pieces were much larger than for others.

Cleavages between poor and rich, between rural and urban, and between party cadres and regular citizens were expanding in the last years. Inequalities and structural differences emerge, for example, out of the hukou – the national household registration system that is linked to pension schemes, health insurance and many more – as well as the gaokao – the national university entry test, which was perverted by the possibility of essentially circumventing it with the rich buying their children into the elite universities. Many riots and public conflicts arose at the local level out of such inequalities or out of perceptions of injustice (Minzner 2018: 87). In addition, the promise of a growing cake for everyone is not sufficient any more. Many Chinese citizens ask for less inequality or at least for equal chances, which are not given anymore, as the example of the gaukau shows.

One could say this is a lack of consistency in policy making. These inconsistencies partly emerge due to the differences in political thoughts at top level, but also due to 1) the changes of positions of regional or ministerial leaders at the regional and sectoral levels, as well as 2) China is still a learning nation in terms of policy, and it is open to correction of incorrect policy, and 3) policies coming from different ministries or different government departments that lack of coherence or coordination.

A recent discussion in the literature on Chinese (innovation) policy emerged addressing the changed governance style and increased control and evaluation mechanisms – some call this authoritarianism (e.g. Shambaugh 2016; Minzner 2018) – as well as more centralized policymaking in the era of Xi Jinping since his first term started in 2012. "... [M]any local officials below the provincial level report a substantial increase in the need to file work reports to supervisors who are concerned with meeting new guidelines for central supervision."[9] On the one hand, the heterogeneity and flexibility in adapting central policies is a necessary prerequisite for the economic, social, and structural change that is underway (Breznitz and Murphree 2011; Teets et al. 2017). It is hampered by control and reporting systems, formal evaluation criteria, and especially by reprisals and threats of negative career paths, or even legal consequences including lifelong prison or death sentence in case of deviating action. As an effect of this, policy learning does not take place (to the same extent) and an improvement of the overall innovation system – seen as an aggregation of provincial or municipal systems – is considerably slowed down. "Although some officials are still conducting policy experimentation, the overall reduction in innovation strongly suggests that potential solutions to governance problems remain trapped at the local level, and that the central government might lose this 'adaptable' governance mechanism that has contributed to its past economic and political successes" (Teets et al. 2017: 505).

On the other hand, the perspective that is taken by Minzner (2018) emphasises the negative effects of the last decade's flexible/liberal policies. He argues that the reform era ended and the pendulum swings back to – although modernised - socialist, communist and especially Chinese norms and values. The liberalisation and flexible interpretation of policies under Hu Jintao and Wen Xiabao led to a deterioration of the previously existing institutions that guided policy making at the local level, which then resulted in excessive negative effects. While Teets et al. (2017) argues that stronger controls and top-down policy implications lead to negative effects in terms of policy learn-

9 Jessica Teets at http://www.chinafile.com/conversation/what-does-xi-jinpings-top-down-leadership-mean-innovation-china

ing and policy experimentation, Minzner's (2018) line of argumentation could be summarised as the necessity to rule an otherwise destabilising country.

In Minzner's eyes, a logical reaction to this is the centralisation of power, the control and assurance of implementing central policies, the increase of the party discipline, and also the anti-corruption campaign to fight injustice and inequalities as well as reviving traditional Chinese norms with Xi Jinping's 'Chinese Dream', which is the appellation to Chinese traditionalism and nationalism. He explains it by historical as well as societal/cultural reasons. Most of the time, China has been ruled top down with a centralised power system, so his argumentation.

The improvement of the 'rule of law', which means greater reliability of laws and judicial decision making is stressed by Xi Jinping in several speeches, also in his opening speech at the 19th People's Congress in March 2018, can also be seen as part of this intention to stabilise the system.[10] One could interpret this positively as bringing back greater predictability and trust in the legal system by the citizens. Some scholars, however, are very sceptical, given the recent trends in 'social credit scoring' as well as internet and social media censoring, and see the 'rule of law' narrative effectively as an intention to implement a stronger system of 'rule by law', which means control and patronising as well as intimidation. The Party sets the rules and might even be exempt from the general ones, defining its own rules.

2.3 Concluding remarks on policy learning

Flexible adaptation of central policies as well as policy learning and policy experimentation still exists in today's China. It still provides a relevant contribution to the development of the economic, social, innovation or overall political system. The academic questions are not, whether the negative effects of this policy making predominate or the positive effects justify the acceptance of the negative outcomes. Scholar mostly agree that for reasons of avoiding inefficiency as well as gaining stability and justice, the negative effects should be reduced. Cronyism and bribery were always criticised. However, the discussions that arose in the recent years address the question, if the approach taken under Xi Jinping is the appropriate way to tackle these issues. A final answer can neither be found in the literature nor in the current status of the Chinese economy or innovation system, so the future needs to show. At least, where most of the authors take the same position is on the changing effects of the governance style

10 http://www.xinhuanet.com/english/download/Xi_Jinping's_report_at_19th_CPC_National_Congress.pdf

under Xi Jinping compared to the previous administration under Hu Jintao. Local bureaucrats and policy makers are much more cautious in what they do and how far they deviate. "...midlevel bureaucrats have hunkered down in fear that a wrong move will end their careers, or worse" (Minzner 2018: 29).

3 Current Science and Innovation Policies

3.1 The Innovation-driven Economy Development Strategy

The Chinese science and innovation policy is mainly dedicated to overcome the so called middle-income-trap and to move away from low-cost, low value added production to a more balanced economic structure that generates higher value added. For Chinese policy makers, one of the core challenges is to become less dependent on foreign markets and especially on technology imports in crucial sectors. President Xi Jinping pointed this out: "China's foundation for science and technology innovation is still not firm. China's capacity for indigenous innovation, and especially original innovation, is still weak. Fundamentally, the fact that we are controlled by others in critical fields and key technologies has not changed" (European Chamber 2017: 7).

While the 'National Medium- and Long-Term Programme for Science and Technology Development' (MLP) that was published in 2006 as well as the 12th Five-Year-Plan (12th FYP) already addressed the innovation orientation and the upgrade of the economy, it was made explicit in the National Innovation-driven Strategy in 2012 and its outline, published in 2016. This strategy conveys three main steps for the further development of the country that were then adopted as strategic goals for achieving a socialist modernization by the 19th National Congress of the Communist Party of China in October 2017. By 2020 China will be an innovative nation, an international innovation leader by 2030, and a world powerhouse of scientific and technological innovation by 2050.[11]

The shift from a low-cost to an innovation-driven economy as formulated in the National Development Strategy is the overarching approach. It was explicitly stressed in the 13th FYP and several measures and policies were put into the planning to support this goal, among them MIC2025 or Internet Plus, but also the reform of the science system, a focus on mass entrepreneurship and mass innovation as well as additional R&D investments. Elements of an innovation-driven economy are talents, enhancing innovation capabilities, an adequate entrepreneurial ecosystem, or general improvements of

11 http://english.gov.cn/policies/latest_releases/2016/05/20/content_281475353682191.htm

the innovation system as such (Jung 2016). Quantitative targets like the 2.5% goal of R&D expenditures over GDP that were already defined in the MLP in 2006 were emphasised again. A change towards a consumption-oriented economy and a development of the local market, thereby becoming more independent of exports and global markets, is also stressed in the strategy.[12]

Individual policies, like Made in China 2025 or the Internet Plus strategy are contributing to this overall goal. Individual fields and technologies should also contribute. "Make breakthroughs in key technologies and equipment, such as additive manufacturing, smart sensing and control … [as well as] breakthroughs in a range of key equipment which are subject to export restrictions abroad and urgently needed domestically, such as aero-engines, gas turbines and high-end CNC machine tools."[13] In addition, the strategic industries, firstly mentioned in connection with the release of the 12th FYP in the year 2011 and updated in 2017, still play a major role also for the general economic upgrade. The list of these industries covers energy efficient and environmental technologies, next generation information technology, biotechnology, high-end equipment manufacturing, new energy, new materials, and new-energy vehicles (NEVs). In the year 2017 two more industries were added, namely digital innovation and related services.

Additional focal points of research that were announced in the second half of 2017 are quantum research, 5G, and artificial intelligence (AI)[14], including autonomous driving[15]. Furthermore, basic research will be strengthened by restructuring the funding system (see previous chapter) and the increase of the budget of the National Natural Science Foundation of China (NSFC). Technology transfer and collaboration between science and industry is still a challenge in China. The State Council had identified this already several years ago and just recently released a notice, which drafts a plan to set up a national technology transfer system in two steps. By 2020 a first professionalization of institutions and people is foreseen and by 2025 the transfer system should be in full operation.[16] The concrete measures and policies to implement these plans are not yet published, however.

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12 https://www.rieti.go.jp/en/events/bbl/13041201.html

13 http://english.cd-smartindustry.com/news_show.aspx?id=245

14 http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm; http://www.usito.org/news/china-launches-implementation-national-ai-development-plan

15 http://www.usito.org/news/ndrc-releases-intelligent-vehicle-innovation-and-development-strategy; http://www.ndrc.gov.cn/yjzq/201801/t20180105_873146.html

16 http://www.usito.org/news/china-establish-national-technology-transfer-system

3.2 Internet Plus and Made in China 2025

3.2.1 Internet Plus

The aim to develop China into an innovation oriented economy and upgrade its performance is mentioned in many speeches and policies.[17] China should shift from a great industrial nation to a strong industrial nation. The dependence on foreign technologies is still seen as the central challenge for climbing up the value chains. The superior goal to change China's role from the workbench of the world to an innovation-driven economy was further fuelled mainly by two new policies.

At the People's Congress in March 2015, among others, two new strategies appeared which have since been intensively debated within China and abroad: 'Made in China 2025' (see next section) and 'Internet Plus'. In his opening speech[18] Premier Li Keqiang mentioned this latter strategy[19], which is essentially the strategy for the integrated use and the application of the Internet in several industries, mainly in the service sector. The Internet economy and traditional industries should merge in several aspects until 2025 and by then an ecosystem should be developed, which is the foundation for the further development. Essentially, this strategy builds the framework for the digitalisation of China, including the needs for infrastructure investments that ensure the fulfilment of the strategy. In addition, it paves the way for future topics and business models that Chinese policy makers deem relevant for the economic development of the concerned sectors. Internet Plus is mainly dedicated to the service industry – including finance - and services within the manufacturing sector. It aims at making the processes 'smarter' and develop new business models.

The strategy is designed to merge the capabilities of the Internet with different parts of the economic system like, for example, production, finance, or public services. More concrete, 11 action points are mentioned: entrepreneurship, intelligent production, modern agriculture, intelligent energy, financial services, public services, logistics, e-commerce, transport, marine economy, and artificial intelligence. In total, the strategy is rather broad and addresses different topics, not only, but mainly in the service industry or at least building on smart services. This means that the strategy is still technology-centred, but takes services and new business models into focus, i.e. it does not only address mastering technologies, but beyond that also further parts of value chains.

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17 http://english.gov.cn/policies/latest_releases/2016/05/20/content_281475353682191.htm

18 http://english.gov.cn/archive/publications/2015/03/05/content_281475066179954.htm

19 http://www.usito.org/news/china-pursues-internet-plus-strategy

In July 2015 the State Council published implementation measures for the Internet Plus strategy. Concrete programs were launched by the National Development and Reform Commission (NDRC) in late 2017 on Internet Plus and Artificial Intelligence.[20] The rules emphasise the role of the market and the companies, which should take an important position in this transition. Core elements of the implementation are further reforms of the system, the increase of quality and efficiency of industry, strengthening new industries and branches, as well as public services and the framework conditions set by the state. Superior aims are the improvement of the quality and efficiency of the economy, better public services, improvement of the networks and network security as well as a more stable economic development.

Therefore, the strategy provides the frame for the broader usage of the Internet and its implications for the further economic development. It intends to make companies sensible, especially small and medium-sized companies, to this topic and support them to use their potentials as well as to develop new business models. In addition, it addresses infrastructure investments and the improvement of general framework conditions as prerequisites for modernising the economy.

3.2.2 Made in China 2025

Many policies and strategies have a similar timing, with 2025 as a first milestone to set up the framework and provide the prerequisites for future developments. Also the case of Made in China 2025 (MIC2025), the most important and most discussed strategy of the past three years, follows this timing. The title is confusing, however, as 2025 is only the first phase of the strategy, where only the foundations are to be laid. There are two more phases, which last up to 2049, when the People's Republic of China will celebrate its 100th birthday. By then China aims to belong to the top innovation-driven economies in the world. The second phase foresees an upgrade of the whole Chinese economy – and not just parts of it or certain provinces or sectors – to a similar level (one could say at least industry 3.0, with high shares of automation and vertical integration). The horizontal integration and especially the overall increase of the productivity level to that of the top performers, is left to the third phase. The first phase, correspondingly, foresees the upgrade of parts of the economy and the generation of a (reasonable) number of world-class enterprises that are able to compete with enterprises from industrialised/Western countries.

20 http://www.ndrc.gov.cn/zcfb/zcfbtz/201710/t20171013_863534.html

The Made in China 2025 strategy itself (Guo Fa 28) was released by the State Council in May 2015. The Implementation rules were published in March 2017 and different accompanying measures and guidelines – for example for the evaluation of the national demonstration zones were released as well.

It is publicly discussed and even confessed that MIC2025 was inspired by and shows parallels to the German Industry 4.0 strategy. This does not mean, however, that China just blindly copied the German policy approach. However, it meanwhile developed in a different direction and is much broader now (Gausemeier and Klocke 2016). This policy, similar to a number of other policies in this context, can be seen as continuations of the MLP or at least are based on the same approach, namely the upgrade of the economy via science and technology, so a very techno-centric, but also very technocratic perspective. Like hardly any other policy or strategy paper by the Chinese government, Made in China 2025 is based on a critical and realistic reflection of the current position of Chinese industry or the Chinese economy in total, as well as the challenges that China faces when turning such a strategy into reality. Because of this critical and realistic reflection, the phases of the strategy have longer perspectives than the usual five or 15 year plans. The Chinese government's analysis resulted in the insight that the Chinese manufacturing sector is large but not strong. It has shortcomings in terms of innovation capacity, efficiency, quality of industrial infrastructure as well as quality of outputs and also the degree of digitalization.

MIC2025 aims at increasing the quality of the products and of the production as well as to achieve a green economy. This means energy and material efficient production as well as the establishment of a circular economy. In addition, the structures and framework conditions shall improve, also to increase the efficiency. This refers to public finding for major projects, including equipment, as well as an upgrading of major industries. Policy support by legislation and regulation shall be provided as well as investment guidelines for major industries (see section 3.7 of MIC2025 on the adjustment of the structure of the manufacturing sector). Furthermore, the aim is to set up a human capital and knowledge intensive production with well-qualified personnel and a strong service orientation. Overall, quality and efficiency are repeatedly mentioned in this strategy document. Furthermore, structural reforms and improvements of the framework conditions, mainly driven by market forces and market needs, are frequently referred to. Besides, a lower product quality, less established and famous trademarks, a high dependency on foreign high-technology, low energy efficiency and environmental pollution, as well as an unfortunate industrial structure are seen as challenges or caveats throughout the document.

The strategic tasks and priorities are manifold, which should serve an overall quality improvement and a general change of the structures. First, innovation in product technologies are mentioned, which would be achieved by a better market orientation, and an orientation at the big national strategic needs. Furthermore, research and development in key technologies should contribute here. The role of universities and research organisations, innovation alliances and the collaboration with industry are stressed. As a first core component of the implementation, 15 innovation centres should be established by 2020 and by 2025 there should be 40 of such centres, which address demand oriented topics (for example information technology, advanced manufacturing, new materials) in collaboration with industry. In addition, the deeper usage of information technologies, for example industrial Internet, cloud computing, big data as well as a general strengthening of the Internet infrastructure are mentioned, which offers an implicit connection to the Internet Plus strategy. Joint research, national science and technology programs as well as the implementation of platforms and alliances between different actors of the innovation system (companies, universities, and research organisations) are quoted as examples for innovation policy instruments.

3.2.3 Implementations of MIC2025

A status report of the implementation of MIC2025 was released in March 2017 by the Ministry of Industry and Information Technology (MIIT).[21] It states that by then 19 provincial manufacturing innovation centres and 109 smart manufacturing pilot programs have been launched. Outstanding examples are the National Power Battery Innovation Centre in Beijing and National Additive Manufacturing Innovation Centre in Xi'an. The National Information and Optoelectronics Innovation Centre in Wuhan started in April 2018. Demonstration centres are one of the main tools of the MIC2025 strategy and they fit into the idea of policy learning and the establishment of best practice example. The intention is to link academic with industrial research and develop standards jointly between science and industry.

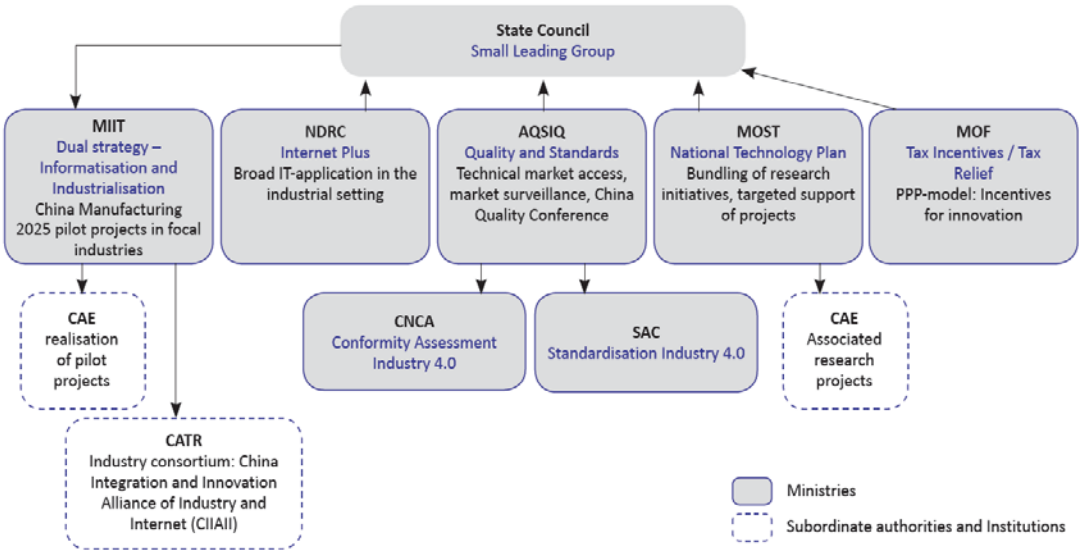
Eight cities and five city clusters act as pilots for the implementation of the policies. Seen from this perspective, the original targets of the MIC2025 planning are already achieved. The document claims that relevant agencies have improved their performance and the collaboration and coordination with other agencies and relevant actors. So far, eleven supporting plans have been drafted and a number of supporting measures have been put forward. Pilot programs initiated new collaborations between

21 http://english.cd-smartindustry.com/news_show.aspx?id=245

companies, universities, and research institutes, with the aim of strengthening the application orientation.

The responsibilities and contributions to Made in China 2025 and its implementation are distributed among different ministerial and supporting actors, which themselves have different focal points. The State Council acts as a coordinating organisation, while the MIIT is in direct charge of MIC2025. Other ministries make reference to MIC2025 via their own programs, namely NDRC by the Internet Plus strategy or MOST by the National Technology Plan. The Chinese Academy of Engineering (CAE), which was already involved in drafting the strategy itself, is responsible for the implementation of the demonstration centres and the pilot programs. They act as a kind of project management agency in this case. The CAE is an academy without own institutes, but a strong management and consultative body. The CAE has own staff members and a number of academicians, who are outstanding researchers with a high reputation in the field of engineering, affiliated to universities and research institutes from all over the country. With the MIC2025 CAE goes beyond its original mission of research and policy consultancy, as it is directly involved in policy implementation.

Figure 1: Chinese actors in the context of Made in China 2025



Source: GIZ; cf. European Chamber of Commerce in China (2017: 9)

3.2.4 Perspectives on Internet Plus and Made in China 2025

Both, with the Internet Plus strategy as well as Made in China 2025 the Chinese government formulates ambitious goals, but at the same time delivers a realistic assess-

ment of the current development status as well as the timeframe to catch up with the developed industrialised countries. In particular, MIC2025 was intensively discussed in the recent past and defines the figurehead of current Chinese innovation policy making.

In the first phase until 2025 China intends to develop multinational enterprises and industry clusters with a strong international competitive position, with a strongly increased role in the national and global value chains. Up to 2035 China's manufacturing industry in total shall be brought to a higher level. In 2049 the People's Republic intends to achieve globally leading production capacities and a global competitive advantage. China should be number one by then, so the intentions. Also in this document the intention to strengthen the market and market forces are repeatedly stressed, but also government as a major player is pointed out when it is said that the policies need to "address the balance of government guidance and market role".[22]

This strategy is much more comprehensive than previous plans, which mainly targeted the mastering and the generation of technologies. This holds for both, MIC2025 as well as Internet Plus. Especially the latter one is going beyond most of the previous plans and strategies as it addresses also 'soft' solutions and particularly deals with value creation outside the classical product or technology-based innovations. For a very long time, however, 'technocrats' with a narrow view on engineering and natural science solutions as well as the belief in manufacturing as the main vehicle of economic upgrading governed China. Leaving these 'old habits' behind might not be an easy task. Concerning an overall assessment of the innovation policy in China, after the inspection of the current and ongoing reforms in the science system, however, a report by Development Solutions (2018) on behalf of the European Commission comes to the following conclusion: "Chinese decision-makers in many cases still tend to see industrial upgrading and technological transformation as a relatively technical task of developing and installing advanced equipment, products, facilities, and infrastructures for innovation, rather than innovation of operation and management processes" (ibid.: 129). Therefore, also in this case it needs to be seen what the future brings and if Chinese policy makers are serious about widening the perspective beyond manufacturing and product innovations.

Critics on MIC2025 from within the country point out that the needs of the company's for connected production technologies and even for first automatisations (this would be industry 3.0) are currently not visible nationwide, but general industrialisation and optimisation as a first step seems necessary. However, this strategy can be read in a way

22 http://english.cd-smartindustry.com/news_show.aspx?id=245

that the government is realistic about the goals and also about the needs and the time horizon. The government is aware of the problems and challenges, which emerge from the low development level of certain regions. For example, different to the area of electro-mobility, where a fast leapfrogging with the established manufacturing countries was expected, Made in China 2025 as well as Internet Plus seem to be more realistic in terms of the time frame and the current status and opportunities of China.

Derived from the document analyses alone, an assessment of the quality and the operational capabilities of the centres and clusters cannot be given. Interviews with researchers and policy makers in 2016 and 2017 have shown that there was a huge interest of local (provincial/municipal) actors in locating demonstration centres in their region or become part of the clusters.[23] Not all of them, however, were capable of fulfilling the high aims and providing the scientific capabilities as well as the economic structures. The incentives to participate are high, because the funding and investments by the government are enormous. In 2017 the budget allocations were released[24] and the intention is to spend 10 billion yuan (about 1.2 billion €) on about 100 projects in the years 2018-2020. 30 million (3.8 million €) to 50 million yuan (6.4 million €) and projects in core technology areas like robotics or integrated circuits[25] will receive even more than 100 million yuan (13 million €) each. It needs to be seen, if all of the centres and clusters will be successful and reach the expectations. The impact on R&I policy making, however, is huge. On the one hand, the strategy sets the aim that researchers and companies can follow. It offers investment security and thematic orientation. On the other hand, it releases large budgets for technologies and implementations in the context of production technologies and related software competences as well as new business models. Furthermore, at the provincial or municipal level, further investments in R&D and implementations will be released as well.

Critics from outside China, among others, stress the (techno)nationalism. This is based, for example, on the following section in the MIC2025 strategy: "Build several innovation design clusters with international collaboration, cultivate industrial design enterprises, and encourage original equipment manufacturers (OEMs) to build R&D centers to transfer knowledge to **domestic brands**".[26] A report by the European Chamber of Commerce in China points out: "The appearance of ‘indigenous innova-

23 see also: https://www.iotone.com/guide/iot-one-index-made-in-china-2025/g988

24 http://www.chinadaily.com.cn/business/2017-10/12/content_33165546.htm

25 http://en.people.cn/n3/2018/0426/c90000-9453646.html

26 http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm [translation by IoT-ONE; emphasis added].

tion' – along with mentions of the need to realise 'self-sufficiency' – is particularly concerning – it suggests that Chinese policies will further skew the competitive landscape in favour of domestic companies" (European Chamber 2017: 1). In addition, there are also explicit goals of local content that need to be met, according to the plan. In the year 2020 about 40% of essential parts and materials should stem from domestic sources and until 2025 this share should rise to 70% (Wübbeke et al. 2016). This is an intention of import substitution, which as such is not condemnable, but the fear by most foreign spectators is that this will be achieved by massively biased market interventions in favour of Chinese enterprises.

3.3 The Belt and Road Initiative

The Belt and Road Initiative (BRI) was first mentioned by president Xi Jinping in 2013 during different visits to Central and Southeast Asian countries. The aims are high: "The connectivity projects of the Initiative will help align and coordinate the development strategies of the countries along the Belt and Road, tap market potential in this region, promote investment and consumption, create demands and job opportunities, enhance people-to-people and cultural exchanges, and mutual learning among the peoples of the relevant countries, and enable them to understand, trust and respect each other and live in harmony, peace and prosperity."[27]

In its core it is a huge infrastructure project that aims at setting up new trade routes from China to Europe, Africa, and also to Central and South America (Pacific area). As it will pass countries that were part of the ancient Silk Road, it is sometimes also called "New Silk Road Initiative"[28]. The main aim is to increase prosperity by trade and collaboration along the different routes of the Silk Road. This, however, does not only cover goods and commodities, but explicitly also information (Information Silk Road!) – information infrastructure like optical cables is an essential part – or services. Geographically it has one axis and two wings, as the Chinese call it. The axis is the connection of China with Central and South-East Asian countries down to Oceania. The west wing is the route to Europe and Africa, while the East Wing is the maritime connection to Central and South America. However, the Chinese government invites any interested country to join by keeping the concept open and flexible. The BRI consists of two segments, namely the land route, which is called the Silk Road Economic Belt, and a number of sea routes, called the Maritime Silk Road. In consequence, the infrastructure covers new roads, train tracks, or logistic centres and everything that is connected

27 http://en.ndrc.gov.cn/newsrelease/201503/t20150330_669367.html

28 http://china.org.cn/opinion/2014-06/26/content_32776912.htm

to it (bridges, power supply etc.). The Maritime Road mainly means building and modernising of harbours.

To achieve mutual benefits for countries along the Silk Road and China, collaboration and exchange in different dimensions – NDRC calls them 'cooperation priorities – is foreseen. These are policy coordination, connectivity of facilities (infrastructure), unimpeded trade, financial integration and people-to-people bonds, where the latter comprises of student, personnel, academic and cultural exchange and collaboration. The offer to sign trade agreements with the partners along the New Silk Road is made by the Chinese government as well as cooperation in emerging industries. The joint exploration of natural resources is addressed, but also the joint development of the use of renewable energies.

The megaprojects are mainly developed by Chinese state-owned enterprises, but according to a recent Deloitte report (Xu and Chen 2018), also foreign multinational enterprises are able to benefit from the huge infrastructure projects, among them Siemens, General Electric, or ABB, to name a few. The Chinese government does not only plan and develop the projects, but also offer the funds to finance them, mainly by loans via the four big state-owned commercial banks in China (Bank of China, China Construction Bank, Industrial and Commercial Bank of China, Agricultural Bank of China) the China Development Bank, an extra Silk Road Fund, or also the Asian Infrastructure Investment Bank (AIIB). Current estimates expect investments of 4-8 trillion USD for the whole BRI (Xu and Chen 2018). The Silk Road Fund contains 40 billion USD and the AIIB reserved a budget of 100 billion USD for the BRI project (Yu 2017). Deloitte (Xi and Chen 2018) provided statistics according to which these two funding sources covered about 2% of the loans and private equity investments for BRI by the end of 2016, while the big four Chinese banks as well as the China Development Bank provided almost 90% of the funds.

The connection of the BRI to research and innovation policy is only of indirect nature, but several aspects are clearly relevant also in this context. First, in the first dimension the initiative foresees the policy coordination between the countries along the Silk Road, which might also cover R&I policy. The Belt and Road Summits that were held annually since 2015 had not yet explicitly contained sessions for research or innovation. The topics as such are present in the discussions anyway. Second, academic and student exchange is one of the aims covered by the fifth dimension (people-to-people bond). Third, and most importantly, the infrastructure projects will use and develop innovative technologies.

While the positive aspects of the BRI are obvious, and the Chinese officials strictly emphasise the openness and collaborative approach of the BRI, still critiques arose. "Many […] participant countries have doubts and fears about issues in sovereignty, autonomy, local employment, distribution of budgets, and the general returns on investments" (Yu 2017: 7). One of the critical points is the fact that China does mainly develop the projects along its own interests - which might or might not overlap with the interests of the partner countries. The new government of Malaysia, for example, has recently withdrawn from the BRI, stating that the foreseen projects are not in the interest of the country. In addition, the countries along the Silk Road might not sufficiently benefit not only from the building of the infrastructure, but also from the use. For example, Kazakhstan or some other countries in Central Asia, where a new train track to Europe passes by, cannot put own containers with own goods and commodities on the trains as they are already fully loaded.[29]

Second, as the Chinese companies not only develop the project, but also provide the funding to realise them, they also dictate the conditions for the projects. These conditions force – more often than not – the local partner to sign a contract with a Chinese company that then conducts the projects or individual lots. In case of Europe this directly violates the procurement rules in the European Union, given that there are no equal chances of tenderers and no open competition (Yu 2017). In extreme cases, China defines the project, offers the loans at favourable conditions and at their own terms, conducts the work with Chinese (state-owned) enterprises, and finally, exclusively uses the newly built infrastructure. This is one reason to argue that BRI is an implementation of Chinese imperialism.

Another reason is that also political interests might be put forward, for example in case of Eastern Europe. China set up the so-called 16+1 collaboration with 11 Eastern European EU member states and five Balkan countries, among them accession countries to the EU.[30] The Chinese infrastructure investments in Bosnia, for example, sum up to almost 4 billion USD for the period 2012-2016. In the Czech Republic it was more than 3 billion USD and in Romania and Serbia it was more than 2 billion. Hungary, Montenegro and Macedonia received more than one billion USD in Chinese investments under BRI (Xu and Chen 2018). While several European countries are sceptical about the Chinese intentions and the dependency that might occur because of the debts that come along with the loans, Eastern European countries see the opportunities for a

29 China Contact 5/6 2018: Wildes Zentralasien, OWC-Verlag; https://owc.de/epaper/chinacontact-5-6-2018/

30 http://ceec-china-latvia.org/about

considerable improvement of their infrastructure. In consequence, there is a political divide in the European Union. The fact that the political system in China is considerably different from the one in Europe comes on top.

Third, the fact that Chinese companies develop and conduct the projects might also mean that Chinese technologies and Chinese standards are used throughout the partner countries. In this way, they might broadly spread across large parts of the world and define the de facto standards with which others need to comply. Especially in countries without own technological capabilities, the threshold to accept Chinese technologies might be low. In Africa or Central Asia, Chinese enterprises find markets for their technologies and products, which would so far still fail on Western markets. These enterprises thereby climb up the learning curve, achieve economies of scale, and set de facto standards in certain branches or technologies. An example where this strategy was already successful is the railway transport sector. A similar approach might work in other sectors as well.

The motivations behind BRI are mainly economic in nature. China intends to develop new markets for its products and technologies. At the same time, China needs to stay on the growth path of the past years. Moreover, that past growth considerably built on infrastructure investments, for example in the case of R&D. While R&D expenditures in developed countries are mainly covering the remuneration of scientists and researchers, the majority of the R&D expenditures in China were on R&D infrastructure and equipment. BRI is a way to extend this infrastructure investment model as a basis of economic growth. "China should not automatically assume that the growth through gigantic infrastructure investments, which drove China’s economic success in the past, is a panacea and embraced by all stakeholders" (Yu 2017: 7).

4 Current reforms of the R&I funding and the governance of the innovation system at the central level

4.1 Changes of the previous system

In an academy-oriented science system like it still prevails in China, a traditional focus on basic research especially in natural sciences can be found. In the past 10 to 15 years the Chinese system, however, more and more focused on application-oriented fields as well as engineering, in particular. From the perspective of Chinese policy makers, these areas were more important for catching up and developing the national innovation system. Basic research was – and still is – mainly funded by the National Natural Science Foundation of China (NSFC). In addition, the Chinese government

initiated the so called 863 Programme for the funding of high-tech fields already in the mid 1980s, originally in areas like biotechnology, space or materials research, and in particular information technologies. Beneficiaries of this programme were not only universities, but also non-university research organisations like the Chinese Academy of Sciences. Furthermore, the big National Basic Research Programme, the so called 973[31] Programme was dedicated[32] to universities, scientific institutes and registered companies in mainland China, but it essentially also funded several application oriented research projects, even though it was originally tailored to address basic research. Although both programmes were rather successful and were evaluated positively, they were discontinued in 2014, when the Chinese government started to re-organize[33] the national S&T funding scheme (Huang et al. 2016; Development Solutions Europe 2018; Schüller and Schüler-Zhou 2017), including more than hundred previously existing programmes next to 863 and 973. The main aims of this reorganisation are higher effectiveness and even more so a higher efficiency. This will be achieved, so the ideas underlying this reform, by clear evaluation rules and independent evaluation processes. It is implemented via funding agencies that act like project management agencies. The previously decentralised programming and especially funding decisions are now put together in these agencies, which are coordinated by a joint inter-ministerial council uniting all relevant public funding bodies. Under this organisational umbrella, currently seven (originally planned were eleven so more might still follow) new project management agencies were installed to implement and manage the programmes. In addition, the joint council will also set up joint evaluation rules and processes, both of the applications as well as of ex-post of the projects and programmes themselves.

It seems that this change of the funding system is just one of the steps of which more can be expected as Chairmen Xi Jinping pointed out in his speech at the 19th Party Congress in October 2017: "We will strengthen basic research in applied sciences, launch major national science and technology projects, and prioritize innovation in key generic technologies, cutting-edge frontier technologies, modern engineering technologies, and disruptive technologies."[34]

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31 http://www.most.gov.cn/eng/programmes1/200610/t20061009_36223.htm

32 https://www.access4.eu/_media/MoST1_NationalBasicResearchProgramme_973Programme_new.pdf

33 http://www.gov.cn/zhengce/content/2015-01/12/content_9383.htm

34 http://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-11/04/content_34115212.htm

4.2 The governance of the R&I system

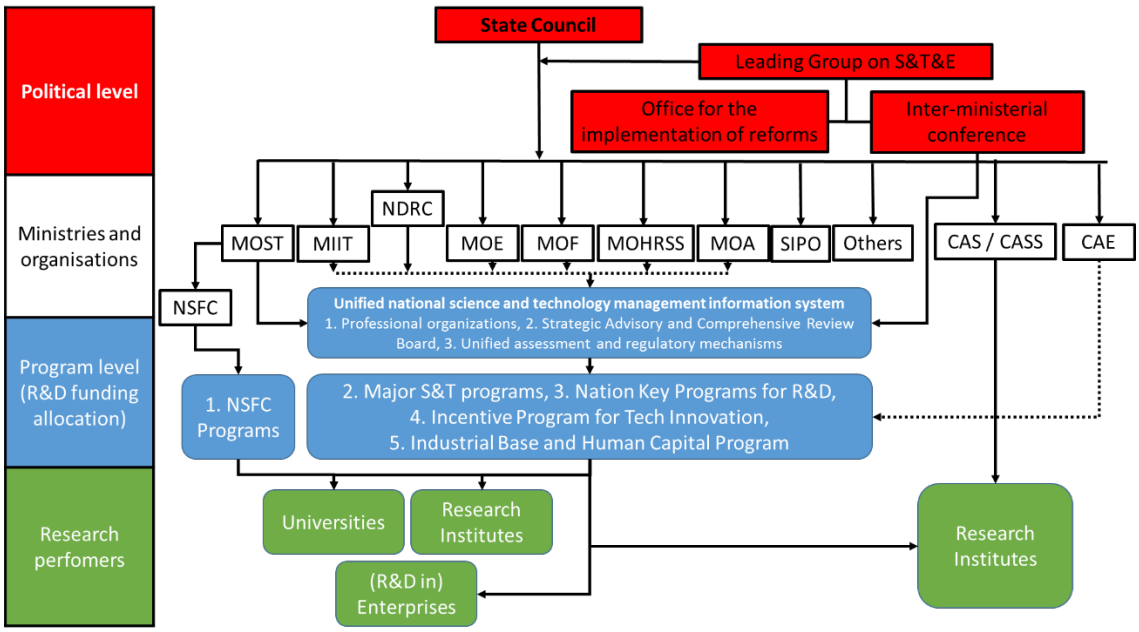
The main responsibility also in questions of research and innovation in China is with the State Council. It presides over the other ministries and it coordinates their activities to some extent. The National Development and Reform Commission (NDRC) plays an extraordinary role within the group of ministries as it acts directly under the State Council and oversees the economic developments and, among other activities, drafts and monitors the Five-Year-Plans. It also pursues direct policies, for example like the Internet Plus strategy. The Ministry of Industry and Information Technology (MIIT) is responsible for communication infrastructure as well as the IT industry. It plays an outstanding role in the rejuvenation of the Chinese economy as it manages the Made in China 2025 strategy.

The layout of and the relations between the ministries have hardly changed in the recent years in the organigram, but responsibilities as well as budgets have been altered. In addition, the role of 'small leading groups', which are mostly inter-ministerial coordination groups and part of the Party organisation, have gained importance in the recent past. Since a couple of years the reform[35] of the science system is underway (Huang et al. 2016), which led to increased responsibilities and budget of the Ministry of Science and Technology (MOST). The funding system was already reformed and the funding programs are united in currently seven commissions under Inter-ministerial Conference, which are administratively attached to MOST, with the aim of increasing the efficiency and coordination and to avoid duplicate research.

Since March 2014, for example, a national S&T reporting system is in operation that collects all research reports of publicly funded projects in a standardised format. The information is collected, on the one hand, to support researchers in defining their research topics and to provide them a starting point for their own research, reflecting on the research status in the particular topic. On the other hand, the information is also used in the evaluation phase of the project applications to avoid duplicate research projects that might fall back to what is already the current state of the art. This task is fulfilled by the Institute for Scientific and Technological Information of China (ISTIC), a research institute in the direct downstream of the MOST.

35 http://www.gov.cn/zhengce/content/2014-03/12/content_8711.htm; http://www.most.gov.cn/tpxw/201501/t20150106_117285.htm

Figure 2: Layout of the science and innovation governance structure



Source: own representation based on: OECD (2008: 429); Huang (2016: 23-24); Schüler-Zhou and Schüller (2016); Mu (2014); McCuaig-Johnston and Zhang (2015)

One of the critics of the previous system addressed the potential of corruption due to the intransparent granting and evaluation processes (Cao et al. 2013). The separation of program ownership and evaluation of projects was established by the introduction of project management agencies that manage the programs, separated from a commission that grants the projects and an evaluation system that assesses the outcomes. The project management agencies are under the supervision of MOST and the granting commissions are fuelled by the individual ministries or related experts. A joint inter-ministerial commission/conference coordinates and sets the operational rules (Schüller 2018; Schüler-Zhou and Schüller 2016). "… [T]he reform unveiled in December 2014 by the State Council, focus[es] in particular on the new institutional layout and management structure, where a newly-emerged inter-ministerial joint council acts as general coordinator among tens of government bodies, and where the daily operations of funding programmes are delegated to a series of professional agencies, through a unified and comprehensive information management system" (Development Solutions 2018: 6).

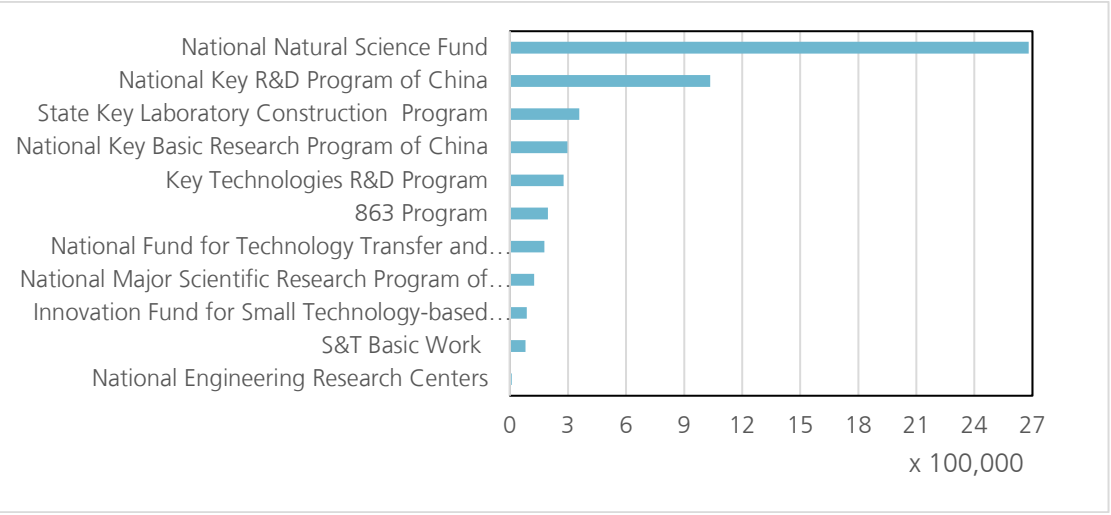
Following the re-appointment of Xi/Li administration at the People's Congress in March 2018, the responsibilities of MOST further increased. The National Natural Science Foundation (NSFC) as well as the State Administration of Foreign Experts Affairs

(SAFEA) are now annexed under MOST.[36] It is expected that the attraction of foreign talents and researchers will gain importance in the future, though these were already addressed, for example with the 1,000 Talents Program for oversea returnees in the last decade. Concerning the inclusion of NSFC in MOST, on the other hand, is a signal that the already announced policy to increase the importance of basic research will be under the responsibility of MOST. Whether the independence of the NSFC in scientific terms will suffer from this reorganization is unclear yet, but the most probably not. The intention of the overall reform of the funding system is to set common rules and procedures to increase the efficiency and transparency. As the project management agencies are administered by MOST, it is just consequential to add NSFC as well.

The government funding of S&T under this new governance structure and following the new rules was just finished by 2017. Data for the appropriation of budgets are not yet available for 2017. Some of the new programs, however, already started earlier and are mentioned in official statistics like the National Key R&D program as well as the fund for technology transfer (see Figure 3). The 863 Program or the National Key R&D Program of China, for example, still appears, but they will merge into the National Key Programs for R&D. For the next release of the statistical data, a reflection of the new structure will appear. The NSFC budget is by far the largest individual position in the list of appropriations. The budget almost doubled compared to 2011 to a level of about 27 billion yuan (3.5 billion €). For the years 2017/2018, a further increase will be visible in the statistics. Currently, all the other appropriations for S&T in the listed programs sum up to about the same as the NSFC budget. Institutional funding, however, like the CAS or the universities, are not included in these statistics.

36 https://www.natureindex.com/news-blog/chinas-science-ministry-gets-power-to-attract-more-foreign-scientists

Figure 3: Appropriation for S&T by Central Government in the main programs of S&T, 2016 (latest available year)



Source: S&T Statistical Yearbook (NBS and MOST 2017).

In March 2018 MOST minister Wan Gang's second term ended and a new minister, Wang Zhigang, was appointed. Wang Zhigang is the former vice minister and Party Secretary of MOST. On the one hand, this signals continuation in the policies and the management of the ministry. On the other hand, this reflects the increased role of the Party at the ministerial level. While Wan Gang was a renowned researcher and engineer before he took office and not member of the Party, all leading positions within MOST are now occupied by members of the CPC.[37]

4.3 The reform of the CAS

The Chinese Academy of Sciences is seen as a governmental entity similar to a ministry and also the president of the CAS enjoys ministerial status. The CAS is therefore self-dependent on reforming its structures. In the late 1990s the CAS already started a reform where it had sharpened its mission and restructured the portfolio of institutes (Suttmeier et al. 2006; Xu and Li 2016). Within the Knowledge Innovation Program (KPI) that lasted from 1998-2010 some institutes were closed, some were privatised and the others were strengthened to meet the aims of the raising Chinese economic and political demand for a strong science system within a National Innovation System as it was intended by the State Council to be built by then. The reforms were successful and the CAS is nowadays the largest public research organisation in China. The CAS unites 104 institutes in very different disciplines and covers the full range from

37 http://www.most.gov.cn/eng/organization/leadership/

basic to applied sciences. It has more than 64,000 employees, files large numbers of national and transnational[38] patent applications every year and is responsible for large numbers of scientific publications.

When CAS President Bai Chunli took office in 2011 he initiated the so called Innovation 2020 programme. It shall be finished by 2021. Similar to the overall reforms in the science system, also this reform aims at increasing the effectiveness and efficiency of the Academy and its institutes as well as widening the evaluation criteria (Cao et al. 2013: 462). The (still ongoing) reform changes the criteria for assessment and evaluation from mainly output indicator based measures (publications) to indicators like innovativeness and contribution to society.[39]

With the Innovation 2020 programme, the CAS also introduced what they call the 'strategic niche', differentiating the institutes into four categories with different strategic aims and perspectives. The four categories are: basic research-oriented centres of excellence, institutes focusing on applied research and commercialisation, big science centres, and finally regional-oriented institutes. Therefore, within the CAS the institutes will be differentiated according to different missions in the science system, which will then be monitored by particular performance indicators.

5 Concluding remarks: Chinese policies and European strategies

The Chinese research and innovation system has considerably changed in the past 10-15 years. It was adapted to new needs and demands, emerging from the overall economic success, but also from external requirements for structural changes like digitalisation, new technologies or global economic framework conditions. The guiding idea of the induced changes and reforms is, on the one hand, to turn China from a low-cost economy to an innovation-driven economy. This is seen as the next evolutionary step for the further economic development and to overcome the so called middle-income trap. Efficiency/productivity as well as quality are seen as the vehicles to achieve this goal. On the other hand, next to the economic stability also the social and political stability with the absolute claim of power by the Communist Party is a core task that also affects research and innovation.

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38 Transnational patent applications are defined as patent families with at least a PCT or an EPO family member (Frietsch, Schmoch 2010). These patents are targeting international markets and best correlate with R&D expenditures (Frietsch et al. 2017).

39 See http://english.cas.cn/about_us/introduction/201501/t20150114_135284.shtml

In governmental documents and public speeches the role of the market is repeatedly emphasised. It should be clear by now, however, that Chinese officials do not mean a market-liberal economic system, but a semi-capitalist economic structure with a strong and active role of the state and explicit socialist elements. They call this the 'Chinese Way', which is neither the one nor the other, but a 'modern socialist country' as President Xi called it at the 19th party congress in October 2017.

Over the past two decades of the Chinese enormous economic growth, the true belief of several Western spectators and policymakers was that China enters the Western development path (Fukuyama 1992). According to the role model of other Asian countries like Japan, Singapore, or also the area of Taiwan, it was expected that China's economic development would be similar. Moving from labour to more capital-based production and also moving from imitation to innovation strategies, with all its consequences, for example like the adoption of Western intellectual property rights, standards and norms, and even societal organisations, was foreseen. Many scholars (Fukuyama 1992; Minzner 2018) and policymakers expected China to become a capitalist market economy as well as the implementation of political reforms – some even anticipated a democratisation of China. In this perspective, the deviance from this Western role model was just a temporary phase of 'not-yet-developed' institutions.

However, there were also always scholars and spectators who took a different position. China has been considerably different from the West as well as from other industrialised countries in Asia – and China will be different at least for the coming years. "… China should not be analysed in the same way as developed, free-market, capitalist national economies because, simply put, it is not free, capitalist, or, as a matter of fact, truly national." (Breznitz and Murphree 2010: 9). So on the one hand, in Western countries it is time to wave good-bye to the ideas that China assimilates. On the other hand, also the idea of the modern economic Eldorado in Asia – the land of gold – that provides the world with low-cost products and buys high-tech goods from Western companies is also over. Sooner than later, the Chinese market will be the largest national, homogenous market in the world. And it will keep on growing for a while, at least what can be seen from today's perspective – at least as long as the debt crisis does not surface. Chinese industry will improve its competitiveness in several sectors in the coming years – nationally and internationally. The core question is, if they will do it with fair or unfair means. Without any doubt, it is important to insist on fairness and non-discrimination. At the same time one should be prepared for unfairness and discrimination – or simply stop doing business in China.

The nowadays by Westerners often demanded 'level-playing field' not only means that China needs to accept and implement internationally agreed rules and institutions –

which is for sure a legitimate demand. Even more so, it means that Westerners accept the differences and that the Chinese Way and the Chinese market economy will not be the same like in Europe or North America. This insight and the acceptance, by the way, then also offers a better strategic acting. Waiting for the day when China assimilates was never a reasonable option. Reported challenges are - like in previous years - intellectual property issues as well as finding and keeping qualified personnel.

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